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THE GEOLOGY OF THE TAROOM 1:250,000 SHEET AREA AND OF THE WESTERN PART OF THE MUNDUBBERA 1:250,000 SHEET AREA, QUEENSLAND.

by

A.R.Jensen, C.M.Gregory and V.R.Forbes.*
*(Geological Survey of Queensland).

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THE GEOLOGY OF THE TAROOM 1:250,000 SHEET AREA AND OF THE WESTERN PART OF THE MUNDUBBERA 1:250,000 SHEET AREA, QUEENSLAND.

SUMMARY

This report describes the geology of the Taroom 1:250,000 Sheet area and the western third of the Mundubbera Sheet area, which were mapped during 1963 by a joint Bureau of Mineral Resources - Geological Survey of Queensland field party. The area lies at the southern end of the exposed Bowen Basin, and at the northern end of the Surat Basin, about 250 miles north-west of Brisbane. The Permian-Triassic Bowen Basin sequence, in part intruded by the Auburn Complex, is overlain with angular discordance by the Lower to Middle Jurassic Surat Basin sequence.

The Permian Triassic sequence consists of a basal volcanic unit, the Camboon Andesite, which is overlain by the marine Back Creek Group, and this in turn is overlain by a thick sequence of continental clastics. The Camboon Andesite, whose thickness although unknown could be of the order of 10,000 feet, includes within it those volcanics formerly named the Cracow Volcanics. The unit is intruded by the Auburn Complex. The Complex may be in part however, older than Permian, as granitic boulders in conglomerate of the Camboon Andesite attest to a pre-Permian granitic source area.

The Back Creek Group, equivalent to the Middle Bowen Beds in other parts of the basin, comprises the Buffel Formation, and the Oxtrack, Barfield and Flat Top Formations. The Lower Permian Buffel Formation which reaches a maximum exposed thickness of 640 feet, overlies the Camboon Andesite with probable disconformity. This unit was formerly mapped as part of the Oxtrack Formation, but it is a distinct formation having a slightly different lithology and being significantly older. The Upper Permian Oxtrack Formation which varies in outcrop thickness from 100 to 350 feet, is overlain conformably by the Barfield Formation (3000 feet), and this is overlain by the Flat Top Formation (1800 feet).

The Back Creek Group is overlain conformably by the Gyranda Formation (1,600 feet), which is the lowest formation in a sequence of dominantly terrestrial units. It is overlain by 800 feet of Upper Permian coal measures which are equated with the Baralaba Coal Measures. The coal measures are overlain by the Triassic Rewan Formation with no apparent angular discordance. The Rewan Formation,

which varies in thickness from 2,000 feet in the western part of the area to about 12000 feet in the eastern part, may contain a slight angular unconformity within it, but for the present it is regarded as one formation. It is overlain by the Clematis Sandstone which is about 1,000 feet thick. The Clematis Sandstone is conformably overlain by the Moolayember Formation of Middle to Upper Triassic age. The Moolayember Formation is 2,000 feet in its type area in the western part of the Taroom Sheet area, and about 4,500 feet in the eastern part.

All pre-Jurassic units in this area were subjected to weathering during the Upper Triassic and in some places remnants of the silicified regolith are evident. In the Cracow area the remnants form an exhumed peneplain.

The Lower and Middle Jurassic sequence of the area, comprising the Precipice Sandstone, the Evergreen Formation, the Hutton Sandstone, and the Injune Creek Beds, is about 1,800 feet thick. It unconformably overlies the Bowen Basin sequence, and consists mainly of fluvial and lacustrine deposits; but there are some indications of a short marine transgression into the area during the Lower Jurassic. The evidence for this is the presence within the Evergreen Formation of an oolitic chamositic rock, herein referred to as the oolite member. Apart from the fact that chamosite is normally regarded as being suggestive of marine conditions, the oolite member is invariably associated with hystrichospheres which also suggests a marine environment of deposition. In the western part of the area the oolite member is underlain by the Boxvale Sandstone member.

Tertiary rocks in the area consist of basalt interbedded with quartzose sandstone, and small patches of unconsolidated gravel and clay.

Gold has been mined in the Cracow area since 1931, and coal in the Injune area since 1933. The oolite member is a potential source of low grade siliceous iron ore if an economic beneficiation process can be devised. Seven exploration wells have been drilled in the area in search of petroleum, but no economic accumulations have been discovered. Good supplies of underground water, both artesian and non-artesian, have been tapped in many bores in the area.

INTRODUCTION

The Bureau of Mineral Resources, in conjunction with the Geological Survey of Queensland, commenced a programme of regional geological mapping in the Bowen Basin in 1960. As part of this programme the Taroom 1:250,000 Sheet area and the western third of the Mundubbera 1:250,000 Sheet area were mapped in 1963. This report and accompanying maps (Enclosures 1 and 2) summarize the results of the mapping in 1963.

The area mapped is in south-eastern Queensland, about 250 miles north-west of Brisbane and about 100 miles north of Roma. Of the three towns in the area, Taroom, Injune and Cracow, only Injune is a railhead. However, all three are linked with Brisbane by roads, sealed for much of the way. Good unsealed roads join Taroom, Cracow, and Theodore (a town to the north of the area) and an unsealed road, (the Carnarvon Highway), runs from Injune to Rolleston. The road from Injune to Taroom via Hornet Bank is in poor condition and crossings of the Dawson River are difficult for normal vehicles. Good access for four-wheel drive vehicles is provided by station tracks over much of the area, except in the northern part of the Taroom Sheet area, where tracks are few and the terrain is rugged.

Field work was done in the relatively dry winter months from June to October, by A.R. Jensen and C.M. Gregory of the Bureau of Mineral Resources, and V.R. Forbes of the Geological Survey of Queensland. Although each geologist mapped parts of most units the work was divided so that Jensen was mainly concerned with the Permian and Triassic sequence, Gregory with the Camboon Andesite, Auburn Complex, part of the Triassic and Jurassic sequence, and Tertiary basalt, and Forbes with the Jurassic sequence. Dr. Dickins, and Messrs. Malone and Perry visited the party and helped with the mapping.

Our thanks are also due to Shell Development (Australia) Pty. Ltd. for permission to use the mapping by J.B. Wooley in the Arcadia area. The Management of Mines Administration kindly allowed us to use Bouguer gravity results to compile figure 15.

In the field the geology was plotted at photo-scale (1:85,000) on transparent field sheets, the slotted template bases being supplied by the Division of National Mapping, Canberra. The six field sheets covering the area were reduced photographically to 1:250,000 scale to form the geological plate for the maps accompanying this report (Enclosures 1 and 2). The topographic base was compiled by C.M. Gregory and V.R. Forbes in Canberra prior to the field season. Photo interpretation maps of the Taroom Sheet area by V.R. Forbes, and the western third of the Mundubbera Sheet area by W.J. Perry, were prepared before the commencement of the field season.

At the end of the field season eight shallow holes (maximum depth 105 feet) were drilled in the Permian and Mesozoic sequence for stratigraphic information. Their positions are shown on the Mumdubbera map (Enclosure 2) and in Appendix C. A brief log of each hole is also given in Appendix C.

NOMENCLATURE

Crook's (1960) classification of arenites is followed in the text. The term labile is applied to those arenites in which quartz forms less than 75% of the total quartz-rock fragments-feldspar content; and if the proportion of quartz is from 75% to 90% the term sublabile is employed.

Siltstone is used as a grainsize term ($\frac{1}{16}$ mm to $\frac{1}{256}$ mm). The term 'mudstone' is used as a general term for sediments of the lutite class, and 'shale' is defined as a mudstone with a shaly or papery fissility.

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Terms used to describe stratification are those of McKee and Weir (1953).

TOPOGRAPHY

Great variation exists in the topography and altitude within the area mapped. The Expedition Range is rough and mountainous with peaks reaching nearly 2,400 feet above sea level. In contrast to this, the area around Taroom, flat country with very few hills, does not exceed 700 feet above sea level. For the purposes of description, five topographic units are recognized. Their characteristics are tabulated in Table 1, and their distribution is shown in Fig. 1.

TABLE 1.

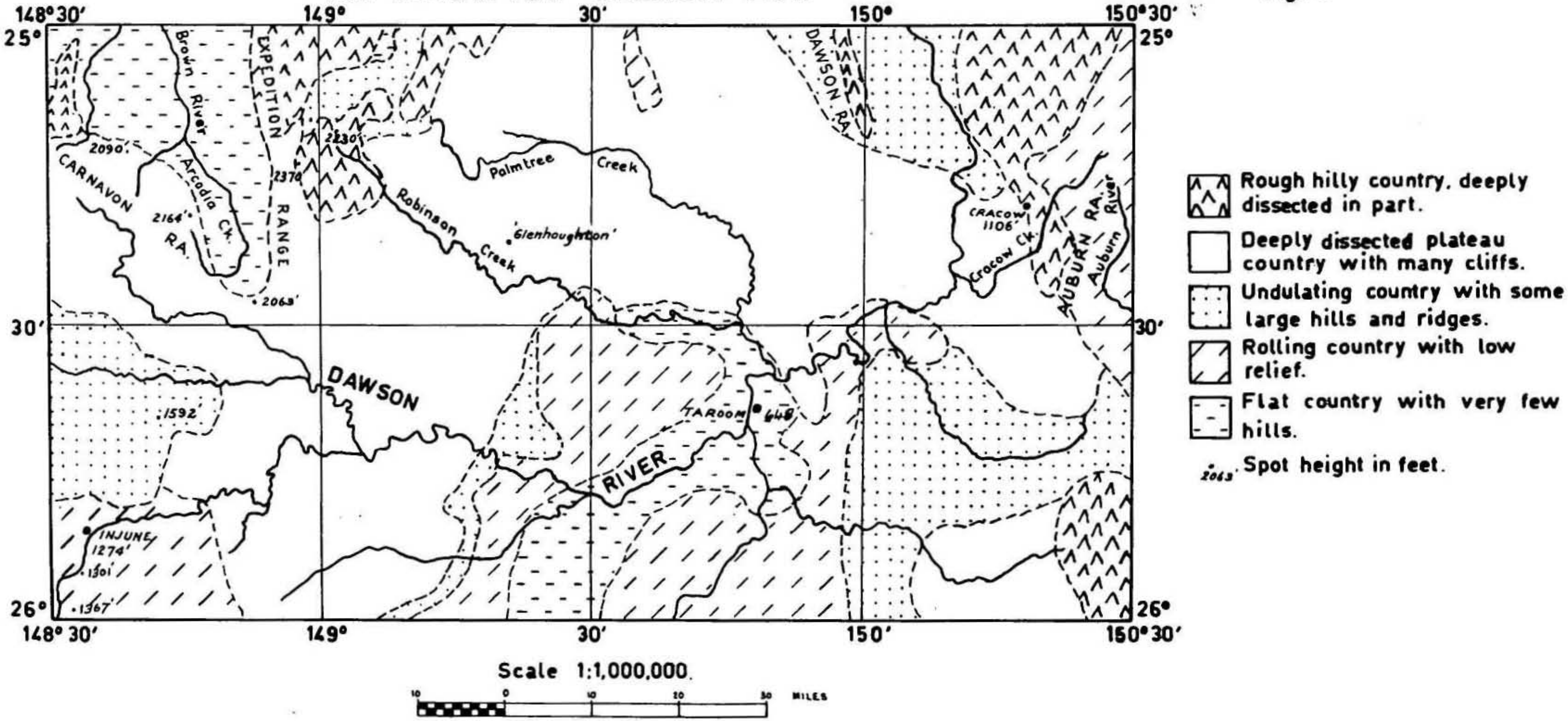
Type of Topography	Max. relief	Best development	Geological associations
Rough hilly country, deeply dissected in part, with steep-sided V-shaped valleys	500ft.	Expedition Ra.	Clematis Ss. Camboon Andesite Moolayember Fm.
Plateau areas with vertical cliffs.	300ft.	Carnarvon Ra.	Precipice Ss. Boxvale Ss. Member
Undulating country with large hills and some strike ridges.	500ft.	north-west of Cracow	Back Ck. Gp. Clematis Ss. Moolayember Fm. Hutton Ss. Gyranda Fm. Baralaba Coal Measures
Rolling country with low relief	150ft.	Auburn Ra.	Injune Creek Beds Auburn Complex Evergreen Fm.
Flat country with very low hills	50ft.	Arcadia Valley	Rewan Fm. Bandanna Fm. Injune Creek Beds

Three river systems drain the Taroom-Mundubbera area: (1) the Dawson River and its tributaries; (2) the Brown River; (3) the Auburn River. The Dawson River and its tributaries, drain most of the area. The Dawson rises in the Carnarvon Range and flows east across the area to where Cracow Creek joins it. It then flows north, eventually joining the Mackenzie River to form the Fitzroy River which flows into the sea near Rockhampton. The Brown River drains the very flat Arcadia Valley, and runs north to join the Comet River, a tributary of the Mackenzie. The Auburn River drains the Auburn Range and flows east to join the Burnett River at Mundubbera.

Shallow lakes, confined to the outcrop of the Hutton Sandstone, are common along Palmtree and Robinson

TOPOGRAPHIC SKETCH MAP

Fig. 1.



Bureau of Mineral Resources, Geology & Geophysics. February 1964. To accompany Record 1964/61 G55/A8/8

Creeks. They are not normally connected to the main streams except during floods, when the water in the lakes is replenished. During most of the year the only loss of water from these lakes, which are up to a mile wide, is by evaporation and slight seepage and as a result the water becomes brackish. The lakes have formed behind levees created by the main streams, apparently because of the streams' inability to carry the vast loads of sand derived from the erosion of the soft Hutton Sandstone.

Lake Nugga Nugga is a shallow lake with a maximum width of three miles, covering about five square miles in the northern part of the Arcadia Valley. It is possibly formed by the damming of the Brown River behind alluvium brought down by Moolayember Creek.

GENERAL GEOLOGICAL SETTING OF THE AREA

The area mapped lies at the southern end of the exposed Bowen Basin. In this area it is overlapped by the Surat Basin a lobe of the Great Artesian Basin. The Surat Basin sequence of Jurassic and younger sediments unconformably overlies the Permian-Triassic sequence of the Bowen Basin. A summary of the stratigraphic units in the area is given in Table 2.

PREVIOUS INVESTIGATIONS

GEOLOGICAL.

L.C. Ball (1924) investigated a report of oil seepages at Cockatoo Creek and found outflows of coal gas. He reported that flat bedded sandstone crops out in Cockatoo Creek, 7½ miles east of Cockatoo Homestead, and contains small molluscs identified as Unio and fragments of Thinnfeldia. He placed the sandstone in the Bundamba Series, giving it an Upper Triassic age.

The first regional geological report in the district was that by H.I. Jensen (1921a, 1926a), describing the geology of the area between Roma, Springsure, Tambo and Taroom. This included most of the Taroom 1:250,000 Sheet area and the western part of the Mundubbera 1:250,000 Sheet area. This is a long report which is divided into five parts, B and D dealing with the Taroom-Mundubbera area under discussion. Jensen split the Jurassic Walloon into Upper, Middle and Lower, and the Triassic into the Bundamba, Ipswich and Clematis Formations in the Taroom area. In the Cracow area he mapped Auburn River Complex, Undifferentiated Volcanics, Lower Bowen, Permo-Carboniferous, Clematis, Ipswich, Bundamba

TABLE 2

SUMMARY OF STRATIGRAPHIC UNITS - TAROOM-MUNDUBBERA AREA

Age	Formation	General lithology	Stratigraphic Thickness in Outcrop	Fossils	Relationships	Probable depositional environment
Tertiary		Unconsolidated gravel; clay	up to 90'	-	Lies unconformably on Palaeozoic and Mesozoic units	Fluvial
		Basalt, olivine basalt, vesicular basalt, quartzose sandstone	50' - 100'	-	Lies unconformably on Palaeozoic and Mesozoic units	Terrestrial
Middle Jurassic	Injune Creek Beds	Calcareous labile and sublabile sandstone	500	Plants, spores	Apparently conformable on Hutton Sandstone	Paludal
Lower to Middle Jurassic	Hutton Sandstone	Sublabile lithic sandstone, siltstone, claystone.	400-550	Small pelecypods plants, spores	Conformable on Evergreen Formation	Fluvial or lacustrine
	Evergreen Formation	Labile and sublabile sandstone, mudstone, argillite siltstone, shale, coal	400'-540'	Plants, spores, pelecypods	Conformable on Precipice Sandstone	Fluvial and shallow water marine
	oolite member	Oolitic or pelletal limonite	20'-30'	Plants, pelecypods, spores hystrichospheres	Member within the Evergreen Formation	Shallow water marine
Lower Jurassic	Boxvale Sandstone Member	Quartzose sandstone	30'-150'		Member within the Evergreen Formation; when present it lies conformably below oolite member.	Deltaic and possibly lacustrine.
	Precipice Sandstone	Quartzose sandstone, siltstone, argillite	100'-400'	Spores, plants	Unconformable on Permian and Triassic units	Fluvial
Middle to Upper Triassic	Moolayember Formation	Mudstone, lithic sandstone, sublabile lithic sandstone conglomerate, carbonaceous shale, tuff.	2000-4500'	Plants, spores hystrichospheres	Conformable on Clematis Sandstone	Fluvial, possibly lucustrine in part.
Triassic	Clematis Sandstone	Sublabile lithic sandstone, quartzose sandstone, sublabile feldspathic sandstone, volcanic pebble conglomerate, siltstone, mudstone.	800-1000'	Spores, plant fragments.	Conformable on Rewan Formation	Fluvial
Lower Jurassic	Rewan Formation	Brown mudstone, lithic sandstone, conglomerate	2000'-12000'	Plants	Basal part conformable on Baralaba Coal Measures or equivalents. Slight angular unconformity within the formation in the Arcadia area	Terrestrial, in part certainly fluvial; ?aeolian
	Brumby Sandstone Member	Conglomeratic coarse lithic sandstone	15'		Member of the Rewan Formation	Fluvial
	Baralaba Coal Measures	Feldspatho-lithic sandstone, carbonaceous mudstone, coal.	650'-800'	-	Conformable on Gyranda Formation	Paludal, fluvial
	Gyranda Formation	Mudstone, lithic sandstone, tuff, minor conglomerate	1600'	Plants	Structurally conformable on Flat Top Formation	Fluvial
Upper Permian	Flat Top Formation	Mudstone, argillite, tuffaceous siltstone	1800	Marine shelly fossils	Conformable on the Barfield Formation	Marine -
	Oxtrack Formation	Fossiliferous limestone, calcareous siltstone, silicified limestone	100'-350'	Marine shelly fossils	Disconformable on Buffel Formation	Marine - shallow water
Lower Permian	Buffel Formation	Fossiliferous limestone, silicified limestone.	30'-640'	Marine shelly fossils	Probably disconformable on the Camboon Andesite	Marine - shallow water
Palaeozoic	Camboon Andesite	Andesite, dacite, pyroclastics, rhyolite, conglomerate	Unknown could be 10,000'	Plants	Intruded by Auburn Complex	
?Palaeozoic		Metaquartzite,	Unknown		Intruded by Auburn Complex	

and Walloon. He described the lithology of each unit and associated soils, topography, and vegetation.

The discovery of gold in 1931 at Cracow and subsequent mining led to many geological investigations of the mine and the area surrounding the mine. Published reports include L.C. Ball (1931), A.K. Denmead (1931 to 1946), J.H. Reid (1931b), J.H. Brooks (1959 and 1960), M.H. Bonner (1952), and J.V. Buley (1953).

Geological surveys of the western part of Taroom 1:250,000 Sheet area were carried out by Oil Search Ltd. from 1933 to 1939, resulting in reports by F. Reeves (1935, 1936a, 1936b), Reeves and Condit (1935), Condit (1936), and F.W. Whitehouse (1935a, 1935b, 1936, 1938). These investigations led to a better understanding of the Triassic and Jurassic sequence in this area, the delineation of two structures, and the subsequent drilling of two wells, (at Arcadia and Hutton Creek). Reeves (1947) summarized the results of oil exploration in the area.

Shell (Qld.) Development Pty. Ltd. commenced geological investigations in an area west and north-west of the Taroom 1:250,000 Sheet area in 1940. In 1942 part of the western third of the Mundubbera Sheet area was examined, in particular the Permian sequence. This area was later (1954), mapped in greater detail by J.E. Glover, S.S. Derrington and K.H. Morgan. Formal names resulting from this mapping were published in 1959 (Derrington S.S., Glover J.E., and Morgan K.H., 1959).

Since 1959 the results of further oil exploration by private companies in the Taroom-Mundubbera area, have been recorded in many unpublished reports, (Traves D.M. 1959; Webb E.A. 1961; Laing A.C.M. 1961; Williams G.K. 1962). Private companies have investigated coal prospects (King 1961) and a low grade iron ore deposit (Urquhart G. 1962).

GEOPHYSICAL

Much of the area mapped has been investigated by geophysical surveys, subsidized in many cases by the Commonwealth Government, in connection with the search for petroleum. The areas covered by aeromagnetic, seismic, and gravity surveys are shown in Figs. 14 and 15.

Figure 15 shows both gravity and aeromagnetic survey results. Most of the gravity measurements were made in the western part of the Taroom Sheet area. The aeromagnetic results are those obtained by Union Oil Development Corp. (1963a). The Bureau of Mineral Resources has also made an aeromagnetic survey of this area, but final results are not yet available.

The area covered by seismic surveys is shown in figure 14. The seismic reflections shown are mainly from Upper Permian coal measures.

DRILLING FOR OIL AND GAS.

Seven wells have been drilled in the search for petroleum in the area mapped, and many more in areas immediately adjacent. The position of each well is shown in figure 2, and the lithological and electrical logs are presented in Enclosure 3, and a general summary of each is presented in Table 3. None of the wells encountered commercial quantities of oil or gas.

The first two holes in the area mapped were drilled by Oil Search Limited between the years 1935 and 1938. Hutton Creek well (OSL No. 2) was commenced with a cable tool plant in October 1935, and drilling was discontinued at 3,715 feet. The drilling of Arcadia (OSL No. 3) was commenced with the same plant, and this hole was taken to 4,110 feet before reaching the limit of the rig. Drilling of the Hutton Creek well was resumed in 1938 using a rotary plant, and after the well was abandoned dry at 4,688 feet, the plant was transferred to the Arcadia structure where that hole was deepened to 6,025 feet. Some flows of gas mainly carbon dioxide were encountered. One million cubic feet of gas per day flowed for a period of eighteen hours when the well was tested in 1957, and subsequently the well was permanently plugged. During 1957, Associated Australian Oilfields drilled another well on the Arcadia structure (AAO No. 7) to a depth of 3,280 feet, and this well was dry.

The next two holes drilled in the area, UKA Burunga No. 1 and UKA Cockatoo Creek No. 1, are located on the Mundubbera Sheet area. Burunga was commenced in July 1962 and finished in September of that year, with only a number of small hydrocarbon shows being reported. Cockatoo Creek No. 1 was spudded in November 1962, and abandoned as a dry hole, in April, 1963.

In the following month, Planet Exploration spudded Warrinilla No. 1 in the north-western corner of the Taroom Sheet. The well, which reached a depth of 6,701 feet encountered no commercial oil or gas.

The most recent well in the area, Glenhaughton No. 1, was drilled by Marathon Petroleum late in 1963 and early 1964. Its location is shown in figure 2. No shows were recorded in this well which was plugged and abandoned.

Completion reports of all subsidized wells are available at the Bureau of Mineral Resources six months after the A.G. release date.

TABLE 3.
EXPLORATORY OIL WELLS DRILLED ON AREA MAPPED

Name of Well	Latitude	Longitude	Commenced	Finished	Operator	Plant	Subsidized	Total Depth	Hydrocarbon Shows	Status
Hutton Creek (O.S.L.No. 2.)	25°42'S	148°42'E	5/10/35	29/10/38	Oil Search Ltd	Percussion and rotary	No.	4688'	13,000cfd Oct 2,325 3% CO_2, 89% CH_4. Inert gas 8%.	Abandoned
Arcadia (O.S.L. No.3.)	25°17'S	148°45'E	Aug.,'36.	Dec.,'39	Oil SearchLtd	Percussion and rotary	No.	6036'	Many shows of gas. Above 2030ft. gas was mainly CH_4, below 2030ft. mainly CO_2. From 1187ft. 250,000cfd 2670ft. 2,300,000cfd.	Abandoned
Arcadia (A.A.O. 7.)	25°18'S	148°48'E	8/4/57	14/7/57	Associated Australian Oilfields N.L.	Rotary	No.	3280'	Nothing significant	Abandoned
Warrinilla No. 1.	25°07'S	148°33'E	12/5/63	18/7/63	Planet Exploration Co.Pty.Ltd.	Rotary	Yes.	6701'	Main Shows at 3361' (38,000cfd.) and 4167' (140,000 cfd.)	Abandoned
Cockatoo Creek No. 1.	25°30' + 5 miles south.	150° + 6.5 miles east.	13/11/62	30/3/63	Union - Kern - A.O.G.	Rotary	Yes.	12,082'	Nothing significant	Abandoned
Burunga No. 1.	26°00'S	150°05'E	6/7/62	28/9/62	Union - Kern - A.O.G.	Rotary	Yes.	10,242'	Nothing significant	Abandoned
Glenhaughton No. 1.	25°13'S	149°08'E	17/11/63	23/1/64	Marathon Petroleum	Rotary	Yes.	9418'	Nothing significant	Abandoned

UNDIFFERENTIATED PALAEOZOIC METAMORPHICS

Meta-quartzite and granulite are exposed in two areas near Camboon Homestead on the western third of the Mundubbera 1:250,000 Sheet area. They are intruded and metamorphosed by the Auburn Complex and are possibly the oldest rocks in the area. They are mapped as Undifferentiated Palaeozoic Metamorphics. Their thickness and relationship with other units is unknown.

The most accessible outcrop is a small scrub covered hill about 1½ miles south-east of Mount View Homestead and about ¼ mile east of the road. The second outcrop is the scrub covered top 30 feet of Mount Coangal, west of Camboon Homestead. A third exposure of these metamorphics was examined east of the area mapped.

Jensen (1926a), mentions "completely recrystallized sedimentaries", which he described as "aplitic-looking quartzites" near Camboon Homestead. He includes these rocks in the "Auburn Range Complex". These metamorphics are separated from the Auburn Complex in this report but are not formally named.

LITHOLOGY.

Only four specimens were examined in thin section; three are metaquartzite and the fourth is a granulite.

The meta-quartzite is a massive, equigranular rock derived by complete recrystallization of quartz sandstone. It consists of approximately 90 percent quartz and up to 10 percent muscovite with some chlorite and, in one specimen, minor corundum. One specimen shows weakly developed schistosity in thin section.

The granulite is a medium grained rock consisting of intergranular quartz 45 percent, microcline 30 percent, sodic plagioclase 15 percent, orthoclase five percent and very minor biotite, less than one percent. Its mineralogy indicates that it is probably the result of recrystallization of an arkose. This rock type, containing dominantly sodic and potassic feldspar, is quite foreign to the Auburn Complex and the Camboon Andesite which both contain predominantly calcic plagioclase.

LOCALITY [redacted] of EXPLORATORY OIL WELLS

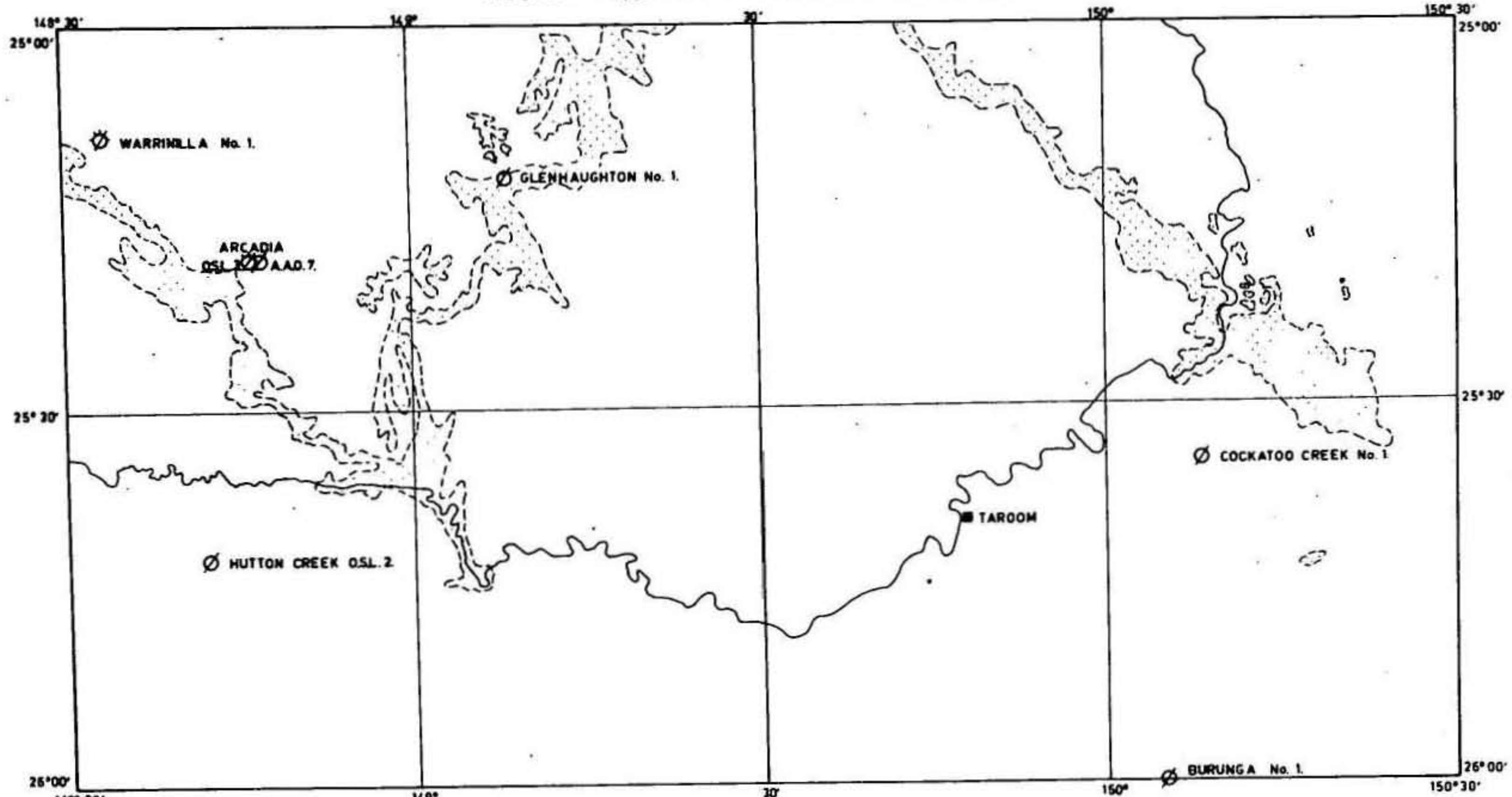


Fig. 2.

10 8 6 4 2 0 10 20 30
MILES

Outcrop of Precipice Sandstone

Ø Dry hole (Abandoned)

Ø Abandoned well with show of gas

G55/A8/4

Bureau of Mineral Resources, Geology and Geophysics. March, 1964. To accompany Record No. 1964/61

PERMIAN STRATIGRAPHY

NOMENCLATURE

The Permian sequence cropping out in the Cracow area was examined in some detail by geologists from Mines Administration Pty. Ltd. in 1954. On the basis of this work, formation and group names were published in 1959 and 1960 (Derrington, Glover, and Morgan, 1959; Hill and Denmead, 1960). In the Cracow area, the Back Creek Group was defined as comprising the Oxtrack Formation, the Orange Creek Formation, the Acacia Formation, the Passion Hill Formation, and the Mount Steel Formation. In the Monto area, the same group comprises the Oxtrack Formation overlain by the Barfield and Flat Top Formations. The present mapping has indicated that the Mount Steel Formation is lighologically and stratigraphically equivalent to the Flat Top Formation. It is also apparent that the Barfield Formation is equivalent to the Orange Creek Formation, the Acacia Formation and the Passion Hill Formation. Within the Back Creek Group therefore, the nomenclature of the Monto area will be used in the description of the Cracow area. A new unit. however the Buffel Formation, is recognized for the basal part of the sequence previously mapped as Oxtrack Formation.

The term Theodore Group is not used in this report. It can be argued that the Gyranda Formation and Baralaba Coal Measures form a group and that the Rewan Formation should not be included. For the present, however, a new group name is not introduced.

The stratigraphic nomenclature used within this report for Permian and Lower Triassic rocks is shown in Table 4. It is not suggested that the Kia-Ora Formation is exactly equivalent to the Baralaba Coal Measures, nor that the Isla Formation is equivalent to the Rewan Formation.

TABLE 4.

Stratigraphic nomenclature in the Permian-Triassic sequence of the Cracow area

Group name	Previous nomenclature used in the Cracow area	Nomenclature used herein
Theodore Group	Isla Formation	Rewan Formation
	Kia-Ora Formation	Baralaba Coal Measures
	Gyranda Formation	Gyranda Formation
Back Creek Group	Mount Steel Formation	Flat Top Formation
	Passion Hill Formation) Acacia Formation } Orange Creek Formation)	Barfield Formation
	Oxtrack Formation	Oxtrack Formation
		Buffel Formation
	Camboon Andesite	Camboon Andesite

CAMBOON ANDESITE

Summary:

The Lower Permian Camboon Andesite is predominantly a sequence of andesitic-dacitic volcanics cropping out in the eastern part of the mapped area. It is disconformably overlain by the Buffel and Oxtrack Formations, is intruded by the Auburn Complex, and is unconformably overlain by Jurassic units.

Nomenclature and Previous Investigations:

Denmead (1931, 1937, and 1938) described rocks of this unit which he equated with the Lower Bowen Volcanics. The formal name for the unit in this area, Camboon Andesite, was published by Derrington, Glover and Morgan (1959). They nominated the type area as 'near Camboon Homestead'.

Denmead (1937, 1938) mapped a younger volcanic unit lying unconformably above the Lower Bowen Volcanics which he named the Cracow Series. He suggested that it was Triassic. We regard the rocks of the Cracow Series as part of the 'Lower Bowen Volcanics' or Camboon Andesite and they are not, therefore, differentiated on the map or in the report.

Distribution and Topography:

Within the area mapped the Camboon Andesite extends south-south-east from the northern edge of the Mundubbera Sheet area to where its outcrop is terminated by the Auburn Complex. As well as this main strip of outcrop there are a few scattered inliers around Cockatoo Creek and in the south-east corner of the mapped area.

The unit produces a variety of land forms: black soil plains with no outcrop; gently undulating country with moderate outcrop and generally good access; and quite rough country with good outcrop but difficult access. In the area between the Cracow-Eidsvold road and Dearne Homestead the country is flat to gently rolling with scattered hills capped by laterite, and in this area outcrop is very scarce.

Roads through the unit are suitable for four-wheel drive vehicles only, and are quite abundant since the properties in this area are small and densely stocked. Bores and dams are closely spaced and all have some sort of track into them although many of these tracks are not recognisable on the ground without the assistance of the land holder.

Lithology:

The Camboon Andesite consists of andesitic and dacitic flows and pyroclastics with minor rhyolite and conglomerate. A summary of the major lithologies is presented in Table 5; additional details are given below.

Andesite: Porphyritic andesite occurs throughout the unit and ranges widely in colour, texture and mineralogy. The phenocrysts are plagioclase, quartz and hornblende.

The plagioclase phenocrysts are in the range andesine-oligoclase and most show normal zoning. Carlsbad, pericline and albite twins have been noted in some phenocrysts, while others from different samples show only one type of twin. Phenocrysts range up to $\frac{1}{2}$ inch in diameter. Most show alteration to secondary minerals, generally to sericite and saussurite, but some have been partly replaced by calcite or epidote. Iron staining has coloured the whole of some phenocrysts; in others it has developed only along cleavage traces.

Quartz occurs as anhedra and these commonly show magmatic rounding and resorption. Their maximum size is $\frac{1}{4}$ inch diameter. Hornblende phenocrysts are generally subhedral and tabular and are up to $\frac{1}{8}$ inch long. Alteration and replacement of hornblende by chlorite and to a lesser extent by epidote is very common.

Fragments, between $\frac{1}{4}$ and $\frac{1}{2}$ inch in diameter, of earlier formed massive, non-porphyritic and coarser grained andesite make up as much as ten percent of some porphyritic andesite.

The groundmass is holocrystalline or hypocrystalline in the andesite. The holocrystalline groundmass consists of

TABLE 5

SUMMARY OF MAJOR ROCK TYPES IN CAMBOON ANDESITE

Lithology	Estimated % of Unit	Colour	Texture	Thickness of beds in feet	Estimated % of Minerals: As Phenocrysts: Plagioclase	Potash Feldspar	Quartz	Hornblende	In Groundmass: Plagroclase	Potash Feldspar	Quartz	Hornblende	Biotite	Chlorite	Iron Oxides	Calcite, epidote, Sericite, etc.	Average Size of Phenocrysts in inches: Plagioclase	Potash Felspar	Quartz	Hornblende	Phenocrysts Shape
Andesite	45	Grey, brown, light to dark green, purplish	Porphyritic, some flow banding, some beds massive. Groundmass either holocrystalline or hypocrystalline	2-50	5 to 70		up to 3	up to 15	20 to 70		up to 10	up to 10		replacing Hornblende & Plagioclase	up to 3	replacing plagioclase	$\frac{1}{4}$ to $\frac{1}{8}$		$\frac{1}{8}$	$\frac{1}{8}$	Subhedral to anhedral. Some elongate but generally equidimensional, some corroded.
Dacite	40	Brown, red-brown, purple, grey, grey-green, dark and lightgreen, pink, white	Porphyritic, holocrystalline to hypohyaline, saccharoidal in some rocks. Flow banding towards top of unit.	10-50	5 to 70	up to 15	2 to 25		Proportions are indeterminate			up to 2	up to 5	replacing Hornblende & Biotite	1 to 5	replacing primary minerals	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{8}$		Anhedral, Subhedral, some rounded, some tabular laths of plagioclase.

TABLE 5 contd.

SUMMARY OF MAJOR ROCK TYPES IN CAMBOON ANDESITE

Lithology	Estimated % of unit	Colour	Main Fragment type (and percentage)	Average grain size	Maximum Fragment Size	% Matrix	Thickness of beds, in feet.
Tuff	5	Grey, green, purple, pink, white.	Complete gradation between proportions of crystals, lapilli and lithic fragments.			10 to 70	1 to 100
			Plagioclase crystals, 5-80 Rock fragments, 10-70 Lapilli	$\frac{1}{8}$ $\frac{1}{2}$ $\frac{1}{4}$ inches	6 feet.		
Agglomerate	5	Green, brown, purple, in places blochy purple-green.	_ndesite and dacite with some granite.	6inches to 2 feet	20 feet.	40 to 95	10 to 100

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plagioclase up to 80 percent, hornblende together with chlorite up to 15 percent, and quartz up to 10 percent. Grain size ranges from medium to fine. The texture in the holocrystalline groundmass is usually granular but flow textures have been noted in some specimens in which laths of plagioclase have been oriented along flow lines. Primary minerals have been altered and replaced to varying degrees by chlorite, saussurite, epidote, calcite, hydrated iron minerals and clay minerals. The hypocrystalline groundmass is devitrified and replaced by a cryptocrystalline mass of indeterminate material, probably largely clay minerals and quartz stained with hydrated iron minerals.

Massive non-porphyritic varieties of andesite have been found throughout the unit but they are rare and may represent sills or dykes within the unit. In these rocks the mineralogy is otherwise identical with the porphyritic varieties.

Colour in the andesite depends largely on the degree of alteration of the groundmass. The grey and some of the green rocks are often relatively fresh, but the others are extensively altered with chlorite, epidote and hydrated iron minerals lending them their colour.

Gold mineralization occurs in the unit and rich gold lodes have been worked near Cracow. Pyrite mineralization, with pyrite occupying one or two percent of the rock is rare.

Dacite: Porphyritic and generally massive dacite flows range widely in composition, texture and colour, (see table).

The colour is a function of the degree of alteration and of the groundmass composition. The presence of very finely divided chlorite in the groundmass produces dark green rocks while chlorite and epidote produce a lighter colour. Brown, purple and pink dacite contain hydrated iron minerals in the groundmass. Fresh dacite is generally grey, or white if it is lacking in mafic minerals.

The texture of the dacite ranges from holocrystalline to hypohyaline although most of the glass is devitrified. Flow banding has developed in some specimens with minute flakes of biotite and chlorite aligned along flow lines, and weak flow orientation of the macro-crystals in others. Glassy rocks show swirls and signs of very viscous flow.

The phenocrysts are quartz and plagioclase. Twinning is well developed in the plagioclase phenocrysts. Quartz phenocrysts are often glassy, rounded and resorbed although some are anhedral. The ratio of quartz to feldspar ranges from approximately one to one, to one to five, and generally the quartz crystals are smaller.

Mafic minerals are not abundant and seldom form more than 5% of the rock. Biotite occurs as small flakes and is the most abundant primary ferromagnesian mineral. Hornblende has formed to a lesser extent and occurs as short tabular crystals. Chlorite is found replacing these two primary minerals in most rocks and often is the only ferromagnesian mineral present. The chlorite may pseudomorph earlier crystals or be developed as very finely divided flakes throughout the groundmass. Opaque iron oxide forms one or two percent of the rock and in rare cases, near the contact with the granite, it is as high as 5%. Much of it has been altered and is responsible for the brown staining in the groundmass and in the weathered feldspar crystals.

Many of the dacite flows contain rock fragments and fragments of pumice up to an inch long. Most of these fragments are rounded. Rock fragments are of fine grained volcanics similar to others in the Camboon Andesite.

Where the groundmass is holocrystalline it is composed of granular feldspar and quartz with minor biotite, chlorite and iron oxide. Glassy groundmasses are now represented by a cryptocrystalline mass of indeterminate material much of which is iron stained. Chalcedony occurs in a few specimens as masses of small spherulites.

Many of the primary minerals have been weathered and altered to secondary materials, mainly chlorite, clay material, epidote and hydrated iron oxides. Epidote also fills micro-veins in the rock in places. Some rocks are relatively fresh or only altered in their groundmass, while others are very extensively altered throughout.

Quartz veining occurs in a few places, the quartz veins usually being about ¼ inch wide. Dykes of andesite invade the dacite flows but contact zones show no signs of metamorphism.

<u>Tuff</u>: Andesitic and dacitic tuff make up about five percent of the Camboon Andesite. The tuff includes crystal, lithic and lapilli tuff and combinations of these. They contain plagioclase and quartz and fine grained andesitic and dacitic rock fragments, in a matrix of fine grained granular feldspar and quartz, small flakes of chlorite, glass shards, relict pumice, white mica, minor amounts of glass and iron stained clay and cryptocrystalline material.

The composition of the tuff varies through a wide range, both locally and regionally: in a single outcrop the percentage of plagioclase crystals or other macro-components may range from five percent of the total rock in one specimen to 50 percent in an other. The groundmass is more uniform over small areas but ranges widely in its constituents throughout the area.

The matrix of the tuff is largely cryptocrystalline, iron stained material, much of which is probably clay minerals. Most of this material has probably been derived from the devitrification of volcanic glass. Glass shards are randomly oriented or aligned with their long axes roughly parallel to the bedding.

Alteration of primary minerals to clay, saussurite, chlorite and hydrated iron oxide has been extensive, especially in the finer grained crystals and in the groundmass.

Beds are usually massive. Some contain ¼ inch thick layers, each layer being of a slightly different composition from the adjoining layers. One such is a white and pink tuff in which the pink layers contain a higher proportion of iron material.

Some of the thicker tuff beds contain boulders, up to six feet in diameter, of andesite and dacite.

Agglomerate: Agglomerate ranges from coarse to fine and tends to grade into lapilli tuff. In composition it is andesitic or dacitic. Size of boulders varies greatly from blocks about 20 feet in diameter down to the size of lapilli. Matrix is crystal or lithic tuff, or dacite or andesite. Beds are usually quite thick, in the order of 20 to 30 feet, but they may be over 100 feet thick.

One very coarse and thick bed of agglomerate contains boulders of dacite up to 20 feet diameter and boulders of leucocratic granite up to five feet in diameter; the average boulder diameter is in the order of one foot. Many of the larger blocks are subangular and show little sign of rounding; however, average size blocks are well rounded. The groundmass, a green chloritic andesite, makes up 60 percent of this rock. Boulders of granite are notably different from the granodiorite seen in the Auburn Complex, the latter being distinctly rich in mafic minerals.

Rhyolite: Rhyolite forms about one percent of the Camboon Andesite. These rocks are generally pink, massive or flow layered, the layers being about half an inch thick. They are composed of potash feldspar approximately 60 percent, plagioclase approximately 30 percent, and quartz 10 percent, and are very poor in mafic minerals; some are iron stained red-brown. Phenocrysts are poorly developed and are small compared with those of the dacite.

Conglomerate: Conglomerate forms about one percent of the unit. Where seen it occurs as beds up to 80 feet thick and is composed of cobbles and boulders of andesite, dacite and granite in a sparse matrix of labile sandstone; they are well rounded but sphericity is only medium, most of them being slightly elongate.

The dacite and andesite components are identical with rocks found lower in the sequence. The granite is a pink, allotriomorphic granular rock with potash feldspar 65 percent, quartz 25 percent and chlorite 10 percent, (some of this feldspar identified as potash feldspar may be iron stained plagioclase).

Intrusives into the Camboon Andesite.

A number of intrusives into the Camboon Andesite are included in the unit. These make up about one percent of the unit and include micro-diorite, and quartz basalt, andesite and aplite dykes.

The andesite dykes are generally non-porphyritic, fine grained, dark green rocks with chilled margins. They consist of approximately 50 percent plagioclase, 40 percent green hornblende, eight percent opaques and two percent quartz, although in most specimens much of the primary minerals are altered to chlorite, clay minerals, saussurite, epidote and hydrated iron minerals. Their texture is different from that of the andesite flows in the unit. In the dykes, small needles of hornblende and cubes of magnetite are set in a granular mass of plagioclase and quartz.

Quartz basalt is porphyritic with subhedral phenocrysts of plagioclase (15 percent), augite (five percent), in a groundmass of plagioclase (60 percent), chlorite (16 percent), iron oxide (three percent) and quartz (one percent). Chlorite has formed replacing augite. The plagioclase phenocrysts are extensively altered along closely spaced cleavage. In the groundmass the plagioclase has an overall cloudy appearance due to alteration to sericite and clay minerals. Quartz occurs as small anhedra in the groundmass.

Aplite dykes have been noted in Red Range Creek area. These are usually less than six inches wide and some have fine needles of tourmaline concentrated near the margins.

One small intrusion of porphyritic micro-diorite was examined. In this rock type, phenocrysts of subhedral plagioclase (up to ½ inch long), occur in a groundmass of laths of plagioclase, needles of hornblende and minor quartz and chlorite.

Lateritization

Probable Tertiary laterite is developed in the eastern part of the area mapped, near Rockybar and Dearne Homesteads. The areas of laterite are low, more or less flat-topped hills, up to 30 feet above the general level of the plain. The ferruginous zone and some of the mottled zone is well developed, but the pallid zone is seldom seen except in deep creek exposures.

A series of low scrub-covered hills on the Camboon Andesite in the Cracow township area, is composed of soft white kaolinitic rock, in places brecciated; it overlies a tough white siliceous rock. Both rock types appear to have been formed by subaerial alteration of volcanic rocks, possibly tuffs. This might have been the result of Tertiary lateritization, or alternatively, Upper Triassic weathering as described in a later section. The kaolinitic rock contains 9% to 12% aluminium; the siliceous rock contains 7% aluminium, (see Appendix F).

Relationship with Other Units.

The Camboon Andesite is intruded by the Auburn Complex, is overlain disconformably by the Buffel and Oxtrack Formations and uncomformably by the Jurassic Precipice Sandstone and Evergreen Formation.

The principal evidence for intrusion of the Auburn Complex into the Camboon Andesite is the abundance of quartz veining and silicification in the volcanics near the contact. The quartz veins are usually thin, up to ½ inch wide, and are discontinuous. In places they criss-cross the rock and form up to 10 percent of the outcrop. The volcanics in these areas are extensively silicified and hydrothermally altered, becoming light grey or white; they are brecciated in part.

One sample of dacite taken from near the granite contact was found to contain five percent of opaque iron oxide, an amount far higher than normal. Hydrothermal introduction of iron by the granite is suggested.

The shape of the contact between the Auburn Complex and the Camboon Andesite suggest that the former intruded the latter. There are outliers of volcanics on the granite and the main mass of volcanics is embayed by the granite.

In two places the contact between the volcanics and the Auburn Complex is faulted.

In an earlier survey of the area Denmead, (1937, 1938), mapped a unit of volcanics, called the Cracow Series, conformably underlying a sequence of quartz sandstone now recognised as Precipice Sandstone. He regarded the Cracow Series as Triassic. In the present survey, localities mentioned by the earlier investigator were examined, especially Mt. Elvinia and the hills immediately to the south. Here volcanics were found underlying the Precipice Sandstone, but these volcanics could not be separated from the Camboon Andesite. The volcanics in these hills could be conformably under the Precipice Sandstone; however dips cannot be measured in the volcanics so no evidence as to the nature of this relationship is available. No gradation was observed between the tuff of the volcanic sequence and the sandstone, as was suggested by Denmead.

Similarly in other areas described as areas of outcrop of Cracow Series no real lithological differences could be found between these rocks and volcanics in the Camboon Andesite.

It is important to note that there are no volcanics below the Precipice Sandstone where it overlies Back Creek Group and younger units. It might be expected that if the Cracow Series were conformable below the Precipice Sandstone then these volcanics would crop out in these areas.

<u>Age of the Camboon Andesite</u>.

The only fossil found in the unit in this area is <u>Glossopteris</u> (Wass, 1962), which suggests a Permian age. In the Monto Sheet area, Dear (pers. comm.) has mapped limestone interbeds with a Lower Permian fauna in the Camboon Andesite. The Camboon Andesite is lithologically similar to, and in a/ comparable stratigraphic position to the Lower Bowen Volcanics mapped on the Duaringa, St. Lawrence, Mackay, Mt. Coolon and Bowen Sheet areas. The Lower Bowen Volcanics contain Lower Permian marine fossils near the top, and the two units are probably equivalent and possibly continuous.

<u>Structure and Thickness</u>.

No reliable dip information was obtained in the unit and so no structures, other than flow structures were mapped. Thickness of the unit is estimated to be of the order of 10,000 feet on the tenuous basis of the basal dip of the overlying Permian beds.

BUFFEL FORMATION.

Summary.

The Buffel Formation, formerly considered to be part of the Oxtrack Formation, is a Lower Permian marine unit consisting mainly of fossiliferous calcarenite and coquinite with some beds of chert. Dipping generally west, it overlies the Camboon Andesite with probable disconformity, and is overlain disconformably by the Oxtrack Formation. Maximum thickness of the unit is probably of the order 640 feet.

Nomenclature and distribution.

The unpublished name 'Buffel' was first used for beds at the base of the Oxtrack Formation in the Cracow Homestead area, having a significantly older marine fauna than that of the Oxtrack Formation, and consisting dominantly of limestone (Wass, 1962). Wass defined two units above his Buffel Beds, the Pindari Beds and the Wicket Gate Beds. After discussion, he has agreed to our proposal to use the term Buffel Formation to include the Pindari and Wicket Gate Beds as well as his old Buffel Beds, and this nomenclature will be followed in this report. The type area of the Buffel Formation is Buffel Hill (Lat.25°22'30"S, Long. 150°17'6"E), north-west of Cracow Homestead, on the Mundubbera 1:250,000 Sheet area.

The formation crops out only in three places on the Mundubbera Sheet area: at Buffel Hill near Cracow Homestead; at Rose's Pride gold mine, three miles north-west of Cracow township; and at Mount Ox, in the northern part of the area. It generally forms strike ridges up to 100 feet high, but at Rose's Pride mine it only crops out in the base of the ridge which is formed mainly by Oxtrack Formation. The unit does not crop out in the Taroom Sheet area.

Lithology

The Buffel Formation is essentially a fossiliferous limestone, but it grades both laterally and vertically into hard white aphanitic chert or silicified limestone. The best and thickest exposure of the unit is in a long ridge three-quarters of a mile west of Cracow Homestead, where it is a fine to coarse grained, richly fossiliferous dark blue limestone, massive to thick bedded. The base of the unit, exposed about half a mile north-west of this locality, consists of a volcanic pebble conglomerate with a distinctive grey fossiliferous limestone matrix. The pebbles are round and up to four inches in diameter, consisting of brown porphyritic intermediate volcanic rocks, probably andesite. At this place the limestone is overlain by about fifty feet of blue-green hard mudstone having a splintery fracture and containing small lenses of dark blue calcilutite. In the area of Buffel Hill the limestone grades vertically into hard white fossiliferous chert or silicified limestone, which Wass (1962) includes in his Pindari Beds.

At the abandoned Rose's Pride gold mine, three miles north-west of Cracow Township, porphyritic brown andesite is overlain by 30 feet of moderately thick bedded coarse grained brown fossiliferous limestone of the Buffel Formation. It contains round and angular pebbles of volcanic rocks, presumably from the Camboon Andesite. Brachiopods and pelecypods (especially the thick shelled Eurydesma) are common, but half a mile to the north the fauna is characterized by large gastropods which weather out as single specimens.

Farther to the north, at Mount Ox, the Buffel Formation consists of a medium to coarse grained, hard white silicified limestone, with marine fossils abundant in places. The base of the unit was not seen in this area because it is covered by soil and talus from the ridge.

Thickness

Measurements in the field indicate that the unit is more than 200 feet thick, but the top of the formation was not seen. Wass (pers.comm.) estimates a thickness of 640 feet. It has a maximum thickness of 30 feet at Rose's Pride mine and 50 feet at Mount Ox.

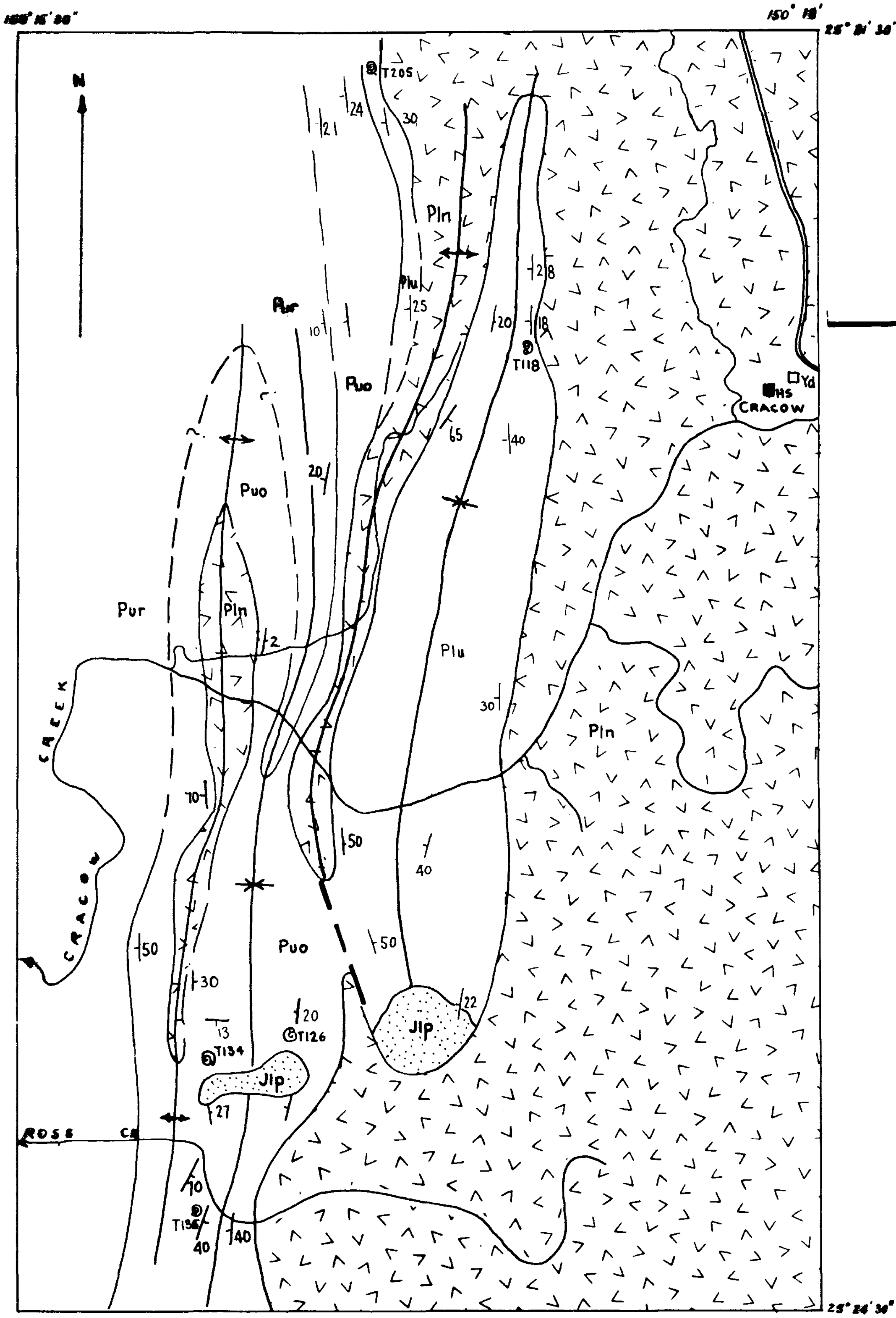
Structure and relationships.

The unit probably overlies the Camboon Andesite disconformably but the period of the break is not known. Evidence for the disconformity rests on the complete change from a volcanic sequence to a carbonate sequence, and the pebbles at the base of the Buffel Formation, which appear to be derived from the Camboon Andesite. The formation was probably deposited in depressions in the volcanic surface, and thereby protected to some degree from subsequent erosion.

There is an appreciable time break between the deposition of the Buffel Formation and the overlying Oxtrack Formation, but no angular discordance has been observed.

The unit dips at about 20° to the west at Mount Ox and at Rose's Pride. At Cracow Homestead the unit is folded into a syncline (Fig. 3). It can be seen from this sketch map that a tongue of Buffel Formation extends from

Fig. 3.



GEOLOGICAL SKETCH MAP

CRACOW HOMESTEAD AREA

SCALE 1:25,000

MILES 0

1000 500 0 1000 YARDS

REFERENCE

Jlp	Precipice Sandstone
Pur	Barfield Formation
Puo	Oxtrack Formation
Plu	Buffle Formation
VPln	Camboon Andesite

Geological boundary - position accurate

Geological boundary - position approximate

Dip of strata

Syncline

Anticline

Fault

Macrofossil

the northern part of the area southwards, where it wedges out against the Camboon Andesite. Outcrop in this critical area is very poor and relationships are uncertain.

Environment of deposition.

The unit is undoubtedly marine as indicated by the abundant brachiopods, pelecypods and gastropods. The depth of water was probably not great, and the deposition almost certainly took place in a neritic environment. The abundance of pelecypods with relatively large shells, such as Deltopecten and Eurydesma may indicate near shore conditions. Eurydesma in large numbers is believed to indicate a cold shallow-marine environment (Dickins, 1957).

Age

Marine fossils found in the unit (See Appendix B) indicate a Lower Permian age (late Sakmarian or early Artinskian).

THE OXTRACK FORMATION

Summary.

The Upper Permian Oxtrack Formation consists of fossiliferous limestone which grades into calcareous fossiliferous siltstone. This unit dips to the west at about 22^{0}, unconformably overlying the Buffel Formation and the Camboon Andesite. It varies in thickness from 100 to 350 feet.

Nomenclature and distribution

The name 'Oxtrack' Formation was first published in 1959 (Derrington, Glover and Morgan, 1959). It was applied to 'strongly outcropping, normally highly fossiliferous, blocky limestone, with intercalated olive green mudstone, cropping out from Cracow Homestead to Banana' (on the Monto 1:250,000 Sheet area). The type area was designated as Oxtrack Creek, and we are therefore obliged to regard the type section as restricted to outcrop in the immediate vicinity of Oxtrack Creek. The Buffel Formation does not crop out in this section.

The unit crops out strongly to form an almost continuous ridge from the northern edge of the area to the Cracow Homestead area. Near Cracow township the ridge is locally known as 'Fossil Ridge'.

Lithology

In the type area, the unit consists of very fossiliferous, brown, flaggy limestone which grades along strike to calcareous fossiliferous siltstone. The fossils include brachiopods, pelecypods, bryozoa, corals, and crinoid stems. The most distinctive feature of the limestone is the abundance of large crinoid ossicles - up to one inch in diameter - and stems seven inches long.

At Mount Ox, north of the type area, limestone was not seen and the unit consists of fossiliferous 'chert', which is possibly a silicified limestone. Farther to the south, at Rose's Pride mine, the limestone is much the same as that in the type area, but it is silicified strongly at the top of the ridge.

South-west of Cracow Homestead, in Ross Creek, the unit is exposed in a small syncline with almost continuous outcrop. The unit in this area consists mainly of fossiliferous calcareous mudstone, which grades laterally into coquinite by an increase of shelly fossil debris, (for greater detail see Fig. 4). The limestone of the type area is not apparent in this section, but the coquinitic mudstone obviously changes laterally into limestone along strike. The basal part of this section is characterized by a hard white lithic sandstone with interbedded siltstone; this lithology was not observed elsewhere in the unit, in this or other areas. Neither the top nor the base of the formation is exposed in this section.

Structure and relationships

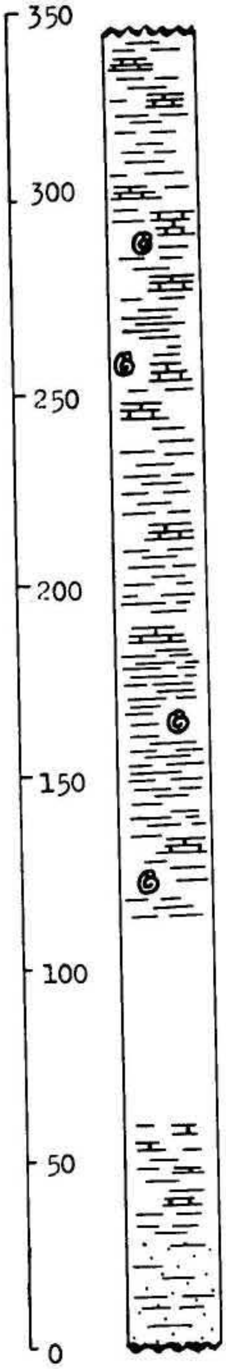
The main reason for distinguishing the Buffel and the Oxtrack Formations is the difference in faunal content, which indicates that a considerable depositional break exists between them. In general, the lithological differences between the formations are minor, but they are sufficient to distinguish the two units at any one place. There appears to be no angular discordance between the Oxtrack and Buffel Formations.

The Oxtrack Formation disconformably overlies the Buffel Formation in some places and the Camboon Andesite in others. It is conformably overlain by the Barfield Formation. From Mount Ox in the north, to a few miles south of Cracow township, it dips consistently to the west at about 20°. The unit is folded in the Cracow Homestead area into an anticline with a core of Camboon Andesite (Fig. 3).

The unit reaches a maximum thickness of 350 feet

Fig. 4.

OXTRACK FORMATION



Calcareous fossiliferous mudstone grading into coquinite in places. Thin to medium bedded.

Hard light blue mudstone with abundant marine fossils. Some small lenses of coquinite. Medium bedded.

No outcrop.

Hard brown mudstone interbedded with blue siltstone. Calcareous in part.

Hard white lithic sandstone and siltstone, medium to thin bedded.

Section measured three miles south-west of Cracow Homestead.

Scale 2"=100'.

in the Cracow Homestead area. Farther north, at Rose's Pride mine and at Mount Ox, it is only in the order of 100 feet thick.

Environment of deposition

The unit is undoubtedly marine, but the depth of water is unknown. As both cross-stratification and graded bedding are lacking, there is no indication of the type of currents operating. The abundance of fossils suggests a neritic environment, but the fauna may have been transported some distance. The complete change of fauna from that found in the Buffel Formation may be a reflection not only of the age difference, but also of a changed environment. For example, the abundance of small corals may indicate deposition in water warmer than that in which the Buffel Formation was deposited.

Age

Fossil collections made within the unit indicate a lower Upper Permian (Kazanian) age (see Appendix B).

THE BARFIELD FORMATION

Summary

The Upper Permian Barfield Formation, lying conformably above the Oxtrack Formation, consists of about 3,000 feet of massive mudstone with calcareous concretions, calcareous lithic sandstone, tuff, agglomerate, and at least one andesite flow. It crops out only in the Cracow area, where it dips consistently to the west at about 20°.

Nomenclature

Derrington et al.(1959) named the units in the Cracow area between the Oxtrack Formation and the Mount Steel Formation as the 'Orange Creek, Acacia, and Passion Hill' Formations. In the Banana area Derrington et al. defined the Barfield and Flat Top Formations, lying conformably above the Oxtrack Formation. From the present work we equate the Mount Steel Formation with the Flat Top Formation, and the Barfield Formation is held to be equivalent to the Orange Creek, the Acacia and the Passion Hill Formations. To justify this correlation the lithologies of the formations are compared in Table 6. Information in this table is based on descriptions by Derrington et al. (1959).

TABLE 6.

Lithology of the Barfield, Orange Creek, Acacia, and Passion Hill Formations.

	Barfield	Orange Ck.	Acacia	Passion Hill
Olive green mudstone	X	Xminor		X
Siltstone mudstone sandy mudstone etc.	X	X	X	X
Feldspathic lithic sandstone	X	X	X	Xminor
Calcareous concretions	X		X	X

The lithological similarity of these formations in the Cracow and Monto areas, is the basis for calling the units lying between the Oxtrack and Flat Top Formations, the Barfield Formation.

Distribution and topography

The Barfield Formation crops out in a strip of country extending from the northern boundary of the map (western part of Mundubbera) to the central part, where the unit is obscured by Mesozoic units. The formation crops out poorly, generally occupying a marked valley between the ridges formed by the Oxtrack Formation and the Flat Top Formation. The base of the section is best seen on the western slopes of Mount Ox. The middle portion of the unit is generally covered by black soil; small creeks in the black soil, although deep and steep-sided reveal no outcrop. Some information on this part of the sequence was gathered in two shallow drill holes (nos. 30 and 31, see Appendix C). The top part of the sequence may be observed in many places in the area, but the best exposure is in a small creek about a mile north of Mount Steel (marked by fossil locality T129 on the Mundubbera map).

Lithology

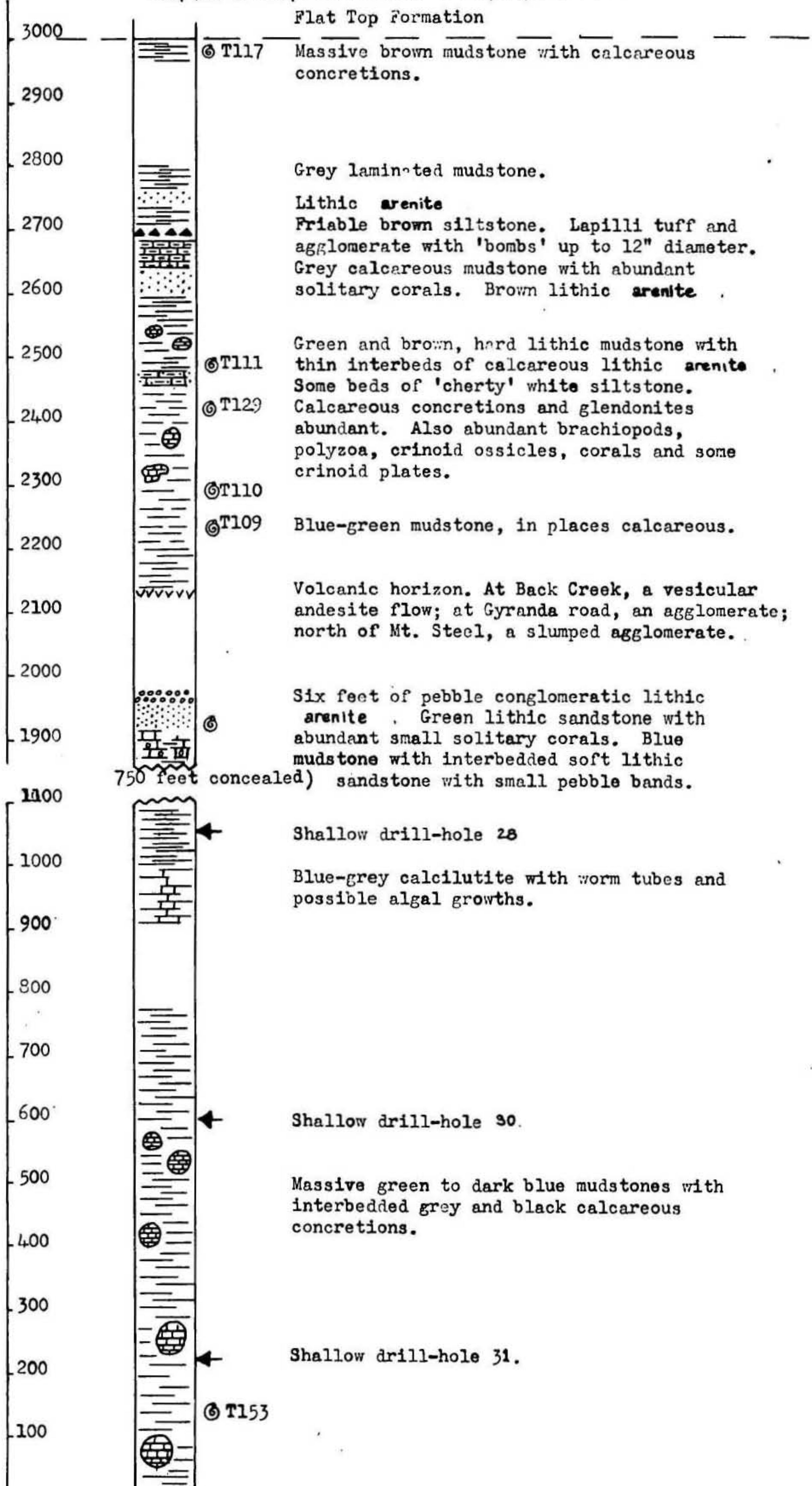
The lower one thousand feet of the unit consists of massive green to dark blue pyritic mudstone with interbedded layers of grey and black calcareous concretions. The mudstone grades into fine grained blue-grey calcilutite with some worm tubes. The overlying 750 feet of section is concealed everywhere, (Fig. 5).

Directly above the concealed section there is about 1,000 feet of blue pyritic mudstone, interbedded with

Fig. 5.

BARFIELD FORMATION

Composite section from observations in the field, Cracow area



lithic arenite. Pebble bands up to six feet thick have been seen in this part of the section, the pebbles being round and of volcanic rocks. About 2,100 feet above the base of the unit a vesicular flow possibly a spilite crops out. It is well exposed in Back Creek. Farther north, on the road into Gyranda from Cracow, and in the creek one mile north of Mount Steel, it is autobrecciated. At the Mount Steel locality the surrounding sediments are slumped and brecciated.

The overlying 500 feet are characterized by massive blue-green mudstone with round calcareous concretions and some concretionary limestone lenses. This part of the section is particularly fossiliferous, containing brachiopods, small corals, bryozoa, and small crinoid ossicles. Glendonites are common in this part of the section and these together with brachiopods commonly form the nuclei around which the concretions have grown.

Above this, volcanic lithic arenite and lapilli tuff dominate the section, with some interbedded grey mudstone. The lapilli tuff forms at least two beds each about three feet thick; it is associated with minor volcanic agglomerate.

The top beds in the sequence consist of massive brown mudstone with calcareous concretions. These beds are different in appearance from the hard buff, tuffaceous, argillite of the overlying Flat Top Formation, and there is no sign of transition between the two units.

Structure and thickness.

The Barfield Formation is conformable with the underlying Oxtrack Formation and the overlying Flat Top Formation. It dips generally to the west at angles ranging from 15° to 30°. This dip is interrupted by north-east trending faults, such as the one south-east of Binda Weir, where the unit dips to the south-east on the northern side of the fault. The unit is involved in the folding at Cracow Homestead (Fig. 3).

The thickness of the unit in Back Creek and near Mount Steel is of the order of 3000 feet. There is no indication of the unit thinning or thickening to the north.

Origin

The unit is undoubtedly of marine origin. Many of the fossil fragments are broken and worn, indicating transportation before deposition. The significance of the glendonites, pseudomorphs after glauberite, is unknown. It has been suggested (Whitehouse, 1932) that they are associated with glacial or sub-glacial climatic conditions, but in this case there is no independent evidence to support this contention.

The lack of current structures probably indicates that the unit was not deposited in very shallow marine waters. The presence of black pyritic mudstone may indicate reducing conditions.

Age

Fossil collections from the unit (see Appendix B) indicate a lower Upper Permian (Kazanian) age.

FLAT TOP FORMATION

Summary

The Upper Permian Flat Top Formation, whose type area is in the Monto Sheet area, consists mainly of fine grained clastic and tuffaceous sediments, with rare marine fossils. This unit, cropping out only in the eastern part of the area mapped, conformably overlies the Barfield Formation. In this area it dips at about 20° to the west, and attainsa thickness of 1,800 feet.

Nomenclature and distribution

The type area of the Flat Top Formation is Flat Top Mountain on the Monto 1:250,000 Sheet area. The unit name was published first by Derrington et al.(1959), in reference to a 750 feet thickness of moderately indurated, fine to coarse grained, light grey, calcareous, feldspathic lithic sandstone, with olive green to blue grey mudstone and hard limestone. In the Cracow area, the formation above the Passion Hill Formation (in this report, the top of the Barfield Formation) was named the Mount Steel Formation (Derrington et al., 1959). It was defined as a grey to olive green mudstone, siltstone, and sandy siltstone succession; but northwards from Mount Steel it was reported to change into a more muddy facies. In this report, the Mount Steel Formation is held to be a lithological equivalent of the Flat Top Formation and it is accordingly termed the Flat Top Formation.

The unit crops out in a series of discontinuous strike-ridges from the northern boundary of the Mundubbera Sheet area to a locality about one mile north of Downfall Creek. The ridges are generally up to 200 feet high. In sharp contrast the underlying Barfield Formation forms flat country. This change in topography is easily picked on the air photos.

Lithology

In the Cracow area the formation is composed of hard buff and blue mudstone which grades laterally into buff coloured argillite. It is interbedded with poorly sorted litho-feldspathic sandy siltstone which contains a high proportion of primary volcanic detritus. The base of the sequence is well exposed in a number of places in the area, but the remainder crops out poorly. The unit is fairly homogeneous, the vertical lithological changes being slight. It is most commonly a very tough mudstone or argillite, intricately patterned with contorted blue laminae. While not ruling out the possibility of some organic origin of these structures, they are planar features most probably produced by slumping. For the mostpart the slump structures are very small, existing in units up to half an inch thick. However, a larger scale slump structure, ten feet thick and about thirty feet long, was observed two miles north-east of Gyranda.

Impressionsof wood fragments are common towards the top of the unit, but no leaf impressions were seen.

Structure and thickness

The Flat Top Formation dips to the west at dips ranging from 12° to 25°. It conformably overlies the Barfield Formation, the contact being observed in a small creek about a mile north of Mount Steel. The contact with the overlying Gyranda Formation was not seen but the relationship between the two units is thought to be one of structural conformity. There appears to be a slight divergence of strike between the two units east of Gyranda but the detail is obscured by Tertiary sediments. The divergence may in fact be caused by a slight change in the amount of dip of the units along strike to the north.

The unit is 1800 feet thick from dip information and outcrop measurement on air photos. The Mount Steel Formation was estimated by Derrington et al. (1959) to be 1400 feet thick.

Age

Fossil collections from the unit (see Appendix B) indicate a lower Upper Permian (Kazanian) age.

Origin

The Flat Top Formation is at least partly marine, as indicated by the presence of marine fossils. In contrast to the formation in the type area and in the Baralaba 1:250,000 Sheet area, however, marine fossils are not abundant. This probably reflects a change of environment from the unit of the type area. Fossil wood impressions are common towards the top of the unit, and coal seams were encountered in the unit in UKA Cockatoo Creek No. 1 (Enclosure 3). It is possible that the decrease in marine fossils, and the increase of plant material may indicate a general shallowing of the environment of deposition from north to south.

Current structures give no indication of the depth of water existing at the time of deposition of the Flat Top Formation. Cross-stratification is absent, but this may be owing to the fine grained nature of the sediments, rather than to the absence of traction currents. The fineness of the sediments may also account for the presence of slump structures.

It is most likely that there was contemporaneous vulcanism somewhere in the area.

GYRANDA FORMATION

Summary

The type area of the Upper Permian Gyranda Formation is in Back Creek, near Cracow. The unit consists of mudstone, lithic sandstone, tuff, and minor conglomerate. It is conformably overlain by the Baralaba Coal Measures, and it appears to be conformable on the Flat Top Formation, although the contact is not exposed. The unit, which is probably non-marine, is about 1,600 feet thick in the type area. It contains well preserved fossil Permian plants.

Nomenclature and distribution

The name 'Gyranda' Formation, derived from Gyranda Homestead near Cracow township, was proposed by Derrington et al. (1959), for "a sequence of siltstone, sandy siltstone and quartz poor sandstone, cropping out in a north trending belt parallel and west of the Back Creek Group". Back Creek was named as the type area, and the unit was said to overlie conformably the Mount Steel Formation, and to be overlain by the Kia-Ora Formation.

The unit in the area mapped, crops out only on the Mundubbera Sheet, in a strip of country extending from the northern boundary to a locality west of Cracow Homestead; southwards it is covered by Jurassic sediments. It has been recognized in the subsurface in Burunga No. 1 and Cockatoo Creek No. 1 (Enclosure 3) but not in wells drilled in the western part of the Taroom Sheet area.

Lithology

The Gyranda Formation is composed of mudstone, lithic sandstone, calcareous lithic sandstone, fine tuff, and minor siltstone, conglomerate and volcanic breccia. The mudstone is thinly laminated, green to brown, and commonly contains abundant carbonaceous plant debris. The sandstone is generally green to brown, with a blocky fracture. It is almost invariably trough cross-stratified, and is composed essentially of lithic fragments. It probably has a high proportion of volcanic detritus at least some of which is primary. In places the sandstone has a carbonate cement. Pebble conglomerate is not common in the unit, and where seen it is composed of round volcanic pebbles. Hard white and brown fine grained cherty tuff, with very well preserved fossil leaf impressions is common at the top of the unit.

The general sequence within the unit is shown in a composite section based on field observations in the Cracow area (Fig. 6). The lowest beds exposed consist of hard, thinly laminated brown and blue mudstone with some exceedingly angular shale clasts. Most of the basal part of the sequence, however, is composed of a green lithic sandstone, which crops out well near the pumping station at Gyranda. It is also recognizable in the logs of Cockatoo Creek and Burunga Wells (Enclosure 3). The top part of the sequence is characterized by hard light coloured tuff, and some volcanic breccia. The base of the overlying Baralaba Coal Measures is taken at the lowest appearance of coal seams or shale rich in carbonaceous plant material.

Structure and thickness

In the Mundubbera area the unit dips regionally to the west with dips ranging from 10° to 22°. It lies conformably beneath the Baralaba Coal Measures, whose subsurface structure beneath the area mapped is known reasonably well from seismic surveys.

The thickness is estimated as 1600 feet, from dip information and outcrop measurements on the aerial photos.

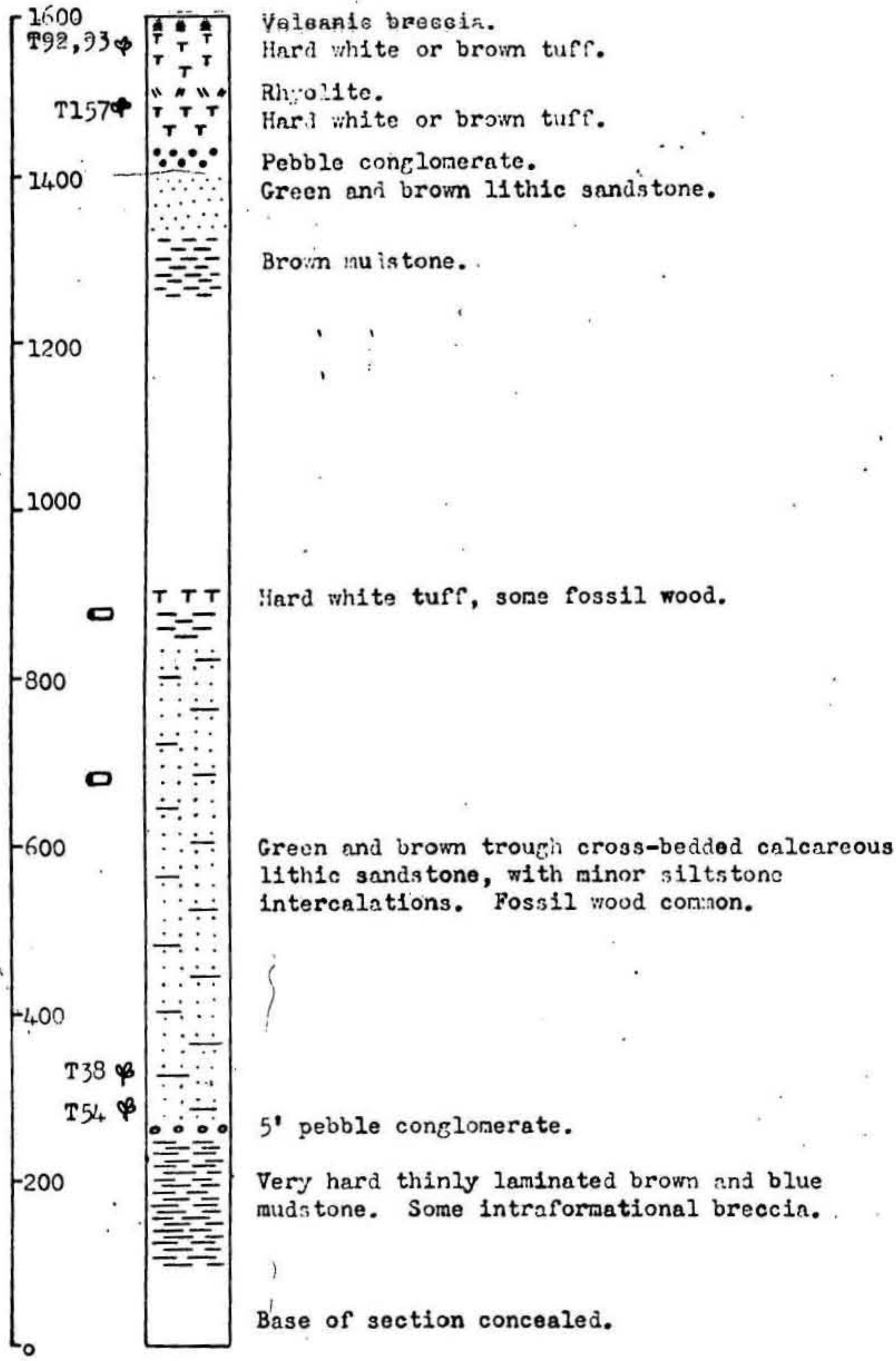
Age

A number of fossil plant collections was made from the Gyranda Formation during the field season, their relative stratigraphic positions being presented in Figure 6. Plants from the top of the formation are extremely well preserved.

The following identifications were made by White (1964).

Fig. 6.

GYRANDA FORMATION



Fossil wood.

T38 Fossil plant collection and number.

Composite section from field observations. Scale 1"=200'.

Bureau of Mineral Resources, Geology & Geophysics.

May, 1964. To accompany Record 1964/61 G56/A5/3

1. Locality T 54: One mile S.E. of Gyranda Pumping Station.
Mundubbera Run 3, Photo 76.
Specimens F 22343, F 22344.
The following plants are identified :-
Glossopteris browniana Brong.
Glossopteris indica Sch.
Glossopteris stricta Bunb.
Glossopteris tortuosa Zeiller.
Glossopteris ampla Dana.
Glossopteris scale leaves.
Gangamopteris cyclopteroides Feist.
Sphenopteris polymorpha Feist.

2. Locality T 38: Four miles S. of Back Creek and 4½ miles W.S.W. of Cracow H.S.
Mundubbera Run 4, Photo 16.
Specimens F 22357.
Plants identified are :-
Glossopteris indica Sch.
Glossopteris ampla Dana.
Glossopteris stricta Bunb.
Vertebraria indica Royle.
Sphenopteris polymorpha Feist.

3. Locality T 157: One mile N.E. of Kia Ora H.S.
Mundubbera Run 1, Photo 56.
Specimens F 22351
Glossopteris damudica Feist.
Glossopteris ampla Dana.
Glossopteris conspicua Feist.
Glossopteris indica Sch.
Glossopteris angustifolia Brong.
Glossopteris scale leaves.
Gangamopteroid small leaves and fragments of the type associated with *Lidgettonia australis* (White, 1960).
Vertebraria indica Royle.
Sphenopteris polymorpha Feist.

4. Locality T 92: One mile S.W. of Gyranda Pumping Station.
Mundubbera Run 3, Photo 76.
Specimens F 22345, F 22345a and b., F 22346.
The following *Glossopteris* assemblage is present :-

Glossopteris indica Sch.

Glossopteris damudica Feist.

Glossopteris conspicua Feist.

Glossopteris paralella Feist.

Glossopteris angustifolia Brong

Glossopteris communis Feist.

Vertebraria indica Royle.

5. Locality T 93: One mile S.W. of Gyranda Pumping Station.
Mundubbera Run 3, Photo 76.
Specimens F 22347, F 22348, F 22349, F 22350.
Phyllotheca etheridgei Arber.
Glossopteris browniana Brong.
Glossopteris stricta Bunb.
Glossopteris communis Feist.
Sphenopteris polymorpha Feist

6. Locality T 33: Two and a half miles S.W. of Gyranda Pumping Station.
Mundubbera Run 3, Photo 76.
Specimens F 22342.
Indeterminate stem casts and impressions and finely macerated plant material.

These fossil plants indicate that the Gyranda Formation is Permian. As the formation overlies Upper Permian units (their age being based on marine fossils) it is also Upper Permian.

Origin

The unit appears to be largely non-marine as it contains an abundance of fossil plants but no marine fossils. It probably represents deposition in a fluvial or possibly deltaic environment.

BARALABA COAL MEASURES

Summary

The Upper Permian Baralaba Coal Measures, 650 to 800 feet thick in the outcrop area, consist of feldspatholithic sandstone, carbonaceous mudstone, and coal. The unit dips regionally to the south-west in the Cracow area, the dip value decreasing southwards from 22° to 13°. In outcrop the unit thins slightly towards the south, but subsurface information indicates an overall thickening of the unit in the southern part of the Mundubbera Sheet area. The coal measures produce good seismic reflection and seismic surveys have delineated the subsurface structure of the unit in the Taroom area.

Nomenclature and distribution

Reid (1944) first used the name 'Baralaba Coal Measures' for a sequence of sandstone and coal in the Baralaba area. A description of the type area is given in Olgers, Webb, Smit, and Coxhead (1964). Reid (1945) traced the unit south-east towards Kianga where he used the term 'Baralaba-Kianga' Coal Measures. This unit has been traced (King, 1961) into the Cracow area, where it overlies the Gyranda Formation.

Cropping out poorly in a number of low strike ridges, the unit, extends from the northern boundary of the Mundubbera Sheet area, in a thin strip, to an area south-west of Cracow Homestead. It can be recognized subsurface in the UKA Cockatoo Creek well and the UKA Burunga Well (Enclosure 3). Coal measures are found in an equivalent part of the section in wells in the western part of the Taroom Sheet area (Enclosure 3).

Lithology

Outcrops of the unit are poor and scattered. The two most accessible ones are (a) at Hilltop Homestead, fifteen miles north-west of Cracow township, and (b) near Kia-Ora Homestead, six miles north of Hilltop.

The unit consists of poorly exposed carbonaceous mudstone which in places grades into carbonaceous shale, medium to coarse grained trough cross-bedded feldspathic lithic sandstone, coal, and minor sublabile lithic sandstone. The coal does not normally crop out, and it is known only from bores (King, 1961). King reported a facies change along strike from sandstone in the northern part of the outcrop area, to a 'more argillaceous' lithology in the southern part.

The Coal Measures are distinguished from the underlying Gyranda Formation by the presence of coal beds, and by the absence of beds of hard white primary tuff. The boundary between the Coal Measures and the underlying formation in the well correlation chart (Enclosure 3) has been taken at the lowest coal bed, and in general tuff does not occur above this horizon. A similar system has been adopted in the wells on the western side of the Taroom Sheet, but the coal measures are not termed Baralaba Coal Measures. They have been referred to the Bandanna Formation (G.S.Q. Publ. 299) but for the present we prefer not to name these coal measures formally.

The top of the Baralaba Coal Measures is taken at the highest coal bed in the sequence, and in the Cracow area this corresponds very closely to the commencement of the conglomeratic sequence of the lower part of the Rewan Formation.

Structure and thickness

In the area of outcrop, the Baralaba Coal Measures dip regionally to the west (actually west-south-west) and the dip decreases along strike from north to south. At Kia-Ora Homestead the dip is 22° to the west, and farther south at Hilltop the dip is 13° west. King (1961) reports a general thinning of the unit from north to south: 800 feet at Kia-Ora to 650 feet west of Dawson Vale Homestead. From the well correlation chart (Enclosure 3) it can be seen that the Coal Measures occupy about 1500 feet of section in both UKA Cockatoo Creek No. 1 and UKA Burunga No. 1 thus the unit thickens appreciably south of the outcrop area. Coal measures in the equivalent stratigraphic position subsurface in the western part of the Taroom area, are only of the order of 300 feet thick.

The subsurface structure of the unit has been delineated by numerous recent seismic surveys over much of the area mapped (Fig. 14). The unit dips to the west from the outcrop area to form the eastern limb of the Mimosa Syncline. It does not crop out in the western part of the Taroom area even though it is close to the surface as part of the western limb of the Mimosa Syncline. The unit is more tightly folded and faulted on the Comet Ridge to the west of the Mimosa Syncline.

Age

No fossils have been found in the formation in the area of outcrop. White (1964) reported Permian fossil plants from the Kianga Coal Measures of the Cracow area. As a result of work not available when White's report was written, the plant localities are now assigned to the Gyranda Formation.

By lithological correlation, the interval between 2180 feet and 3780 feet in UKA Burunga No. 1 well, is Baralaba Coal Measures. Core 6, taken within this interval (2385-2390) was reported to contain a Triassic microflora (de Jersey, appendix in Union Oil Development Corp. 1963d). Evans (1964b), after an examination of cuttings and core 6, is of the opinion that the Permian-Triassic boundary occurs at a higher level, somewhere between 2150 feet and 2210 feet. The Coal Measures are therefore regarded as Upper Permian.

Origin

The absence of marine fossils and the presence of coal, strongly suggests a non-marine paludal environment of deposition.

TRIASSIC STRATIGRAPHY

REWAN FORMATION

Summary

The Rewan Formation, which is named from an area to the north-west of the Taroom Sheet, crops out in two places in the area mapped: (1) in the Arcadia area, and (2) in the north-western part of the Mundubbera Sheet area. It consists of lithic sandstone, in places pebbly, interbedded with brown mudstone and conglomerate. A prominent pebbly sandstone bed, the Brumby Sandstone, occurs towards the base of the unit in the Arcadia area. The upper parts of the unit crop out very poorly, because of the abundance of brown mudstone.

The base of the unit is taken just above the highest coal of the coal measures which conformably underlie it. This closely corresponds to the lowest occurrence of brown mudstone. The top of the unit is taken below the thick beds of sublabile sandstone of the Clematis Sandstone, conformably overlying it.

The thickness of the unit changes from about 12,000 feet in the north-western part of the Mundubbera Sheet area to about 2000 in the Arcadia area. It appears to thin towards the south also.

Palynological evidence points to a Lower Triassic age for the unit.

Nomenclature

The name 'Rewan' was first used in unpublished reports by geologists of Shell (Qld) Development Pty Ltd, who derived the name from Rewan Homestead on the Springsure 1:250,000 Sheet area (Lat. $24^{\circ}59''$S, Long.$148^{\circ}23''$E). The name was first published by Isbell (1955) who used the term 'Rewan Series'. No type area or section has ever been nominated, but it has commonly been assumed that the type area is near Rewan Homestead (Int.Geol.Cong.,1958). As a result of recent mapping in the Springsure area by the Bureau of Mineral Resources and the Geological Survey of Queensland the name Rewan Formation will be formally proposed and a [illegible] type section nominated and described.

The unit in the type area has been described as consisting of a lower Rewan Formation and an upper Rewan Formation (Hill, 1957). The lower Rewan Formation, Hill reports, consists of 'cross-bedded and sometimes calcareous polygenetic sandstone and grit' with 'intercalations of argillaceous beds, chiefly chocolate brown clays'. The upper Rewan Formation consists of 'a complex of unbedded chocolate-coloured clay'.

Reeves (1947) showed a sandstone known as the Brumby Sandstone in a cross section across the Arcadia structure. Shell geologists mapped this sandstone but called it the 'Malta Grit', reserving Brumby Sandstone for the lower Rewan Series. In this report the term Brumby Sandstone is used in the original sense, that is, equivalent to Shell's Malta Grit; this equivalence has already been stated by Hill and Denmead (1960, p188). We regard the Brumby Sandstone as a member of the Rewan Formation. Brumby Mountain from which the name is derived is about one mile west of AAO No. 7 (Arcadia) well.

Distribution

In the area mapped, the unit crops out in the Arcadia Valley which is in the north-west part of the Taroom 1:250,000 Sheet area, and in a long strip west of the Dawson River in the Cracow area (in the western third of the Mundubbera Sheet area). The unit generally produces flat country with a few gentle rises and strike ridges. The Brumby Sandstone, however, forms a steep sided hill in the Arcadia area. In the adjoining valley, the formation supports a dense scrubby vegetation of brigalow and other trees, and does not crop out well. The top of the unit is almost invariably obscured by sand derived from the weathering of the Clematis Sandstone. It can be seen, however, in the gap cut by Moolayember Creek into the Clematis Sandstone, on the Carnarvon Highway.

The unit has been recognized in all wells drilled to date in the area mapped except OSL No. 2 Hutton Creek.

Lithology

In the Arcadia area, the Rewan Formation was observed only in a few places. Where seen it consists of lithic sandstone interbedded with brown mudstone. The sandstone is, in some places, lustre mottled, as a result of carbonate cementation, and it is characterized by brown ovoid mud clasts. A distinctive very coarse sandstone, the Brumby Sandstone Member, forms the ridges west of the Arcadia wells. It is a poorly sorted dense, tough, lustre mottled, pebbly sandstone with fine grained volcanic lithic fragments.

It is generally agreed that most of the formation, especially the upper part, consists of brown mudstone. It has been called brown or chocolate shale, but we prefer to reserve the term 'shale' for a mudstone with fissility. It is invariably massive, showing no current structures or stratification. This is in contrast to the sandstone of the unit, which is commonly cross-stratified.

In the Cracow area, the base of the formation is marked by a volcanic lithic conglomerate, overlain by pebbly lithic sandstone interbedded with brown mudstone. Like the sandstone of the Arcadia area, the pebbly sandstone of this area has, in many places, a carbonate cement. The mudstone in both areas is non-calcareous.

Definition of top and base of unit

In the area near Rewan Homestead, the base of the Rewan Formation is taken as the lowest bed of fine conglomerate, in a sequence dominated by brown mudstone. Where this is not present it is taken at the lowest bed of chocolate brown mudstone (Mollan, Exon, and Kirkegaard, 1964). This boundary coincides closely with the highest bed of coal in the underlying coal measures. In the Duaringa area, the base of the unit has been taken at the lowest beds of chocolate mudstone (Malone et al., 1963).

In the Arcadia area, Shell geologists took the Brumby Sandstone (their Malta Grit) as the base of the Rewan Formation, because no brown mudstone crops out below it and because it unconformably overlies the rocks which crop out beneath it. The well AAO No. 7 (Arcadia), which spudded below the Brumby Sandstone Member, encountered in the first

300 feet, calcareous quartz sandstone and grey micaceous shale interbedded with mottled grey-green and chocolate shales (Derrington, 1957). It is thus probable that the Rewan Formation lithology occurs below the Brumby Sandstone Member. For this reason, and despite the fact that there is a slight angular discordance near the base of the r r- ·, Brumby Sandstone we tentatively include in the Rewan Formation, the sediments between the Brumby Sandstone and the highest coal of the underlying coal measures. Possibly, as indicated in Planet Warrinlla No. 1, later mapping will prove that another formation can be recognized in this interval. There is little doubt that the coal measures beneath the Rewan Formation in this area are Permian, Whitehouse (1935a) reported a Glossopteris - Gangamopteris flora from about 350 feet below the collar of a scout bore drilled by Oil Search Limited prior to the drilling of OSL 3.

Lower Triassic spores were found in Planet Warrinilla No. 1 in a shale interval placed in the Bandanna Formation by Planet Exploration Co. (1963). In selecting the Rewan/coal measures boundary at the top of the highest coal (Enclosure 3) in the Taroom-Mundubbera area, we have made this shale interval in Planet's Warrinilla No. 1 part of the Rewan Formation. Within this shale interval, there is a slight but fairly distinct angular discordance of about 8° (Planet Expl.Co.1963), occurring about 70 feet above the first appearance of Lower Triassic spores. Thus it is possible that two Lower Triassic formations are included within the interval, one below and the other above the unconformity. For the present, we include the whole shale interval in the Rewan Formation.

In the Cracow area, the base of the Rewan Formation is taken as the base of a thick bed of pebble conglomerate which crops out well at Hill Top Homestead and near Kia-Ora Homestead. This occurs above the highest coals of the Baralaba Coal Measures and below the lowest known occurrence of brown mudstone (in B.M.R. bore 25). Work in the future may reveal that this belongs more properly to the Coal Measures.

The top of the unit is marked by the appearance of thick beds of sublabile lithic sandstone of the Clematis Sandstone. The contact between the two units is seen on the Taroom Sheet area in the road cutting where Moolayember Creek cuts through the Clematis Sandstone. At that locality massive green and red mudstone is interbedded with biotitic lithic sandstone and this is overlain by thick beds of sublabile lithic sandstone which grades to quartzose sandstone. Although there are some red and brown beds of mudstone interbedded with the more quartz-rich sandstone, the boundary between the Rewan Formation and the Clematis Sandstone is taken to be at the base of the sublabile sandstone beds. A similar set of criteria was used in the eastern part of the Taroom 1:250,000 Sheet area.

Structure and relationships

In a regional sense, the Rewan Formation is structurally conformable with the underlying coal measures and the overlying Clematis Sandstone, but some local unconformities have been noted. In the eastern part of the area mapped the formation dips at about 20° to the west. One higher dip was noted but this may have been caused by faulting. Outcrop of the unit in the Arcadia area is very poor, but from the mapping by Woolley (1944) the structure is known to be complex. Broadly speaking the Rewan Formation in this area is folded into an assymetric anticline with a steep western limb. The anticline trends north in the southern part of the area and then north-east at the northern end of the exposed structure. The area has been subjected to faulting, most of the faults striking between north-north-east and north-north-west. The Arcadia Anticline may be crestally faulted in the northern parts of the exposed structure, and seismic work shows this to be the case subsurface (Associated Australian Oilfields, 1959). Many of the minor structures mapped by Woolley in the Arcadia area (Woolley, 1944) are not shown on the map accompanying this report because the limitations of the 1:250,000 scale.

In the Cracow area the Rewan Formation appears to overlie the Baralaba Coal Measures without any angular discordance. Because of the scale of mapping and the lack of outcrop it is not known if any small angular unconformity separates the two units. The same situation exists at the top of the Rewan Formation where, within the limitations only a conformable relationship with the overlying Clematis Sandstone can be shown.

In the Arcadia area, the junction between the Rewan Formation and the underlying coal measures (the Bandanna Formation) is not exposed. Woolley (1944) was able to map an angular unconformity at the base of the Brumby Sandstone. Although the degree of the angular discordance varies from place to place, it reaches a maximum of about 10° near the well OSL No. 3 (Woolley, 1944). At present there is insufficient data available to differentiate between the strata above and below this unconformity into two formations. A similar situation has been recorded in Planet Warrinilla No. 1 (planet Exploration Company, 1963), where brown mudstone similar to that of the Rewan Formation occurs below a small but distinct angular break, (see Enclosure 3).

There is no indication in the Arcadia area of angular break between the Rewan Formation and the Clematis Sandstone. The contact between the two units was only seen in two places, however.

Thickness

The unit thins rapidly from the eastern area of outcrop, where it is estimated to be of the order of 12,000 feet thick to the Arcadia area where it varies from 1300 to 2500 feet thick. Although this gives an indication of the amount of thinning in the unit towards the west the reliability of the estimates is not good. The estimate of 12,000 feet is based mainly on seismic evidence in the area to the north of the area mapped (Olgers et al., 1964). On the basis of the few dip measurements taken in the unit in the Cracow area, this figure appears reasonable.

In the Arcadia area, the lack of outcrop and the structural complication hinder reliable estimation of the thickness. From Woolley's (1944) observations the top part of the formation (his upper Rewan Series) is of the order of 1300 feet thick. He reported, however, that the lower part of the sequence ranges greatly in thickness from place to place, with a maximum of 900 feet and a minimum of 15 feet. The Brumby Sandstone (Woolley's Malta Grit) is generally of the order of 15 feet thick in the Arcadia area.

Age

Poorly preserved fossil plant fragments were found about three miles north-north-east of the Dawson River-Downfall Creek junction (collection T71). These were determined as Dicroidium odontopteroides (Morr.) Gothan, by White (1964). Dicroidium has also been recorded from the unit in the Arcadia area, but the exact localities are not known (files of G.S.Q. Whitehouse 1935b; Jones 1943). White (1964) gives the age of the unit, on plant fossils, as Triassic or Lower Jurassic.

Palynological evidence, however, points to a Lower Triassic age for the unit. Lower Triassic spores were found within the unit in A.A.O. 7 Arcadia, although Derrington regarded the interval from which they were taken as Bandanna Formation (Derrington, 1957). Evans (1963) has noted the Lower Triassic age of the Rewan Formation in other areas.

Origin

So little is known of the Rewan Formation that it would be unwise to draw too firm a conclusion about its origin. As it contains no marine fossils, and because it is part of a thick pile of Upper Permian-Triassic non-marine sediments, it is most probably a terrestrial deposit. If this is the case, the trough cross-bedded sandstone, which in places is pebbly, probably represents deposition in a fluvial environment. The environment of deposition and origin of the massive brown mudstone is not known, and this is encompassed within the general problem of the origin of red beds. It seems clear that oxidation of the sedimentary detritus took place at some stage in the formation of the deposit, either before, during or after deposition; but no conclusion can be drawn as to the relative aridity or humidity of the depositional environment, or as to the agent of depositinn - aeolian or fluvial.

THE CLEMATIS SANDSTONE

Summary

The Clematis Sandstone is a Triassic unit composed essentially of cross-stratified sublabile lithic sandstone with minor interbedded mudstone and conglomerate. Conformably overlying the Rewan Formation, it crops out in the area mapped on either side of the Mimosa Syncline and on the western limb of a major anticline, in the north-west part of the Taroom Sheet area. The thickness of the formation is relatively uniform over the area mapped: in the western part of the area it is in the order of 800 feet thick, and in the eastern part it is about 1000 feet thick. The unit was probably deposited in a fluvial environment.

Nomenclature and distribution

The name 'Clematis' was introduced by H.I. Jensen (1926a) for a unit lying between his Upper Bowen and Ipswich Beds. He later designated the type area as the gorge of Clematis Creek in the Expedition Range, on the Baralaba 1:250,000 Sheet area (Whitehouse, 1955). In the type area, where neither the top nor the base is exposed, the unit consists mainly of quartz rich sandstone interbedded with minor siltstone (Olgers et al., 1964).

Within the area mapped, the unit crops out only on the Taroom 1:250,000 Sheet area, forming the Carnarvon Range on the western side of the Arcadia Valley, and the Expedition Range on the eastern side. It also forms the Dawson Range in the north-east corner of the Sheet area. The unit generally crops out well, to form rough hilly country with steep slopes and, in some places, vertical cliffs.

Lithology

The dominant lithology of the unit is thick bedded, cross stratified, sublabile lithic sandstone which varies in grain size from very fine to very coarse. It is interbedded with quartzose sandstone, sublabile feldspathic sandstone, volcanic pebble conglomerate, siltstone, and mudstone. Cross-stratification is by far the most common current structure, although irregularly contorted stratification is common in some places.

Much of the sandstone, although rich in quartz, is characterized by a brown matrix of unknown composition - possibly clay minerals. This gives the sandstone a distinctive brown colour. Mica flakes are not uncommon. Sorting is poor to moderate, pebble bands being common. In places the sandstone grades vertically into pebble conglomerate, most of the pebbles being quartz or quartzite. Lateral gradation to pebble conglomerate is evident at the southern end of the Dawson Range, at the headwaters of Gap Creek. The dominant lithology at that place is volcanic pebble conglomerate in a brown quartz-rich sandstone. The pebbles, round and up to 3 inches in diameter are almost exclusively of volcanic rocks, but there are some small round fragments of silicified wood. This conglomerate is similar to the conglomerate found in both the Rewan and Moolayember Formations.

Sedimentary rocks finer than sand-size are not uncommon in the sequence, but they form only thin beds. In the basal part of the unit there are thin beds of red-brown mudstone, and green mudstone with plant impressions. Towards the top of the unit there are beds of carbonaceous shale with plant debris. White siltstone, commonly flaggy, is found throughout the sequence.

Structure

The unit is folded into the Mimosa Syncline and into an anticline between the Expedition and Carnarvon

Ranges; both structures are assymetric. In the Dawson Range the dip is about 20° to the west, but this decreases towards the south where, at the headwaters of Gap Creek, the dip is of the order of 10° west. Dips are very much lower in the Expedition Range where, on photo interpretation, the regional dip appears to be less than 5° to the east. The Clematis Sandstone in the Carnarvon Range area dips to the west at about 10° to 15°. Both the Mimosa Syncline and the major anticline to the west, plunge to the south. Mapping did not reveal any angular unconformity between the Clematis Sandstone and the underlying Rewan Formation, or the overlying Moolayember Formation.

Thickness

No sections were measured in the formation, and thickness estimates are based on dip and outcrop measurements on the photos. Unlike the Rewan Formation the Clematis Sandstone has a relatively uniform thickness throughout the area mapped. In the Dawson Range it is about 1000 feet thick, and in the Carnarvon Range, 70 miles to the west, it is about 800 feet thick. In the type area just to the north of the Taroom Sheet area the unit is known to be of the order of 900 feet thick (Olgers et al., 1964).

Age

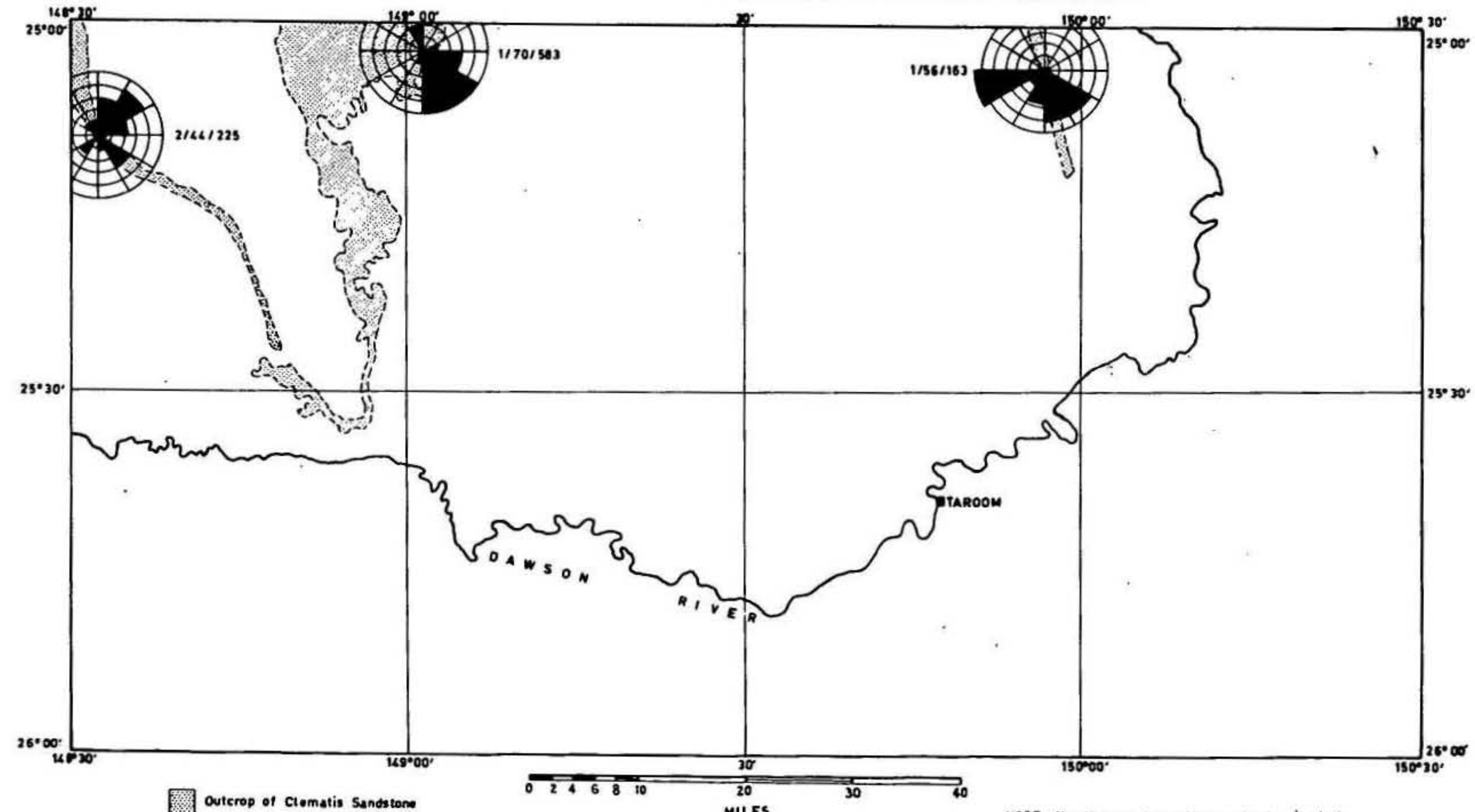
No identifiable macrofossils were found in the unit during the course of the mapping. A sample collected near the top of the unit in the western part of the Taroom Sheet (T227) contained a Middle to Upper Triassic microflora (Evans, 1964b).

Origin

There can be little doubt that the Clematis Sandstone is a terrestrial deposit: the complete lack of marine fossils, and the presence of plant debris supports this contention. The ubiquitous cross-stratification and the poor to moderate sorting with common pebble bands probably indicates a fluvial environment, deposition probably taking place on a [illegible] subsiding flood plain with braided river channels.

It is most likely that the sediments were derived from a source which lay to the west of the area mapped. About 50 measurements of cross-stratification directions were taken in each of three localities. The results are plotted in Figure 7, and if the observations are sufficiently numerous to be significant, then the currents in the western part

CROSS BEDDING AZIMUTHAL DISTRIBUTIONS IN CLEMATIS SANDSTONE



NOTE: Numbers on face of map refer to air photo run, photo and point.

Fig. 7.

Bureau of Mineral Resources. Geology & Geophysics. *To accompany Record 1964/61.*

G55/A8/5

of the Taroom Sheet appear to have come from the south-west. Farther east however, the cross-stratification indicates currents from the north-west and east. Although insufficient observations were made to be sure of the conclusions, there is good correlation of these results with those that were obtained by Olgers et al. (1964) from similar measurements in the northern part of the Mimosa Syncline.

THE MOOLAYEMBER FORMATION

Summary

The Moolayember Formation is the youngest formation of the thick Permo-Triassic sequence of the Bowen Basin. It consists mainly of mudstone, interbedded with lithic sandstone, sublabile lithic sandstone, conglomerate, carbonaceous shale, and tuff. The conglomerate and tuff are best developed in the eastern part of the Taroom Sheet area. The total thickness of the unit is not known, but it is estimated that it is of the order of 5500 feet in the eastern part of the Taroom Sheet area, and about 2000 feet in the western part (which is regarded as the type area). In both areas however, the top of the sequence is either eroded or not exposed. The unit is of Middle to Upper Triassic age on palynological evidence.

Nomenclature and distribution

Reeves (1947) introduced the term 'Moolayember Shale' for a sequence of Middle Triassic 'olive-green, sandy, tuffaceous shale, and thin calcareous sandstone' cropping out beneath his Bundamba sandstone (in this report - Precipice Sandstone) and above his Carnarvon Sandstone (in this report - Clematis Sandstone). The International Stratigraphic Lexicon states that the type locality of the formation is in 'road cuttings where the main Injune Road descends to Moolayember Creek north of Injune', but it does not state the source of this information. No type section has been measured in this unit, and the lack of outcrop in the type area would make it very difficult to measure a section.

On the Taroom 1:250:000 Sheet area the unit crops out in the type area, in the Expedition Range area, and in the Dawson Range area. In most places it forms gently rolling country with few strike ridges and no large hills. It forms more rugged country, however, in the Expedition Range area. The unit does not crop out on the western third of the Mundubbera 1:250,000 Sheet area.

Lithology

The unit consists mainly of green-brown mudstone interbedded with lithic sandstone, sublabile lithic sandstone, carbonaceous shale, conglomerate, and tuff. The lithology is much the same in the type area as in the Expedition Range area, but conglomerate and tuff are much more common in the Dawson Range area.

In the type area the unit consists mainly of green-brown mudstone, interbedded with green lithic sandstone. The mudstone, generally soft and massive, is commonly calcareous, and calcareous concretions in the form of nodules and beds are common. In some places the mudstone contains carbonaceous plant debris, and in some cases the mudstone grades into carbonaceous shale. Sandstone in the type area is medium to coarse grained and moderately well sorted: in many cases the well sorted sandstone has a calcite cement which produces lustre mottling in hand specimen. Trough cross-stratification is common and small scale slumping was observed in a few places. Although most of the arenites are lithic sandstone, there are some beds of sublabile lithic sandstone.

In the Expedition Range area the unit consists mainly of mudstone, interbedded with lithic sandstone, carbonaceous shale, and conglomerate. As in the type area the sandstone is generally lithic and there are a few beds of sublabile lithic sandstone. Conglomerate is rare; where present it consists of pebbles many of which could be identified as volcanic rocks.

In the Dawson Range area the overall lithology is different to that of the type area and of the Expedition Range area. Mudstone is again the most abundant lithology but it is interbedded not only with sandstone but also with conglomerate and tuff. The mudstone is much the same as that of the type area. The sandstone is generally lithic and contains a brown phyllosilicate, possibly biotite. The matrix also consists in part of a brown phyllosilicate. There is some possibility however, that this phyllosilicate is a authigenic phase having formed from the muddy matrix. Pebble bands of volcanic rocks are common in some beds, and mud pellets are common throughout the sandstone. Sandstone at the base of the sequence is sublabile, and it possibly grades downwards into the sublabile sandstone of the Clematis Sandstone. Calcareous concretions are common in the sandstone.

In a few places in the Dawson Range area a hard, aphanitic, dense, brittle 'cherty' rock crops out, commonly containing dark carbonaceous plant debris. It is possible that this is a siliceous tuff, and if this is the case there was active vulcanism at the time of deposition of part of the unit.

Conglomerate interbedded with the unit in the Dawson Range area, consists almost entirely of fine grained volcanic rocks. The phenoclasts, most of which are round to subround, range in size from ½ inch to 4 inches in diameter, and sphericity is moderate to high. The conglomerate crops out in beds up to ten feet thick.

Structure and relationships

The Moolayember Formation, conformably overlying the Clematis Sandstone, is folded into the Mimosa Syncline, and also involved in the fold west of the Mimosa Syncline, in the western part of the Taroom Sheet area. The maximum regional dip of the unit on the eastern side of the Mimosa Syncline is 20° west, but farther towards the centre of the Syncline, at Flagstaff Hill, the dip is only 3° west. The regional dip to the east on the western side of the Syncline is not apparent in dips measured in the field. This is the result of the very low regional dip, poor outcrop, faulting and minor folding.

The base of the formation dips at about 20° west in the Carnarvon Range area, and the dip decreases westwards to values under 5°.

The Moolayember is the youngest formation in the Permo-Triassic sequence of conformable units commencing with the Oxtrack Formation. It is overlain unconformably by the Jurassic Precipice Sandstone, although in many places the Precipice Sandstone has been stripped off and erosion of the Moolayember has commenced.

Thickness

Based on dip measurements in the field and measurements on air photos, the unit in the Dawson Range area is at least 4500 feet thick; this is a minimum figure as the top of the unit is not exposed. Olgers et al. (1964) have estimated a total of 5500 feet for the unit on the Baralaba Sheet area, the figure being based on seismic work by Marathon Petroleum Australia Ltd. (1963).

The unit is estimated to be in the order of 2000 feet thick in the Carnarvon Range area, but the top is either eroded or covered by Jurassic sediments.

Age

Fossil plants were found and collected from three localities in the Moolayember Formation. They have been identified by M.E. White (1964) and the following is an extract from that report:

'T173 Three and a half miles S. of Glenbar Homestead - Taroom Sheet.

Preservation of these specimens is poor. Some pinnule fragments of Dicroidium odontopteroides (Morr)Gothan are present. The range of this species is Triassic to Lower Jurassic.

T185 Three miles S.S.W. of Glenbar Homestead - Taroom Sheet.

Equisetalean stems are associated with Dicroidium odontopteroides (Morr) Gothan, (including D.lancifolia type).

T549 Two and a half miles N.E. of Mopala Homestead - Taroom Sheet.

Preservation of these specimens is exceptionally good. They include Dicroidium odontopteroides (Morr.)Gothan, and Thinnfeldia acuta Walkom.

On plant evidence therefore, the age of the formation is Triassic or Lower Jurassic.'

A sample from the type area (T232), and one from Hungry Creek (T286), to the south of the type area, yielded Middle to Upper Triassic spores (Evans, 1964b). As the overlying Precipice Sandstone is Lower Jurassic (Evans, 1964a), the Moolayember Formation is probably restricted to the Triassic. It is therefore regarded as Middle to Upper Triassic.

Origin

It seems probable from the abundance of plant material and the lack of marine fossils that the Moolayember Formation, for the most part, is a terrestrial deposit. The abundance of conglomerate in the eastern outcrops, and the presence of trough cross-bedded sandstone throughout the sequence points to a fluvial environment, although it is not impossible that some of the deposition took place in land-locked lakes. There are some indications, especially in the eastern exposures, that there was contemporaneous vulcanism, and certainly the eastern lithologies had a largely volcanic provenance.

EXHUMED TRIASSIC REGOLITH

At this stage in the report, which is arranged in stratigraphic order, some mention must be made of those rocks which underwent considerable subaerial alteration and erosion in the late Triassic. These rocks are now exposed in many places where the overlying Jurassic sequence has been stripped off.

The best preservation of this zone of alteration is in the vicinity of Gyranda Homestead on the western third of the Mundubbera 1:250,000 Sheet area (Fig. 8). The zone of alteration lies as a thick almost horizontal sheet on Permian and Triassic rocks which dip at about 20° to the west. At first sight, both on the ground and on air-photos this appears to be an angular unconformity, the top sequence consisting of a hard white aphanitic chert. On closer examination in the field however, two things become apparent (i) faint traces of bedding can be seen in the chert, dipping at the same angle as the underlying formation, and (ii) Permian and Triassic fossils can be found within the chert at various places. The zone is interpreted as the product of deep weathering in Triassic time, later covered and preserved by the Precipice Sandstone.

At some places where the Precipice Sandstone has been stripped off by recent erosion a relatively flat elevated plain has been left, on top of about 30 feet of the chert. This plain is believed to represent the land surface existing in the area just prior to the deposition of the Precipice Sandstone.

It is evident that the rocks were strongly silicified prior to the deposition of the Precipice Sandstone, but there is little evidence of synchronous lateritization. In only two places were there any signs of ferruginization and this was slight. The base of the overlying Precipice Sandstone is commonly ferruginous, however. This may indicate that the basal sediments of the Precipice Sandstone were derived from a lateritized surface.

The silicification cuts out towards the west, and is not present on the Taroom and Baralaba 1:250,000 Sheet areas. On the Baralaba 1:250,000 Sheet area (Olgers et al. 1964), the Moolayember normally exhibits bedding trends which can be seen on the air photos. Towards the southern boundary of the Sheet area the formation loses the bedding trends and the resultant 'unbedded' photo pattern extends southwards on to the Taroom 1:250,000 Sheet area. As far as can be determined in hand specimen there is no difference between

Figure 8

View of exhumed Triassic surface; dip of strata in flat top hills about 20 degrees west. View taken looking south-west towards 'The Braes'. (Mundubbera 1:250,000 Sheet area). (Neg.No.M322.9) the rocks in the area where the bedding trends are evident and similar rock types from the other area. However, the loss of bedding pattern is thought to have been caused by some type of alteration akin to that described on the Mundubbera 1:250,000 Sheet area. This photo pattern change is delineated on the Taroom 1:250,000 map by a dot pattern, in those areas where the bedding trends are not evident.

JURASSIC STRATIGRAPHY

PRECIPICE SANDSTONE

Summary

The Lower Jurassic Precipice Sandstone whose type area is in the western part of the Taroom 1:250,000 Sheet area, is a widespread cliff-forming quartzose sandstone. The top of the unit is composed mainly of siltstone and argillite. The Precipice Sandstone unconformably overlies Permian and Triassic units. In the areas mapped, its regional structure is a broad reflection of the Mimosa Syncline. The thickness of the unit varies from 100 feet on the eastern limit of outcrop to 400 feet in the southern part of the Mundubbera Sheet area and in the western part of the Taroom Sheet area. The basal, cross-stratified, sandy part of the unit was deposited in a fluvial environment, from currents which flowed mainly from the west. The top silty part of the unit might have been deposited in a lacustrine environment.

Nomenclature and distribution

The name 'Precipice Sandstone' was first used by Whitehouse (1952) for the basal formation of his Bundamba Group. Later (Whitehouse, 1955) he stated "the type area may be taken to be the sandstone cliffs in the gorge of Precipice Creek", which is a tributary of the Dawson River, on the Taroom 1:250,000 Sheet area (Lat.25°33' S. Long 148°58' E). The term 'Bundamba' has had a much longer history, being first used by Cameron (1907) for a sandstone sequence overlying the coal-bearing Ipswich Beds. Since that time it has been applied by many authors to sequences which are very different to that of the Ipswich area. The term Bundamba Group is not used in this report because it is felt that a correlation between the rocks of this area and the Ipswich area has not been established, and this is vindicated by de Jersey and Paten (1963a).

The Precipice Sandstone crops out as high precipitous cliffs from the Carnarvon Range in the western part of the Taroom Sheet as far east as Cracow in the western third of the Mundubbera Sheet. Away from the cliffs the unit forms relatively flat sandy country.

Lithology

Although, as the name implies, the Precipice Sandstone is mainly a sandstone unit, it generally has two lithological components, only the basal one of which is sandstone. The top part of the sequence is characterized by very fine grained sedimentary rocks, mainly siltstone and argillite.

In the type area of the formation, in Precipice Creek, the sandstone cliffs mentioned by Whitehouse (1955) are not composed entirely of a conformable sequence. The basal 300 feet is composed of cross-stratified calcareous lithic sandstone, and green mudstone, of the Moolayember Formation. Towards the top of the Moolayember the sandstone becomes hard and slightly silicified - evidence of pre-Jurassic weathering. The unit lying above the Moolayember Formation consists of 180 feet of cross-stratified sub-labile lithic sandstone which is poorly sorted becoming better sorted and finer towards the top of the cliff. At the top of the cliff the main lithology is a hard white argillite interbedded with some siltstone.

Throughout the area mapped, the unit as in the type area, consists of the basal sandstone which becomes finer towards the top, grading to white argillite. The sandstone is generally a quartzose sandstone, but in some cases the lithic fragments are more common and the sandstone is sublabile lithic. Mica flakes and plant stem impressions are common. The sandstone is generally poorly sorted and quartz pebbles are common. Very coarse sandstone is most common towards the base of the unit. The sandstone is invariably cross-stratified, the cross-stratification being generally planar; simple and trough cross-stratification has been observed, however. The scale of the cross-stratification ranges from structures involving laminae to those involving sets of beds (Figs. 9 & 10).

Authigenic pyrite commonly occurs within the sandstone. A bore near Rocky Creek Homestead (Mundubbera Sheet) brought up rosettes of pyrite up to $\frac{3}{4}$ inch in diameter from porous Precipice Sandstone. An outcrop in Cockatoo Creek near Morungulan Homestead (Mundubbera Sheet) exposes heavy light grey, medium-grained sulphurous smelling sandstone containing grains of pyrite. (For Analysis see Appendix F, Sample T 767).

Figure 9

Thickly cross-bedded quartz sandstone. Lower part of Precipice Sandstone. (Taroom 1:250,000 Sheet area).
(Neg.No.M322/6.)

Figure 10

Thinly cross-bedded fine quartz sandstone in lower part of Precipice Sandstone. Also aboriginal hand paintings - red ochre spray. Location six miles south-south-east of 'Mqpala'. (Taroom 1:250,000 Sheet area). (Neg.No.M322/7)

Siltstone, commonly white or yellow-brown, is most common in the upper third of the unit. It is generally laminated, and in places it is thinly laminated: cross lamination is common. The siltstone grades vertically into argillite, which is not laminated. In places the argillite has minute plant impressions preserved on bedding planes. The argillite crops out in the cliff formed by the Precipice Sandstone, interbedded with thin beds of fine sandstone. It differs from the basal argillite of the Evergreen Formation, which is flaggy to shaly, because it is generally massive to slabby in the terminology of Mc Kee and Weir, (1953).

Structure and relationships

An angular unconformity separates the Precipice Sandstone from the underlying Permian and Triassic units, and the unconformity is especially noticeable on the western third of the Mundubbera 1:250,000 Sheet area, where the almost horizontal Precipice Sandstone overlies strata which dip at about 20° to the west.

As far as can be seen in the field the dip of the unit nowhere exceeds 5° in the area mapped. Dip measurements of regional significance are difficult to obtain in the Precipice Sandstone with the methods employed on a regional survey, but from the general outcrop pattern the unit forms part of a large synclinal structure whose axis corresponds closely to that of the Mimosa Syncline. The dip on the limbs of the syncline is less than 5°. The unit is overlain conformably by the Evergreen Formation, the boundary between the two units being transitional.

Thickness

In the area mapped the unit varies in thickness from 100 to 400 feet. It is thinest on the Mundubbera Sheet area where as little as 100 feet of sandstone occurs between the Camboon Andesite and the Evergreen Formation. At no place in this area was the unit actually observed to thin gradually and disappear. Ten miles west of the locality it is 100 feet thick. At Nathan Gorge it is of the order of 300 feet thick. To the south of Nathan Gorge, it thickens gradually and 400 feet of the unit were encountered in UKA Burunga No. 1 (Enclosure 3). The unit is about the same thickness in the Hutton Creek area and 350 feet was measured in the Carnarvon Range area. It thins, however, towards the north-east, and is only 250 feet thick in the north-east corner of Taroom. In that locality, and at Nathan Gorge, UKA Cockatoo Creek No. 1 and UKA Burunga No. 1 the basal coarse part of the unit is consistently about 200 feet thick. It is 300 feet thick in the Carnarvon Range area.

Age

The Precipice Sandstone is regarded as Lower Jurassic (Evans, 1964a) on palynology. Evans reports that spores were found 1½ miles north-east of Buffel Creek Homestead (Taroom Sheet) in the Precipice Sandstone (T 285), 50 feet from the base of the unit. The microfloral assemblage includes species of Classopollos, numerous bisaccate gymnosperm pollens, and a variety of pteridophyte microspores referable to Cyathidites, Baculatisporites, Lycopodiumsporites, Ischyosporites, Perotrilites and several undescribed genera.

Origin

Like the Clematis Sandstone, the Precipice Sandstone is the result of fluvial deposition over a wide flood plain. The lack of marine fossils and the abundance of plant impressions indicates a terrestrial environment. The coarse cross-stratified basal part of the unit testifies to the presence of strong traction currents common in a flood plain. This does not apply to the top finer part of the sequence; the significance of this reduction in grainsize is not known. It may represent a change to the lacustrine environment of deposition.

Many measurements of cross-stratification attitudes were made within the basal, coarser part of the unit. The azimuthal distribution of these measurements is shown in Figure 11. It is apparent that the main direction of currents was from the west, possibly the south-west. It is also apparent that there is less consistency of direction in the western third of the Mundubbera Sheet area. This lesser consistency is a reflection of the fact that the readings were taken near the eastern limits of sedimentation. It is not impossible that there was some shed from the east.

EVERGREEN FORMATION.

Summary

The name "Evergreen Formation" is an extended usage of the name "Evergreen Shales" of Whitehouse (1952), and includes all Jurassic sediments between the Precipice Sandstone and the Hutton Sandstone. Two members have been differentiated - the Boxvale Sandstone Member and an oolite member. The Boxvale Sandstone Member is a lensing well-sorted quartzose sandstone. The oolite member is a widespread pelletal or oolitic chamosite marker occurring above the

CROSS BEDDING AZIMUTHAL DISTRIBUTIONS IN PRECIPICE SANDSTONE

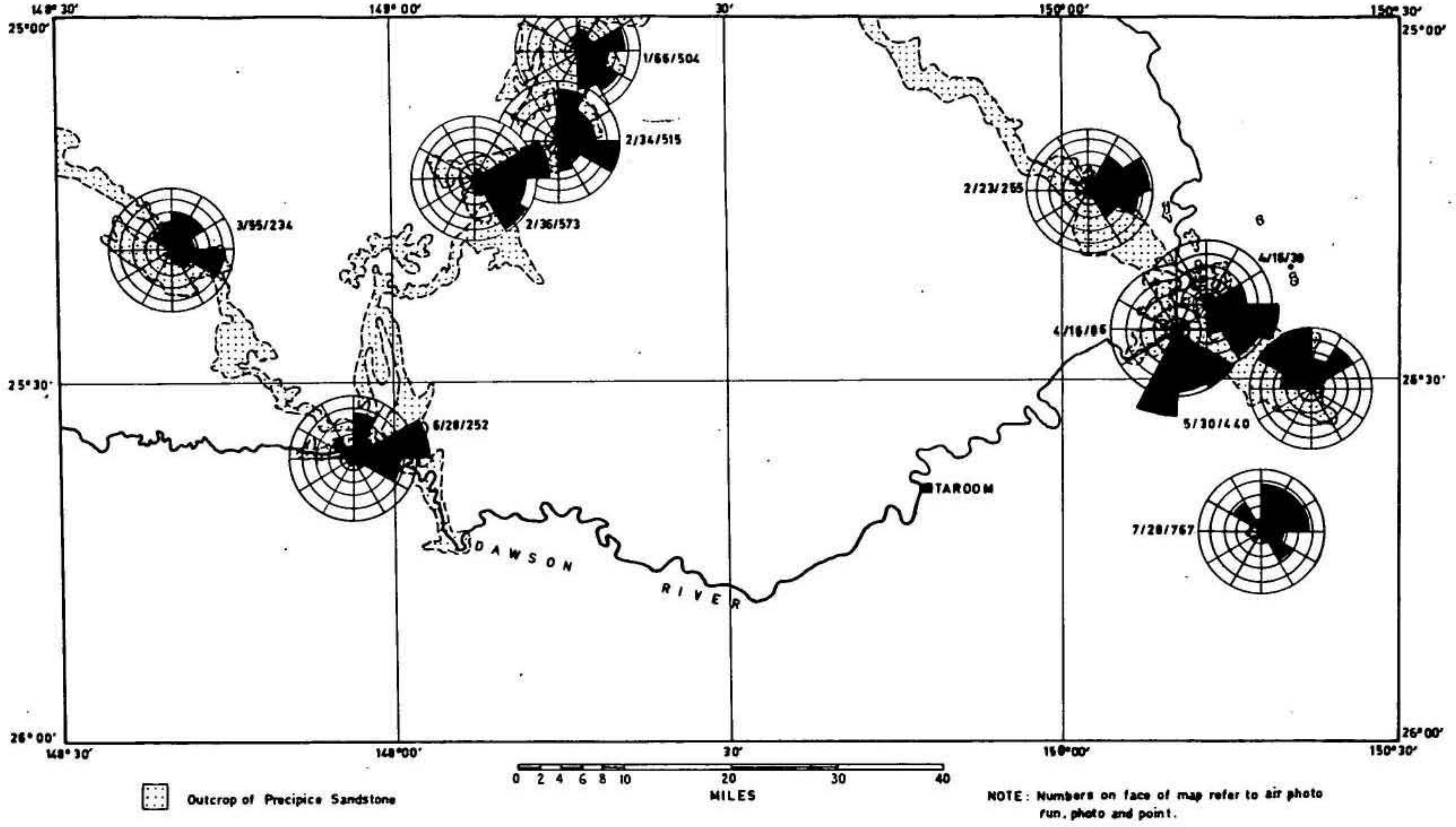


Fig. 11.

Bureau of Mineral Resources, Geology & Geophysics *To accompany Record 1964/61.*

G55/A8/6

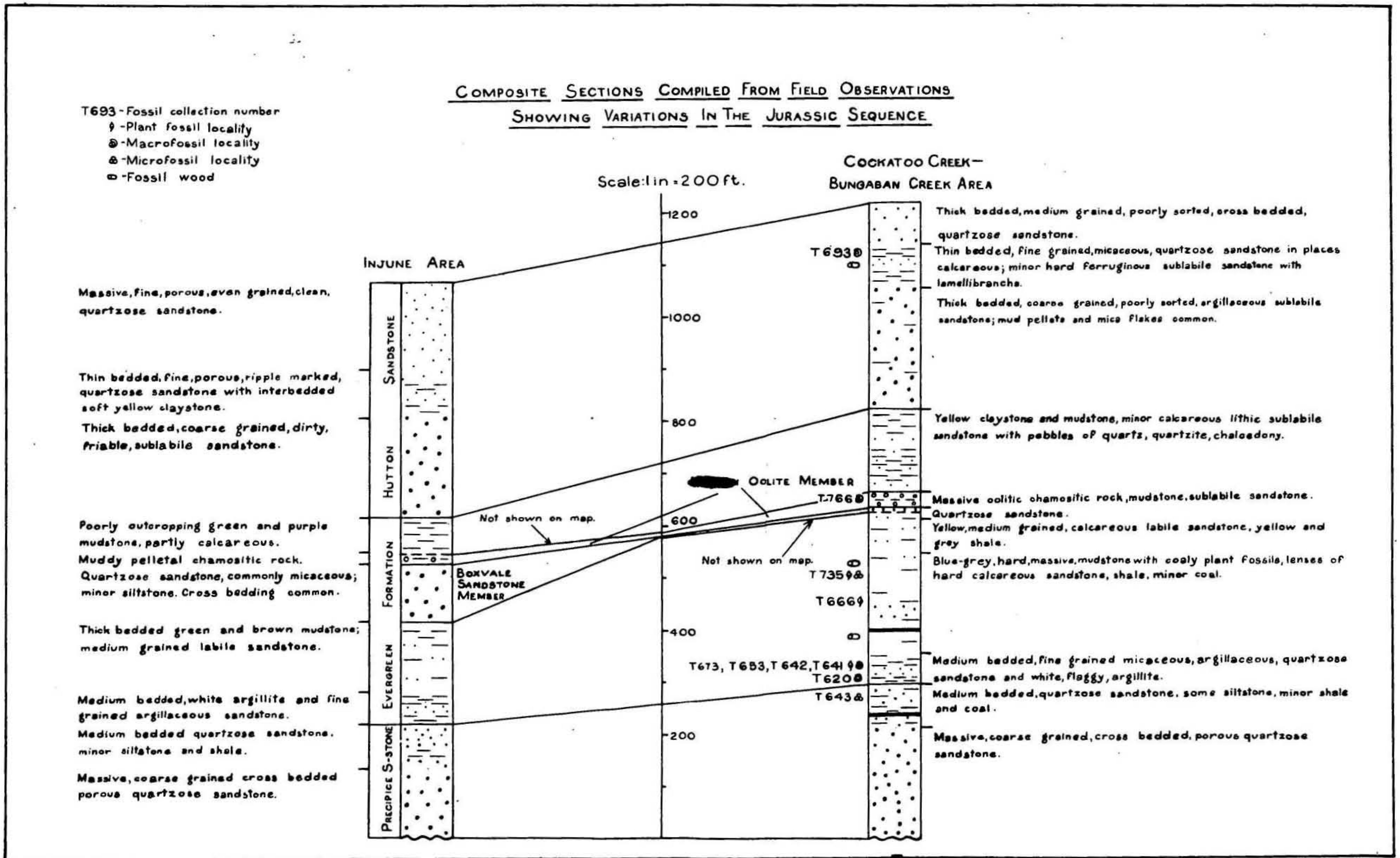
67

Boxvale Sandstone Member. The rest of the Evergreen Formation includes labile and sub-labile sandstone, mudstone, argillite and minor shale and coal. Plant fossils and pelecypods have been collected from the unit. Most of the formation has been deposited under fresh water lacustrine conditions, but some evidence suggests that the oolite member was deposited during an abrupt and short lived marine incursion. The absence of a marine macrofauna, and the cessation of chamosite deposition before any great thickness had accumulated, suggest a quick return to brackish or fresh water conditions.

Nomenclature

The name Evergreen Shales was first used by Whitehouse in 1952 (p. 90) for a formation within the "Bundamba Series". He defined it in 1955 (p. 7) as "the shale sections seen between the upper and lower sandstones in the valley of the Dawson River, immediately below Evergreen Homestead". However the present survey found that even in the type area of the Evergreen Shales and the Boxvale Sandstone, there is a return to a shaly sequence above the Boxvale Sandstone, before the commencement of the dominantly sandy Hutton Sandstone. Moreover, the Boxvale Sandstone is a thin impersistent unit in the area mapped, and it was found to lense out towards the centre of the Mimosa Syncline (Fig. 12), making it impossible to pick the top of the Evergreen Shales, as defined by Whitehouse, on the eastern limb of the Mimosa Syncline. However, rather than abandon the well-known and widely used name "Evergreen", it is thought preferable to regard the Boxvale Sandstone and the oolite member as members within what it is now called the "Evergreen Formation". The Evergreen Formation, so defined, includes the Evergreen Shales of Whitehouse, the Boxvale Sandstone of Reeves, together with the oolite member and the shaly sequence above it. The top of the Evergreen Formation (and the base of the Hutton Sandstone) is placed immediately below the lowest massive sandstone occurring above the oolite member. The top of the Evergreen Formation, as defined, can thus be located in areas where the Boxvale Sandstone Member has lensed out. Even in those few areas where the pelletal chamosite marker has not been located, the break from the fine grained sequence at the top of the Evergreen Formation to the sandy, more quartzose sequence of the Hutton Sandstone can easily be identified. The Hutton Sandstone is a thick, extensive, persistent

Fig. 12.



Bureau of Mineral Resources, Geology & Geophysics. May, 1964. To accompany Record 1964/61. G55/A8/7 formation, recognised in outcrop and in subsurface logs, and its base is thus a good formation boundary. A study of cuttings from petroleum exploration wells in the Injune-Wandoan areas showed that what is usually identified as "Evergreen Shale" in the logs, is not in fact the "Evergreen Shales" as defined by Whitehouse, but corresponds with the revised definition of "Evergreen Formation" in which the Boxvale Sandstone occurs as a sandy member.(L.V. Bastian pers. comm.). Moran and Gussow (1963, p. 46) in a discussion of the Moonie wells note "A persistent 25 foot sand member in the upper part of the Evergreen section may represent the "Boxvale Sandstone Member" of Reeves in the Roma area. A similarly located sand occurs in the Cabawin wells where it is 30 feet thick".

<u>Type Area</u>

No detailed sections have been measured in the Evergreen Formation. Whitehouse (1955) suggests the Evergreen Homestead area as the type area of his "Evergreen Shales". Reeves (1947) suggests the Boxvale Homestead area as the type area of his "Boxvale Sandstone". The whole Evergreen Formation between the Hutton Sandstone and the Precipice Sandstone is exposed in both of these areas, and either could be designated the type area of the Evergreen Formation. More work is proposed during the 1964 field season to determine the best type section for the whole formation.

<u>Distribution and Topography</u>

The Evergreen Formation crops out in a continuous arcuate belt from Boxvale Homestead in the north-west of the Taroom Sheet to Karrinya Homestead in the north-east of the Sheet, and then south-east across the Mundubbera West Sheet to Kilbeggan Homestead in the south-east corner. The Boxvale Sandstone Member crops out prominently and invariably forms a steep scarp. The oolite member crops out poorly in the Hutton Creek area, but is generally well-exposed in the Cockatoo Creek area, forming a small but distinct scarp. The rocks of the rest of the formation are poorly-exposed and do not form scarps. Dark, heavy, clay soils are generally developed on the formation, and support thick scrub.

<u>Lithology</u>

The Evergreen Formation consists of a sequence of labile and sub-labile sandstone, mudstone and argillite, with minor siltstone, shale and coal. Two members within the formation have been recognised - the Boxvale Sandstone Member and immediately above it stratigraphically, the oolite member. Where present, these members occur in the upper half of the Evergreen Formation, but one or both may be thin or absent.

Sandstone probably accounts for half of the lithologies of the Evergreen Formation, and is very common in outcrop, as the other rock types crop out poorly. The lithologies of the Boxvale Sandstone Member and the oolite member are described under those headings. Sandstone in the rest of the Evergreen Formation is generally labile or sub-labile, and beds are generally lenticular. The sandstone is more labile towards the top and more quartzose at the base of the formation, but quartz grains would rarely make up more than 60% of the grains. The sandstone is generally light grey, flaggy, micaceous and probably felspathic near the base of the unit, becoming greenish and massive with more lithic fragments higher up the section. A coarse pebbly sub-labile sandstone in the Mt. Misery area (Mundubbera) contained clean quartz grains, lithic fragments, and pebbles of fossil wood, chert, quartzite and flint. However the sandstone is generally fine to medium grained, and pebbles are not common. Sandstone beds range from two to eight feet in thickness, the thinner beds being most common near the base of the unit. An argillaceous matrix is common, and the sandstone is generally impermeable. Calcareous and ferruginous cement are also common, and lustre mottling has been noted. Ripple marks and small scale cross-stratification have been noted. Fossil wood and stem impressions are common in the lower half of the formation.

Mudstone and argillite are common fine-grained sediments in this unit. A hard, dense, white, flaggy, micaceous, medium-bedded argillite is a characteristic lithology at the base of the formation. This lithology is also commonly interbedded with fine quartzose sandstone at the top of the Precipice Sandstone. This argillite is frequently ironstained along joints, particularly in the Cockatoo Creek area. The mudstone is frequently light green or khaki in colour, weathers easily, and in places has a calcareous cement. A hard blue-grey massive mudstone with coaly plant fossils is a common lithology occurring just below the oolite member in the Cockatoo Creek Area. Whitehouse (1952) states that the clays of the Evergreen Formation are kaolinitic, in contrast with those of the Injune Creek Beds which, he states, are never kaolinitic.

Siltstone and shale are not common. A feature of the finer sediments of the Evergreen Formation, particularly near the base, is the development of flaggy fissility. This fissility is due to the presence of very thin bands of shale, or aligned mica or other platey minerals.

Coal seams are common in the lower part of the Evergreen Formation, but these are always thin and probably discontinuous. Coal seams appear to be more common in the area east of Taroom than in the Injune Area. Rare very thin beds of concretionary limonite have been seen cropping out not far from small coal seams. These appear to be sedimentary limonite and not replacement deposits.

Rocks of the upper part of the Evergreen Formation (above the oolite member) seldom crop out. In the Hutton Creek area outcrops of this section are so poor that it was not separated from the oolite member on the map. Lithologies that have been noted above the oolite member include greenish and purplish calcareous mudstone and lustre mottled siltstone. Lithologies at the top of the Evergreen Formation in the Cockatoo Creek area include yellow claystone and siltstone, and poorly sorted sublabile sandstone with calcareous cement, containing some fossil logs.

Structure

The Evergreen Formation conforms to the general structure of the Jurassic sequence, and regional dips are generally very low. However there are many small local rolls producing dips of up to 10° (see Fig. 13). Some of these rolls are probably produced by differential swelling of the clays of the formation.

The dominant structure in the Jurassic sequence is a broad gentle syncline which has been called the Mimosa Syncline (Hill and Denmead, 1960, p. 314). The axis of the syncline trends approximately south-south-east across the Taroom sheet, and plunges gently to the south (see structural sketch map). Regional dips are very low, with few greater than 2°.

To the west of the Mimosa Syncline is a gentle anticlinel plunging south-east. The existence of this anticlinal structure is evidenced by the outcrop pattern, and by the occurrence of what is almost an inlier of Precipice Sandstone in the valley of Hutton Creek, between Bonnie Doon Homestead and west of Yebna Homestead.

This structure is separated by a broad syncline from the Hutton-Eurombah Creek Anticline (Reeves, 1947, p 1354) in the Hutton Creek area, north-east of Injune. This

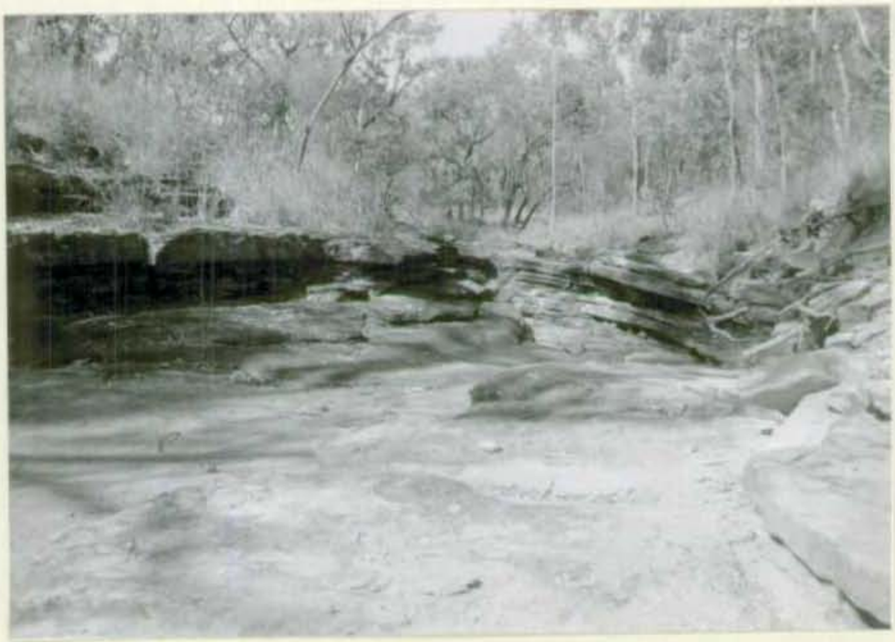


Figure 13

Monoclinal flexure in medium grained feldspathic-quartz sandstone of Evergreen Formation. (Taroom 1:250,000 Sheet area). (Neg.No.M322/3) structure is apparent on the surface just north of Hutton Creek No. 1 Bore. The axis trends south for about five miles, and then swings south-east following Hutton Creek for eight miles, and then swings back towards the south. The occurrence of two inliers of Precipice Sandstone along the axis of this anticline indicates slight cross folding to give domal structures. These domes have been referred to as the Hutton Dome (Reeves, 1947), and the South Hutton Dome (Reeves, 1935). Both domes are elongated along the anticlinal axis and are asymmetric in cross-section. Dips to the west in the Hutton Dome are as high as 10° but the high dips are confined to a very narrow strip and regional dip is less than 2° within a mile of the axis. The maximum observed dip to the east was 2°. Similarly in the South Hutton Dome, dips of up to 7° are confined to a narrow zone on the south-west limb, while highest observed dip on the north-east limb was less than 2°. In places, particularly at either end of the South Hutton Dome there is an abrupt change in dip slope directions along the axis of the anticline. This suggests stresses were relieved by faulting along the axis, as well as by folding. One persistent fault following the axis of the anticline along Hutton Creek, appears to have faulted out part of the Evergreen Formation resulting in Boxvale Sandstone being downfaulted against Precipice Sandstone. This would indicate a throw of about 140 feet. There are numerous, smaller faults and major joints in this area and their pattern of distribution bears some resemblance to an en echelon pattern. The faulting and folding in the Hutton-Eurombah Creek Anticline is the result of movements along faults in the underlying Permian or basement rocks.

East of the axis of the Mimosa Syncline, photo-interpreted dip slopes seem to indicate a slight anticlinal structure with a north-west axis following Cockatoo Creek, just west of Cockatoo Creek No. 1 Well. No other supporting evidence for this structure has been seen. Farther south, near the junction of Kennedy Creek and Cockatoo Creek, a monoclinal structure in the Evergreen Formation is well outlined by the oolite member. The maximum dip observed was 3° towards the west. This structure may also indicate a deep-seated fault. The slight anticlinal structure centred on Mt. Misery is merely an expression of depositional dip off the basement high of Mt. Misery.

Relationships

The Evergreen Formation conformably overlies the Precipice Sandstone, and the boundary is gradational. Although it is quite easy to pick a photo pattern boundary at the approximate base of the Evergreen, it is hard to locate a consistent boundary on the ground with an accuracy better than 20 feet stratigraphically. The boundary in general, is taken above the last massive quartzose sandstone in the Precipice Sandstone. This puts some fine thin-bedded argillite into the top of the Precipice, but excludes massive cross-bedded quartzose sandstones from the Evergreen Formation. Moreover, this boundary seems to coincide with the photo pattern boundary. There is commonly a development of thin to medium-bedded hard white argillite at the base of the Evergreen, which generally gives a smooth white photo pattern. In photo interpretation, where no other evidence is available, the Precipice-Evergreen boundary is placed immediately below this photo pattern.

The Evergreen Formation overlaps the Precipice Sandstone and rests directly on the granodiorite in the Auburn Range area. There is also overlap of the lower part of the Evergreen Formation by the oolite member near Kilbeggan Homestead in this area.

The Evergreen Formation is overlain conformably by the Hutton Sandstone. This boundary is more abrupt than the Precipice-Evergreen boundary but probably it also is gradational

Environment of Deposition

The abundant frequently well-preserved plant remains, the thin coal seams, and the absence of a definite marine fauna suggests a general fresh water lacustrine environment for the Evergreen Formation below the oolite member. Collections of small pelecypods have been made from a zone containing abundant pelecypods associated with plant debris near the base of the formation in the Cockatoo Creek area. However, the habitat of these pelecypods is unknown, and none has been seen in the Evergreen Formation outside the Cockatoo Creek area.

The sediments were probably deposited in a moderately shallow basin in which subsidence kept pace with deposition but which was without appreciable uplift of the source area (and consequent rejuvenation of contributing streams). Thus relief (and supply of terrigenous sediment) was probably being progressively reduced throughout the deposition of the Evergreen Formation. The alternation of sandstone and argillite common at the base of the formation over a wide area suggests heavy variable rainfall. The disappearance of obvious alternation, of coarse and fine-grained sediments probably indicates a change to more uniform rainfall. The abundant carbonaceous matter about the middle of the formation suggests prolific vegetation in the source area, and little reworking and poor oxidation of the sediments. The greater total thickness of the formation in the Cockatoo Creek area, combined with the greater proportion of finer, more labile and more poorly-sorted sediments suggests that subsidence may have been slightly faster here, than in the Injune Area (see Fig. 12).

The Boxvale Sandstone Member was probably deposited in a fresh water environment as a shoreline fringing deposit, extending into the basin by the encroachment of coalescing sandy deltaic deposits over the finer, less mature, deeper water sediments.

The most abrupt change in depositional environment in the Evergreen Formation is evidenced in the Hutton Creek Area, with the change from the high energy deltaic environment of the Boxvale Sandstone Member giving way suddenly to the relatively quiet conditions suggested by the oolite member. The saline environment suggested for the deposition of chamosite may be the result of a sudden marine incursion into the basin at about the "red oxidised horizon" noted by Bastian (pers. comm.) at the top of the Boxvale Sandstone Member. This would have resulted in a moderate but abrupt deepening of the water of the basin, with a change in location of deltaic deposition further from the centre of the basin, towards the new shore line, and deposition of chamositic mudstones in the quieter water above the old drowned deltas.

The change in environment of deposition at the base of the oolite member seems to have been just as abrupt in the Cockatoo Creek area. The rocks immediately below the oolite member in this area invariably include light grey mudstone with abundant well-preserved coaly plant fossils. The absence of plant fossils, (other than logs) in the oolite member, suggests it was too far from the shore to receive land plants (i.e. the water became suddenly deeper). Moreover a saline environment of deposition seems most likely for the oolite member. This environment could possibly be provided in a saline non-marine lake. However there is no suggestion of the gradual increase in salinity that would be expected in a large saline lake, possibly under the influence of a long drought period. There is no evidence to suggest conditions other than a fresh water environment for the Evergreen Formation immediately below the oolite member. Moreover, in a saline lake, the water level would be expected to fall, if anything, as salinity increased to the required level for chamosite deposition. Thus the sudden change to deeper water environment to allow the deposition of soft pelletal chamositic mud above the high energy, shallow water, Boxvale Sandstone Member would require tectonic explanation if the concept of a saline lake environment is adhered to.

Certainly there appears to have been an abrupt change in salinity and depth of water over a large area of the basin just before deposition of the oolite member commenced. These changes are consistent with the concept of a sudden marine incursion into the basin at this time. The absence of a marine macro-fauna suggests that the basin had only limited access to the open sea. Moreover this inlet was probably quickly barred, with the return to brackish or even fresh water conditions coinciding with the disappearance of chamositic sediments, and the return to a normal shaly sequence at the top of the Evergreen Formation.

The onset of Hutton Sandstone deposition probably represents the return of encroaching deltaic deposits as the rivers once again built out their deltas. However the thickness, persistence, and general immaturity of basal sediments of the Hutton Sandstone suggests there was also some uplift of the source area, with rejuvenation of the rivers, to account for the greatly increased supply of sediment.

Thickness

The thickness of the Evergreen Formation in the area mapped, as indicated from barometric measurements and bore logs, ranges from 400 feet in the Hutton Creek area to 540 feet in the Cockatoo Creek area. Changes in the thickness of the formation itself, and of the members within it, are illustrated in the composite section.

Macropalaeontology

Collections of plant fossils and pelecypods, and one indeterminate vertebrate bone fragment have been made from the Evergreen Formation. Collection numbers, localities and determinations (White, 1964) are summarised in the following table (All collections are from Mundubbera West Sheet):-

Field Number	Location	Determinations
T641	25°43'S., 150°19'E.	Pagiophyllum peregrinum (?)
T642	25°43'S., 150°19'E.	Cladophlebis australis (Morr) Dicroidium cf. D. odontopteroides
T653b	25°43'S., 150°16'E.	Cladophlebis australis (Morr) Coniopteris delicatula (Shirley) ([illegible]) Otozamites obtusus (L. & H.) Nilssonia minima Gothan
T666	25°42'S., 150°23'E.	Indeterminate fern frond
T735	25°33'S., 150°14'E.	Pagiophyllum peregrinum (L.&H.) ([illegible]) Retinosporites indica Feist Equisitites sp.
T653a	25°43'S., 150°16'E.	Collections of [illegible] pelecypods, not yet examined.
T673	25°44'S., 150°20'E.	
T766	25°37'S., 150°09'E.	
T620	25°53'S., 150°18'E.	Indeterminate bone fragment, tentatively identified as a dinosaur rib bone (J.T. Woods, Qld Museum, pers. comm.)

Stratigraphic positions of these collections as indicated from field evidence are shown in the Composite Section.

The identification of Permian Merismopteria sp. from Cockatoo Creek, reported by Laing (in Hill and Denmead, 1960, p.216) is no longer sustained (Prof. Hill, pers. comm.). The pelecypods appear to have been collected from the base of the Evergreen Formation, and are probably Jurassic in age.

Palynology

Evans (1964b) has discussed the palynology of samples collected from the Evergreen Formation in the Taroom-Mundubbera area. He refers that part of the formation below the oolite member to his unit J1, and the oolite member and the shaly sequence above it coincide with J2. In the present report the palynology of samples from unit J2 is discussed in the section on the oolite member.

Two samples, T653 and T735, were collected from the basal part of the Evergreen Formation. The following identifications were made by Evans (1964b).

T653 On Cockatoo Creek, Mundubbera 1:250,000 Sheet area.

Cyathidites cf. C.minor Couper
"Apiculati sp. nov"
Laricoidites sp.
Disaccites spp. undiff.
Classopollis sp. (very common)

T735 Three quarters of a mile south of Dawson Vale Homestead (Mundubbera 1:250,000 Sheet area). An abundant, but somewhat oxidized yield of:

<u>Stereisporites</u> sp.

<u>Lycopodium sporites</u> spp.

<u>Perotrilites</u> cf. <u>P.tenuis</u> de Jersey

Disaccites spp. undiff.

<u>Classopollis</u> sp. (very common)

Age

Palaeobotanical evidence proves that the Evergreen Formation is of Jurassic age (White, 1964). Unpublished palynological reports (de Jersey and Paten, 1963b) indicate a Lower Jurassic age.

BOXVALE SANDSTONE MEMBER

Summary

The Boxvale Sandstone Member is a lenticular sandstone unit within the Lower Jurassic Evergreen Formation. It is characteristically a scarp former, and has a maximum observed thickness of 180 feet. The typical lithology is a medium-grained, white, well sorted, porous, quartzose sandstone. It was deposited in a high energy environment, probably as a deltaic deposit in a lacustrine environment or as a strand line deposit before an advancing sea.

Nomenclature and Type Area

The name Boxvale Sandstone was first used by Reeves (1947) for a member of the Bundamba Series in the Roma district. He recorded it as "30-80 feet thick and forming prominent cliffs and a network of re-entrant canyons along the principal streams north-west and south-east of Boxvale Homestead". Whitehouse (1952, p. 90) used the name Boxvale Sandstone for the topmost "formation" of the "Bundamba Series". Later, in 1955 (p. 7) in a discussion of the "Bundamba Group" he states "the Group consists of three members, in descending order as follows:- (iii) Boxvale Sandstone (ii) Evergreen Shales (i) Precipice Sandstone".

As outlined in the discussion of the nomenclature of the Evergreen Formation, the "Boxvale Sandstone" of Reeves is regarded by the authors as a member within the Evergreen Formation, and is referred to as the Boxvale Sandstone Member.

No type section has been measured.

Distribution, Topography.

The Boxvale Sandstone Member crops out in a continuous arcuate belt on the western limb of the Mimosa Syncline from Boxvale Homestead, in the north-west of the Taroom Sheet, to Cooranda Homestead, near the northern edge of that sheet.

The unit crops out strongly, and invariably forms a definite scarp. Because of the common occurrence of secondary silica overgrowths on the quartz grains, the unit does not weather easily, and is not a prolific soil former. The soil found on the top of the plateaus of Boxvale Sandstone is generally a residual red soil from the oolite member, and not a sandy soil as might be expected.

Lithology

The Boxvale Sandstone Member consists of quartzose sandstone with some minor thin beds of micaceous siltstone and mudstone.

The sandstone is generally white or light grey in colour, but is sometimes ironstained to a pinkish or yellowish brown. The grains are generally angular, and fine to medium-grained, but some coarse-grained sandstone has been noted. The sandstone is typically well-sorted and even-grained, often with well-developed grain orientation. Primary porosity is good. The deposition of secondary overgrowths on the quartz grains has reduced the porosity and results in a very resistant rock with a sugary appearance. However, porosity is still sufficient to provide a good aquifer. Quartz grains generally make up more than 90%, and rarely constitute less than 75% of the clasts. Mica flakes are very common, and are sometimes concentrated into seams giving the sandstone a poorly developed flaggy fissility. One specimen examined under the microscope contained abundant accessory minerals (zircon, tourmaline, iron ores). More detailed work is necessary to determine whether this is a typical characteristic. An argillaceous matrix is sometimes present, and bands of mud pellets have been noted. Logs of fossil wood have been seen, but are not common.

The member changes along strike in thickness, grain size and bedding characteristics. It varies from 180 feet of coarse, massive, current bedded, clean quartzose sandstone in outcrop near Hutton Creek No. 1 Bore, to 30 feet of fine-grained thin bedded argillaceous quartzose sandstone north of Baroondah Homestead. Farther to the north-east it lenses out completely.

There is another thin sandstone member at about the same stratigraphic level (immediately below the oolite member) in the Geddesvale Area on the Mundubbera sheet. It is well exposed in places in the upper reaches of Impey Creek, and ranges from a red, heavy hematite impregnated, quartzose sandstone, to a fine, white, porous, well-sorted, quartzose sandstone. Ferruginisation has developed along a well developed polygonal joint pattern, and in places has resulted in the formation of a dark, heavy, concretionary ironstone. This sandy member has not been mapped as it probably does not exceed ten feet in thickness, and like the Boxvale Sandstone Member itself, it lenses out towards the centre of the Mimosa Syncline (this was probably about the centre of the depositional sub-basin also, between the Auburn Range to the east and the Nebine Ridge, or an extension of it, to the west). Both sandstone units may represent part of a belt of shoreline sands which encircled the basin.

Structure and Relationships

No evidence has been seen to suggest any unconformity above or below the Boxvale Sandstone Member. The structure of this member will be described within the section on structure of the Evergreen Formation.

Environment of Deposition

There is little positive evidence to indicate the chemical environment of deposition. The abundance of well-sorted cross-bedded sandstone indicates a high energy environment and suggests aerobic conditions. Palaeontological evidence consists of a few stems and log impressions. There is no evidence to indicate any interruption of the fresh water conditions which probably prevailed during the deposition of most of the lower part of the Evergreen Formation, and therefore a fresh water lacustrine environment is postulated.

The very good sorting of the sandstone suggests that either it was derived from the weathering of another sandstone in the source area or, there was reworking of the sediments in the depositional site. Some specimens show dimensional orientation of grains, and an abundance of heavy accessory minerals. These features indicate reworking in the depositional site, which could suggest a littoral marine environment of deposition. However no other evidence has been seen to suggest a marine environment, and a non-marine deltaic environment is thought more likely. As appreciable tides were probably absent in such an environment, the good sorting and grain orientation suggests vigorous lacustrine wave action. The areal distribution and thickness variations of the Boxvale Sandstone Member in the area mapped are consistent with those that might be expected in a deltaic deposit fringing the shore line of a large lake. Such a deposit would extend into the lake by the encroachment of the coalescoing sandy deltaic deposits over the finer deeper water sediments. It would be expected to be thickest near the shore, becoming thinner and finer-grained towards the centre of the lake, and these features are seen in the area studied. The fact that the member lenses out gradually, and is not truncated abruptly, suggests that longshore currents (and tides) were absent.

Thickness

The Boxvale Sandstone Member has a maximum thickness of about 180 feet near Hutton Creek No. 1 Well and becomes uniformly thinner towards the east. Thicknesses measured by barometer are:-

Near O.S.L. No. 2 Hutton Creek	180 feet
Fairview Holding	150 feet
Pigface Flat	140 feet
Springwater Holding	110 feet
Yebna Holding	35 feet
Baroondah Holding	30 feet

This unit has not been recognised on the Mundubbera sheet, or on the Taroom sheet on the eastern limb of the Mimosa Syncline.

Age

No macro-fossils have been collected from the unit. However palaeontological and palynological evidence from below and above it, indicate a Lower Jurassic age.

THE OOLITE MEMBER

Summary

The oolite member of the Evergreen Formation is a persistent unit, generally less than thirty feet thick, found near the top of the Evergreen Formation. The essential lithology is an oolitic or pelletal rock which is limonitic in outcrop, but which has been identified by X-ray diffraction as being chamositic when fresh. It is a conformable member within the Evergreen Formation, occurring above the Boxvale Sandstone Member in the type area of that member.

Its unusual mineral composition suggests a marine incursion into the Surat Basin in the Lower Jurassic. The absence of a marine macrofauna, and the cessation of chamosite deposition, before any great thickness had accumulated, suggest a quick return to brackish or fresh water conditions.

Nomenclature

The unit has not been named formally as yet. A type section will be located during the 1964 field season, and a formal name selected.

Distribution, Topography, Photo Pattern.

The member occurs within the Jurassic succession and crops out in a continuous north-west trending area across the Mundubbera west sheet, from Kilbeggan Homestead in the south-east to the Glebe Homestead in the central west, and onto the Taroom sheet. This will be referred to as the Cockatoo Creek area. The unit has also been mapped in the Injune area on the Taroom sheet, where it crops out from Boxvale Homestead in the north-west, around the Hutton Anticline to Currajong Homestead in the centre of the sheet. This will be referred to as the Hutton Creek area. Topographic expression and photo pattern are different in these two areas.

In the Cockatoo Creek area, the harder beds of the unit generally crop out well, and invariably form a small but definite scarp, which often has a thin line of thicker vegetation along its edge. Vegetation over the whole unit is generally not as thick as on the overlying mudstones of the Evergreen Formation, and a smooth patterned moderately vegetated plateau with a thin line of thicker vegetation along the edge of the scarp, is a characteristic photo pattern of the unit. Dark soil, generally red or brown, is commonly developed on the unit in this area.

In the Hutton Creek area, the unit crops out poorly and rarely forms a scarp. Deep red soil and thick, sometimes patchy, vegetation is common. In places, the thick scrub is absent, and here the unit gives a smooth photo pattern which contrasts strongly with the coarser textured pattern developed on the underlying and overlying sandstone.

Lithology

Cockatoo Creek Area

The dominant lithology of the oolite member in the Cockatoo Creek area is a pelletal or oolitic chamositic rock which crops out as oolitic limonite. Oolitic rock from cores obtained in drill hole B.M.R. 29, and from outcrop samples revealed the presence of chamosite on X-ray determination (L.V. Bastian, pers. comm.). The rock varies in outcrop from a homogeneous aggregate of tightly packed pin head sized spherical limonite ooliths, to a fine brown poorly sorted ferruginous sandstone containing small ovoid earthy limonite pellets. However, there is generally a sharp contact between the pelletal or oolitic rock, and the interbedded siltstone or mudstone and gradational lithological changes from oolite to siltstone (apparently non chamositic) are rare.

A mineragraphic investigation of outcropping oolitic material revealed an aggregate of elliptical and spherical limonite pellets with concentric oolitic structure, and with the interstices filled with siliceous material and hydrated iron oxides (see Appendix A). It is not known whether the whole rock was originally completely chamositic, or whether limonite was originally present in the matrix, or forming the ooliths, either by itself, or in alternating concentric bands with the chamosite. Hallimond (1925) notes that chamosite on weathering retains its structure, but is converted to a clay-like mineral stained with limonite.

Probably the best exposures of massive oolitic beds are found in the scarps bounding Pigeon Creek, a tributary of Cockatoo Creek. Outcrops in the area expose at least four feet of continuous oolite and Urquhart (1962) reports over ten feet of unbroken oolite in one bed in this area. However there is usually more than one horizon of oolite within the unit, each generally less than three feet thick, and often only a few inches thick. Urquhart notes that in the Geddesvale-Kilbeggan area, the assay results indicate that three different highly ferruginous zones exist, all of which may contain oolitic rock. However the maximum thickness separating any two adjacent zones is less than seven feet. Moreover, within each ferruginous zone, oolite may be found in one, two, or rarely three separate horizons. The rock is yellowish brown in outcrop, and tends to split into thick flags parallel to the bedding. Ooliths are generally spherical and uniform in size, most being about 0.5mm in diameter. In hand specimen, many of the ooliths seem to consist of a hollow dark brown spherical shell, filled and coated with soft light brown earthy limonite. The ooliths themselves make up the major part of the rock, but some ferruginous silty matrix is generally present in the interstices. Weathering and solution activity has resulted in the formation of thin veins of dark ferruginous material cutting through the rock, and in places, partially replacing the oolites.

The chief rock type associated with the oolite in outcrop is a heavy, hard, iron-rich rock, banded various shades of red and yellow and referred to as a concretionary banded ironstone. This rock is closely associated with the oolite and probably formed by replacement of a fine-grained sedimentary rock by iron bearing solutions acting along joints. However rare specimens of concretionary banded ironstone contain small patches of relict yellowish pellets suggesting that at least some of the banded ironstone may be formed by weathering of a partly pelletal, possibly chamositic mudstone.

Most of the sediments interbedded with the oolitic and concretionary ironstone are more or less ironstained, but some non-ferruginous mudstone and sandstone occurs. Interbedded sandstone is generally thin bedded sublabile, in places calcareous, but some quartzose sandstone has also been noted. Mudstone varies from structureless dark purple or chocolate ferruginous mudstone, to grey or white mudstone, becoming shaly in places. Urquhart (1962) reports five feet of "massive structureless, slightly micaceous silty ferruginous tuff (?), which is talcy to the touch" in the log of cores obtained from a drillhole through the unit about two miles north-east of Cockatoo Homestead. No tuffaceous rocks have been noted in outcrop.

The rocks immediately below the oolite member in the Cockatoo Creek area include yellow and grey shale, yellow feldspathic sandstone and white quartzose sandstone, but these are generally underlain within thirty feet of the base of the ironstone, by massive blue-grey mudstone with coaly plant fossils.

(b) <u>Hutton Creek Area</u>

The lithology of the oolite member in the Hutton Creek Area differs in several respects from that described in the Cockatoo Creek area.

Massive oolitic beds like those found at Pigeon Creek are less common. Oolite is usually found in outcrop as small discontinuous patches within the concretionary banded ironstone. In outcrop, the ooliths are common yellow opaque spherical or ovoid pellets, with in places a dark brown ferruginous shell. They occur in a fine-grained concretionary ferruginous mudstone and were probably chamosite pellets before weathering. A partial analysis of oolitic limonite from an outcrop in Expedition Creek (T789) revealed

1.51% phosphorus. This suggests some collophane may be associated with the chamosite. Results of other analyses are shown in Appendix (F).

An examination of cores and cuttings from Glentulloch 1 in the interval 1060-1080 feet showed pellets of chamosite and crystals and larger masses of siderite in a mudstone with abundant sideritic cement. The pellets of chamosite are generally flattened, and oolitic coatings are not common. It is not known whether the mudstone itself is chamositic.

Lithologies interbedded with the oolite and concretionary banded ironstone in the Hutton Creek area include more siltstone and mudstone, and less sandstone than in the Cockatoo Creek area. Siltstone and mudstone are generally greenish or purplish in colour, commonly calcareous, and in places lustre mottling is developed. An unusual, though not uncommon, lithology is a heavy dark green sandstone, consisting largely of dark green (chamositic ?) grains, with some clear quartz, and very little matrix.

Jointing is common and is generally followed by replacement of the finer sediments, especially the calcareous ones, along the joint planes to give concretionary ironstone. Bedding planes are gently undulating. Log impressions up to five feet long, and ferruginised fossil logs of wood are common.

Correlation, Structure and Relationships.

Although the oolite member in the type area (Cockatoo Creek area) has not been traced in outcrop around the Mimosa Syncline to correlate with the pelletal member mapped in the Hutton Creek area, it is considered that their correlation can be justified by the following facts:-

(1) the deposition of chamosite represents an unusual sedimentary environment which, in an open basin, could be expected to persist over large areas.

(2) Although more than one bed of oolitic or pelletal rock occurs, these beds are confined to a stratigraphic interval that has not been measured at greater than 50 feet in outcrop, either in the Hutton Creek or Cockatoo Creek areas.

(3) The base of the Hutton Sandstone appears to mark a widespread break between the mudstone, shale and labile sandstone of the Evergreen Formation and the thick predominantly quartzose sandstone of the Hutton Sandstone. This boundary, located with some confidence, is always

less than 200 feet above the pelletal member, in both areas.

(4) The pelletal chamosite member cropping out in the Hutton Creek area can be recognized as a consistent horizon above the Boxvale Sandstone Member in Glentulloch 1, Rosewood 1, Kooringa 1 and Meeleebee 1 (Bastian pers. comm.). In Wandoan 1 and Burunga 1, the pelletal beds are still present, but appear to occur in two horizons. However these two horizons are still contained completely within 90 feet of section, and this observation may merely suggest a thickening of the oolite member in the Wandoan area.

Although the oolite member represents an unusual sedimentary environment in the Jurassic sequence, no evidence of any appreciable unconformity has been found above or below it, and it forms a conformable member within the Evergreen Formation. Its structure is the same as that of the Evergreen Formation as a whole.

After a study of cores and cuttings from Glentulloch 1, Rosewood 1, Kooringa 1 and Meeleebee 1 in the vicinity of the oolite member, Bastian (pers. comm.) reported "strongly coloured brick-red to reddish-brown oxidised siderite in a definite horizon below the pelletal chamosite level, at, or perhaps a little below the top of the Boxvale Sandstone". He notes "as this is a consistent level, it indicates a widespread oxidation event in the basin, perhaps a period of weathering".

If this red horizon is, in fact, "oxidised siderite", then the conclusion of a widespread oxidation event must stand. If however the horizon is merely a horizon of red iron oxides of unknown origin, Hallimond (1925) has another explanation of their significance. He notes that the ferruginous compound usually precipitated from oxidising solutions in pure water is the hydrate, limonite, and under the continued action of fresh water it becomes yellow and soft, probably as a result of colloidal hydration. However, in solutions containing a sufficient amount of dissolved salts, less hydrous forms are obtained, and these have a more or less red tint. Similar changes might possibly be produced in limonite by underground mineral waters, but Hallimond notes that in the British sedimentary iron ores "the red rocks are confined to definite horizons, and were apparently deposited in their present form".

Thus the red horizon may indicate an oxidation event in the basin, or alternatively may represent deposition of iron under saline conditions produced by a marine incursion at the base of the oolite member. The red horizon has not been noted in outcrop, where it would be obscured by general weathering and ironstaining.

Environment of Deposition.

Determination of environment of deposition rests on the uncommon mineralogical properties (occurrence of chamosite) and structural properties (oolitic and pelletal structure) of the sediments, and must depend on both of these characteristics being original sedimentary characteristics. There is little doubt that oolitic coatings must be original structures, but it could be suggested that the chamosite was formed through replacement of other original minerals. Hallimond (1925) in a comprehensive study of the petrography and chemistry of British bedded iron ores records the replacement of chamosite by calcite, siderite, quartz, calcium phosphate, limonite, pyrite, magnetite and clay, but discounts any suggestion that chamosite could be the replacing mineral. He concludes "the evidence obtained points decisively to the conclusion that the bedded ores were deposited substantially in their present condition, and were not formed by the replacement of limestone or similar rock". No evidence has been seen in the present survey to indicate that the chamosite may have been introduced after the consolidation of the sediments, and the theory of metasomatic origin is not held.

Environment of deposition is considered under:

(a) Chemical environment

(b) Physical environment

(a) Chemical Environment

Chamosite is a hydrated ferrous silicate mineral whose composition is generally taken as $3FeO \cdot Al_2O_3 \cdot 2SiO_2 \cdot 3H_2O$. The iron is in the ferrous state and this suggests that the mineral was deposited under reducing conditions. It is not known whether limonite was originally present with the chamosite, or whether it is merely a weathering product, as fresh samples have not been examined mineragraphically. However, the absence of hematite (except in exosolution-type needles) suggests incomplete oxygenation during precipitation. The presence of siderite lends support to concept of anaerobic environment, but it is not proved that the siderite present is not a metasomatic replacement (although there is no evidence to suggest that it is).

Most workers regard chamosite as a marine chemical precipitate which is thrown down whenever the product of the ferrous ion concentration and that of the alumosilicic acid ion exceeds the solubility product of chamosite. The concentration of the alumosilicic acid ion is fixed by the almost universal presence of clays, with which the sea water will be saturated. As the concentration of the ferrous ion increases (due to the action of reducing organisms) the solubility product of chamosite will be reached, and the clay will be progressively transformed into a chamositic mud.

Hallimond concludes (p. 42) "chamositic mudstones are generally, if not invariably, marine", and he suggests that the return to deposition of non-chamositic sediments corresponds with the transition from marine to estuarine or fresh water environment. Sheppard and Hunter (1960) in a study of Devonian chamositic oolites concluded that the environment was marine, and slightly reducing.

Palaeontological evidence is inconclusive. Broken plant stems and fossil logs are common, but no leaves have been seen. One small pelecypod has been collected, but its habitat is as yet, unknown. The absence of a prolific marine macrofauna probably indicates that the basin had only limited outlet to the open sea and after an abrupt marine incursion, was soon returned to brackish conditions by the fresh water contributed by the rivers. The presence of hystrichospheres in the oolite in B.M.R. shallow bore 29 may indicate a marine environment.

(b) Physical Environment

The occurrence of pelletal and oolitic structure suggests some sort of wave or current action, but the probable chemical environment suggests that turbulence was not strong enough to result in complete aeration of the water. Moreover the preponderance of pelletal chamosite rather than true oolitic chamosite in most areas, suggests that the soft chamositic muds were subjected to only gentle wave action which broke up the deposits to form pelletal chamosite. This indicates deposition at moderate depth, probably just above wave base. With more vigorous wave action and continuing deposition, chamositic ooliths could be formed. A feature of the oolite in the Cockatoo Creek area is the well developed sphericity of the ooliths, and the uniform size grading. The mean size developed must be the equilibrium size at which the weight of the rolling oolith is such that fresh deposits of soft chamosite are worn off as quickly as they are precipitated.

The absence of coarse clastics from the chamosite beds suggests they were deposited in areas of water in which the currents were not moving fast enough to carry appreciable detrital material. However, the chamosite is probably dependent on land derived material for its iron content. Moreover, the shale and sandstone interbedded with the chamositic sediments indicate a depositional site close enough to the land to receive detrital material during periods of abundant sediment supply. The alternation of clastic sedimentation with chemical precipitation may thus be a reflection of variation in rainfall and terrigenous sediment supply.

Conclusions

The oolite member seems to have been deposited on the bottom of a moderately shallow basin, under marine conditions, in a slightly reducing environment, remote from strong current action, but with gentle wave or tidal action. A source area of low relief with marked variation in rainfall seems most likely.

Thickness

Thickness, measured by barometric levelling, from studies of Urquhart's (1962) drill logs in the Cockatoo Creek area, and from water bore logs in other areas, is less than thirty feet, and generally between twenty and thirty feet.

The unit has not been recognised in the axial part of the Mimosa Syncline between Currajong Homestead in the west, and Karrinya Homestead in the east. In this area the oolite member has either become very thin and is covered by the blanket of sand weathered from the Hutton Sandstone, or it has lensed out completely.

Palaeontology and Age

Macro-fossils collected from the unit include indeterminant plant stems, and wood impressions, and one small pelecypod (T766), which is being examined. However the oolite member is included completely within the Evergreen Formation which on palynological and palaeobotanical evidence is regarded as being Lower Jurassic in age.

The shallow drill hole, B.M.R. 29, encountered the oolite member, and samples from that interval yielded spores of Evans' unit J2 (Evans, 1964b). Evans notes that the oolite member appears to mark the boundary between units

ADDENDUM

Identification of Evergreen Formation bivalves

Dr. D. McMichael of the Australian Museum, Sydney, has examined three collections of shelly fossils from the Evergreen Formation (T673, T653, and T766). The following is a quotation from his letter dated 26/6/64 :

'The Evergreen Formation bivalves are not sufficiently well preserved to be certain as to their identity and ecology. Three kinds seem to be present; one looks like the freshwater mussel *Mesohyridella ipsviciensis*; one looks like a species of *Unionella*; and the third looks like a mytiloid genus. The first two suggest freshwater deposits, the third a marine or esturine environment. More positive identification at this stage is impossible though I am inclined toward an "estuarine" facies (possibly the coastal lagoon type of environment).'

J1 and J2. He also notes the association of hystrospheres with this pelletal member, as in the Roma area.

Hallimond (1925) notes that in the British bedded iron ores, the ironstone facies may transgress time boundaries, implying a slow migration of the favourable conditions for deposition. No evidence has been seen to suggest that there was restriction of a particular environment to small areas of the Surat Basin in the area studied, and thus transgression of time boundaries by the oolite member is not suggested.

HUTTON SANDSTONE

Summary

The Hutton Sandstone is a thick, widespread, dominantly sandy formation which conformably overlies the Evergreen Formation. The sandstone is commonly poorly sorted and largely impermeable, particularly in the lower part of the formation. It is not a scarp former, and weathers easily to give abundant sandy soil. It was probably deposited in a fluvial or lacustrine environment. There are some indications of deposition under brackish water in the lower part of the formation. Macrofossils collected compose one collection of small pelecypods. Palynological evidence indicates a Lower Jurassic age, probably extending into the Middle Jurassic at the top of the formation.

Nomenclature and Type Area.

The name Hutton Sandstone was first used by Reeves (1947, p. 1346) for the top member of the Bundamba Series. He states "the Hutton sandstone forms the sandy soils that cover extensive areas on Westgrove Station", which is on the Eddystone 1:250,000 Sheet about 25 miles north-west of Injune (Lat. 25°32'S., Long. 148°29'E.). Whitehouse (1955) considered this formation to be the equivalent in the Roma district of the Marburg Formation of the Ipswich district. However since basalt and other cover precludes tracing the Hutton Sandstone into the Marburg Formation type area in the Moreton basin, it is thought preferable, at least for the present, to retain the name Hutton Sandstone.

No detailed sections have been measured in the formation.

Distribution and Topography.

The Hutton Sandstone crops out in a continuous arcuate belt from the western boundary of the Taroom Sheet to the southern boundary of the Mundubbera Sheet. The formation is represented by a broad belt of sandy plains with low rounded hills and forms a strip of more open country between the cliffs and gorges of the older formations and the thick scrub or cleared farmlands and plains of the Injune Creek Beds. The sandstone is generally soft and weathers easily to give sandy soil and rounded outcrops. Vertical cliffs are rare, and massive outcrops are generally smooth sided and rounded towards the top, falling away more steeply at the base. The abundant but poor sandy soil supports some grass and open forest of pine, lancewood, and wattle.

Lithology

Sandstone is the dominant lithology in the Hutton Sandstone. Siltstone and claystone occur in places, and pebble conglomerate occurs rarely. In general the lithology changes from coarse, poorly sorted, sub-labile sandstone with clay matrix at the base of the unit, to fine, well sorted, quartzose sandstone at the top. Mud pellets occur in the sandstone throughout the unit, but appear to be more common near the base. Quartz grains are generally angular and argillaceous matrix is common. The sandstone is generally poorly cemented and friable, but ferruginous cement and less commonly, calcareous cement, has been noted.

The sandstone in the lower half of the formation is generally brown or grey in colour, poorly sorted, thick bedded, and in places current bedded. Micaceous felspathic, and lithic fragments are common, but quartz rarely forms less than 75% of the clasts. Argillaceous matrix is common, and cement is largely absent. Thus the sandstone is generally friable, earthy and easily eroded, except for the rare beds of very hard yellow calcareous sandstone up to five feet thick, that have been noted. Mud pellets occur throughout the sandstone, but are more abundant in some beds than in others. A very common lithology near the base of the unit is a medium-grained, thick bedded, micaceous, quartzose sandstone with white argillaceous matrix, riddled with button shaped holes which are weathered out mud pellets. These pellets are circular or oval in outline, generally flattened, and often resemble pelecypod moulds. Most are about one inch in diameter and ½ inch thick, but they occur in a great variety of shapes and sizes up to four inches in diameter. This sandstone occurs in a thick (30 to 50 feet) strongly outcropping bed at the base of the formation in the Cockatoo Creek area. Another lithology common in the middle part of the Hutton Sandstone, is a medium to coarse-grained, brown, poorly sorted, thick bedded, friable sub-labile sandstone. The rock consists of quartz grains, muscovite flakes, some weathered feldspar grains and rare lithic fragments, with an argillaceous matrix, and in places with a ferruginous cement. Some bands of quartz pebbles occur, but these are generally thin, often one pebble width thick. The sandstone is commonly current bedded. Patches of black organic material occurring within this sandstone have been noted from widely separated localities, and under the hand lens these appear to be patches of broken up coaly fragments. Water in this sandstone in the Bentley Park area is often salty, with a high percentage of NaCl, $CaSO_4$, Na_2CO_3, and salt encrustations have been noted on the surface of sandstone outcrops in the creeks in this area. The lower part of the Hutton Sandstone seems to be finer, cleaner, and more quartzose in the Hutton Creek area, than in the Cockatoo Creek area.

The upper half of the Hutton Sandstone is more uniform, and more consistent in lithology throughout the area. The most typical lithology is a light brown or white, fine and even-grained, porous, friable, generally thick bedded, structureless, quartzose sandstone, in places with some argillaceous matrix. Poorly sorted sub-labile sandstone, hard yellow calcareous sandstone, and quartz pebble bands have been noted, but are not common. The fine quartzose sandstone commonly occurs as very thick uniform beds, up to 80 feet thick in the Gwambagwine and Pony Hills areas. These thick beds are generally of uniform structureless sandstone, but exhibit minor current bedding in places.

Thin bedded sediments occur at the top of the formation in many areas. The road crossing at Highland Plains Creek, near Hutton Park Homestead exposes thin bedded, ripple-marked, fine quartzose sandstone, interbedded with yellow claystone. Thin bedded sediments are also exposed in the road crossing at Bungaban Creek, near Bungaban Homestead, on the Mundubbera West sheet. Lithologies include fine, yellow, micaceous, quartzose sandstone interbedded with some siltstone, rare hard calcareous quartzose sandstone, and one thin bed of hard, ferruginous, partly concretionary, labile sandstone. This ferruginous bed contained rare plant stems, and a number of small pelecypods (Collection T693). The thin bedded sequence in this area is overlain by thick bedded, medium to coarse-grained, poorly-sorted, strongly cross-bedded, quartzose sandstone.

Laterite has developed on the Hutton Sandstone in a few areas, but it is always very thin and crops out as mottled rubble. Younger basalts in the north of the Taroom Sheet appear to have caused some silicification of the Hutton Sandstone, converting the sandstone into grey billy in one place.

Structure and Relationships.

The Hutton Sandstone lies conformably on the Evergreen Formation and conforms to the structure of that formation. No appreciable overlap of the Evergreen Formation by the Hutton Sandstone has been seen.

The Injune Creek Beds is thought to be generally conformable with the Hutton Sandstone. However, the occurrence of a basal conglomerate in places in the Injune Creek Beds, and the marked lithological differences between the two formations, suggest the possibility of local disconformities between them.

Environment of Deposition.

There is little evidence to indicate the chemical environment of deposition of the Hutton Sandstone. Pelecypods have been collected from one locality in the upper part of the formation. However these are confined to one thin bed, and appear to include one species only, and their habitat is as yet, unknown. Plant stems and logs occur, but no determinate plant fossils have been seen. The generally brackish quality of the water struck in places in the lower part of the Hutton Sandstone, and the occurrence of salt encrustations on outcrops of the formation in the Bentley Park area, suggests that brackish connate water may be held in permeable lenses within the generally impermeable argillaceous sandstone. Thus the lower part of the formation at least, may have been deposited under brackish water.

The thickness, and the poor sorting of the sediments of the lower part of the formation suggest rapid deposition, little reworking, and abundant supply of terrigenous sediment. These characters could be the result of slightly accelerated subsidence, with some uplift of the source area. The preponderance of coarse sediments may indicate heavy, uniform rainfall. The better sorting of the sandstone near the top of the formation may indicate deposition in shallower water, with more reworking of sediments.

Thickness.

Thickness, as indicated from barometric measurements and bore logs, varies between 400 feet and 550 feet, and seems to be greatest near the centre of the Mimosa Syncline. Estimated thicknesses are:-

450 feet in the Injune area.
550 feet in the Pony Hills area.
400 feet in the Cockatoo Creek area.

Macro-Palaeontology and Age.

The only collection of macro-fossils made is T693, a collection of small pelecypods from near the top of the formation from near Bungaban Homestead (Lat. 25°54'S., Long. 150°08'E.). This collection is at present being examined. Plant stems and logs have been seen, but no determinate plant fossils were collected.

The Hutton Sandstone overlies the Evergreen Formation, of Lower Jurassic age. Unpublished palynological evidence (de Jersey and Paten, 1963b) indicates a Lower Jurassic age for the Hutton Sandstone probably extending into the Middle Jurassic at the top of the formation.

INJUNE CREEK BEDS.

Summary

"Injune Creek Beds" is an informal name applied to the Jurassic sequence between the Hutton Sandstone and the Gubberamunda Sandstone in the Injune-Roma area. No comprehensive study was made of the unit, and only the lower 500 feet of the formation was seen in the area studied. The section studied is generally poorly exposed, and develops a rich soil which supports a natural vegetation of brigalow - belah - wilga scrub. The formation consists of a sandy basal sequence about 100 feet thick overlain by a dominantly shaly sequence about 300 feet thick, and containing lenses of sandstone and numerous thin coal seams. The sediments are characteristically labile and calcareous, but no clastic-free limestone was identified. The formation was probably deposited in a paludal environment, and overlies the Hutton Sandstone, with possibly minor local disconformities. No macrofossils were collected, but previous palaeobotanical determinations indicate a Jurassic age.

Nomenclature, previous investigations, and Type Area.

The name "Injune Creek Beds" was first used by Jensen (1921a, p. 92). In the same publication he appears to equate the "Injune Creek coal area" with his "Lower (calcareous) Walloon division". Other names published by Jensen for the sequence include -

Injune calcareous series (1926a, p. 71).
Injune Creek coal beds (ibid, p. 79).
Injune Creek series (ibid, p. 86).
Injune carbonaceous shale series (1926b, p. 52).
Komine-Injune coal measures (1929, p. 283).
Injune coal series (1929, p. 283).
Injune Coal Measures. (1960, map, 1963 section).

Jensen (1926a, p. 24) divides his Walloon Series into four stages - "the Upper, Middle, Lower and Basal Walloons". He also introduces the name "Big Sandstone", or "Big sandstone series" for a feldspathic and calcareous sandstone sequence between 400 and 500 feet thick. In his table of geological succession (1926a, p. 22) he places the "Calcareous (Injune Creek)" into his Walloon Formation between the "Basal Sandstone" and the "Big Sandstone". He notes - "the Marburg beds of the Rosewood district seem to be equivalent of basal sandstone, Injune district; and the Rosewood beds of the Calcareous (Injune)". Thus the lower boundary of his Injune Creek Beds seems to be equivalent to what has been mapped in the present survey as the boundary between the Injune Creek Beds and the Hutton Sandstone.

The determination of Jensen's upper defined boundary is less clear. In 1929 he states "the big sandstone is a transition series between the stated Upper and Lower Walloon". He goes on to divide the Big Sandstone into an "upper sandstone termed the Bymount phase of the Big Sandstone", and a lower phase called the Gunnewin phase. Later in the same paper he concludes "It will be advisable to regard the basal grit....... of the Bymount phase of the Big Sandstone, as the base of the Middle Walloon, and the transition to the .... Lower Walloon series". Jensen's original description of the Big Sandstone seems to apply to a yellow feldspathic calcareous sandstone seen in the Gunnewin area. This sandstone member is not conspicuously different from other sandstone beds below it in the Injune Creek Beds in lithology, vegetation supported, or photo pattern exhibited. It is also probably a lenticular member, as it was not recognised in other parts of the area studied. Thus this calcareous labile sandstone member cropping out near Gunnewin is not a conveniently mappable unit.

However Jensen's intention regarding his definition of the Big Sandstone (and thus the upper boundary of the Injune Coal Measures) is further confused by a later publication intended to supplement and correct his 1926a publication. In it he states (1960, p. 15) "The Big Sandstone is in general a coarse decidedly siliceous sandstone", and "The vegetation is Calciphobe" (i.e. characteristic of non-calcareous country). Moreover, in his table (1960, p. 14) he describes the Big Sandstone as "very siliceous", and gives a thickness of 500 to 600 feet. The fact that no quartzose sandstone members of this thickness are known in the Injune Creek Beds below the Gubberamunda Sandstone (Reeves, 1947) suggests that Jensen's Big Sandstone, or Gunnewin Sandstone, or part of it, may be equivalent to the Gubberamunda Sandstone. However the outcrop of this sandstone is at least eight miles south of Bymount. Jensen does not show his Big Sandstone on any published maps, but in 1963, he refers to it as the "Big (or Gunnewin) Sandstone" in a cross-section, and shows it cropping out to the north of Gubberamunda. Thus, because of the confusing and variable nomenclature, the vague and sometimes contradictory definitions, and the lack of accurate maps, it is impossible to determine precisely the intended limits of these sandstone members named by Jensen. The upper boundary of the Injune Creek Beds is taken at the base of the dominantly quartzose Gubberamunda Sandstone. (Reeves, 1947, p. 1347).

Reeves (1947, p. 1347) used the name "Lower Walloon Coal Measures" for the strata between the Hutton Sandstone and the Gubberamunda Sandstone. Whitehouse (1955, p. 8) used the name "Walloon Coal Measures" for this section. However, the Walloon Coal Measures is defined in the Ipswich district, and until correlation between the Moreton Basin and the Surat Basin is firmly established, it is thought preferable to maintain the name "Injune Creek Beds" for this formation in the Injune area. This informal nomenclature is continued, as no comprehensive study was made of the unit during the present survey, and the top of the formation was not seen. (No outcrops identified as Gubberamunda Sandstone were seen in the area mapped).

No definite type area has been designated. The original siding on the site of the present township of Injune appears on some old Lands Department Parish maps as "Injune Creek", so that the name "Injune Creek Beds" need not necessarily imply that the type area is that area drained by Injune Creek. When the formation is formally redefined, it would probably be preferable to omit "Creek" from the name.

No sections were measured in the present survey. The name "Injune Creek Beds" is used by the authors to refer to that section of the Jurassic sequence between the Hutton Sandstone and the Gubberamunda Sandstone in the Injune-Roma area.

In current reports, both "Injune Creek Beds" and "Walloon Coal Measures" are used to refer to this formation. "Injune Creek Beds" has been used in this sense by Mines Administration Pty. Ltd. in sundry well completion reports submitted to the Queensland and Commonwealth Governments. These have been published in summary by the Queensland Government (Qld. Dept. Mines, 1963, "Petroleum Exploration in Queensland during 1962", p18). It is presumed some will also be published by the Commonwealth Government.

Distribution, Topography, Vegetation.

The Injune Creek Beds crop out continuously across the southern part of the Taroom and Mundubbera West sheets, and extend as far north as Gwambagwine in the centre of the Mimosa Syncline. The basal sandstones in the Injune area are well exposed. Sandstone elsewhere within the unit generally crops out as rounded boulders, but other lithologies are poorly exposed. The formation develops thick rich clay soils, which, before clearing, carried thick brigalow-belah-wilga scrub (the calciphile flora of Jensen 1926a, p. 33). This contrasts strongly with the open forest of pine, wattle, ironbark, and lancewood (Jensen's calciphobe flora) which is developed on the underlying Hutton Sandstone and the overlying Gubberamunda Sandstone. The base of the Injune Creek Beds was placed beneath the lowest calcareous sub-labile or labile sandstone, and above the generally non-calcareous quartzose sandstone of the Hutton Sandstone. The change in vegetation was found to occur at this lithological boundary, and the Injune Creek Beds - Hutton Sandstone boundary has been placed, in many areas, by photo interpretation at this vegetation change.

Lithology

The lower section of the Injune Creek Beds exposed on the Taroom and Mundubbera West sheets is probably at least 500 feet thick. In the Injune area, it includes a basal calcareous sandy sequence with a minimum thickness of between 100 and 200 feet, overlain by an alternating sequence of shale, sandstone and coal seams, about 300 feet thick.

The basal sequence of the Injune Creek Beds is well exposed on top of the scarps of Hutton Sandstone to the south of Hutton Creek, and along Injune Creek and its tributaries, to the north-east of Injune. The typical lithology of the basal sequence in this area is medium to coarse grained, poorly sorted, lithic sub-labile or labile sandstone, with an argillaceous or muddy matrix, and a calcareous cement. It is current bedded in places, and some mud pellets and rare bands of lithic pebbles up to one inch in diameter have been noted in the sandstone. The fresh rock is hard, impermeable, and light khaki-grey or brown in colour. On weathering, the calcareous cement is dissolved, the matrix becomes ironstained and crumbles to give a rich dark brown soil. Angular quartz grains and rounded lithic pebbles, where present, are left in relief on the surface of outcrops as the matrix is removed. Other lithologies in the basal sequence in this area include hard, light grey, calcareous, lustre mottled, cross bedded, sub-labile sandstone, and rare beds of dark, greenish brown, medium grained, non-calcareous, labile sandstone.

In other areas, the basal sequence of the Injune Creek Beds is poorly exposed and appears to be thinner and less sandy than in the Injune area. In places, a thin pebble or cobble conglomerate is seen at the base. The phenoclasts are of sedimentary rocks, and in two places are pebbles of ferruginous siltstone, in a matrix of calcareous lithic sandstone. These conglomerates may indicate local contemporaneous erosion associated with local disconformities at the base of the formation.

The coal bearing sequence of the Injune Creek Beds is very poorly exposed throughout the area mapped. An examination of unpublished driller's logs (Sandstedt, 1922) from six coal prospecting bores in the Injune-Bongwarra area, indicated that the coal bearing sequence is about 300 feet thick. Analysis of these logs indicated that the sequence consists of 66% "shale", 30% "sandstone", and 4% "coal". There is a regular alternation of "shale-coal-shale", with in places "shale-coal-shale-sandstone-shale". The coal seams (and the sandstone beds) are generally overlain and underlain by "shale". A maximum of 15 coal seams were logged. The thickness ranged between five feet and three inches, and averaged one foot. (The worked seam in the Maranoa Colliery had a maximum thickness of 4 ft. 7 ins.). Up to nine lenticular beds of sandstone were logged. The maximum continuous thickness of "sandstone" logged was 85 feet, but most sandstone sections are less than 30 feet thick, and the average thickness was 16 feet. The maximum continuous thickness of "shale" logged was 58 feet, but the average shale section is 12 feet thick. Unfortunately, the lithologies are generally stated briefly as "shale" or "sandstone", so that it is impossible to determine whether the base of the Injune Creek Beds was reached.

Outcrops of the coal bearing sequence of the Injune Creek Beds are poor. The best outcrop seen is in a quarry on the Taroom-Wandoan road about ten miles south of Taroom. Here the sediments are hardened by a sub-surface basalt intrusion, and the claystone and shale is partly converted into hard, brightly coloured, purple and green porcellanite. The porcellanite is closely jointed, and in places, thin fingers of vesicular basalt have been forced along the joints. Some well preserved plant fossils were seen in the porcellanite, but the close jointing made collection difficult. A thin coal seam exposed above the porcellanite and shale does not appear to have been affected by the basalt, but the contact is obscured by weathering. Apart from this exposure, other outcrops of this section of the formation are monotonously similar, and consist of rounded boulders of yellow, hard, medium grained, poorly sorted, calcareous, labile sandstone, surrounded by rich black clayey soil. Some outcrops expose similar sandstone, but light grey in colour, and containing brown mud pellets, and bands of broken coaly fragments, and coaly plant stems. In other places, the sandstone is weathered in situ to a yellow friable rock cut by calcite veins, and covered by rich, yellow-brown soil. Analyses of this sandstone quoted in Appexdix F showed a maximum of 0.044% phosphorus. The fine grained sediments are rarely exposed. Boulders of light green, evengrained, very calcareous siltstone have been seen. This siltstone is very hard, and has a conchoidal fracture, but weathers easily to give brown soil. Although very calcareous sediments are common in the area mapped, no clastic-free limestone was recognised. Thin beds of concretionary limonite have been noted in outcrop. Jensen (1926a p.62) states that numerous thin bands of ferruginous sandstone and shale are found throughout his Walloon Series. He notes that they frequently contain prolific plant fossils, and observes that the more concretionary ironstone beds often occur a few feet above a coal seam. Their significance is not known, but they may represent local diastems in the sequence.

Lateritisation and leaching has produced cappings of mottled sandy laterite and of clean, white, porous quartzose sandstone, on the formation in a number of places in the Taroom area.

Structure and Relationships.

The Injune Creek Beds conforms to the regional structure of the underlying Hutton Sandstone, and Evergreen Formation (q.v.). The bedding shows many slight undulations in the coal bearing sequence in the Injune area, and small normal faults were common in the Maranoa Colliery.

The Injune Creek Beds are generally conformable on the Hutton Sandstone; however there are probably minor local disconformities.

The top of the formation was not seen. Lateritic cappings are developed in places in the Taroom area.

Environment of Deposition.

The formation was probably deposited in a shallow water, paludal environment. The abundance of coal seams suggests prolific plant growth, a low energy environment, and probably a reducing environment of deposition. The regular alternation of sandstone, shale, and coal suggests some periodic climatic variation, probably variation in rainfall. Calcareous sediments are common, and the carbonate content is thought to be essentially a syngenetic chemical precipitate. This abundance of calcareous sediments also suggests a restricted environment. The deposition of the carbonate may also be periodic, influenced by climatic variations, and directly controlled by the amount of carbon dioxide in the water. During periods of accumulation of plant matter, there was little clastic sedimentation, and probably poor circulation of water. The carbon dioxide produced by the decay of some vegetation would saturate the water and tend to keep the calcium carbonate in solution until the water is saturated with bicarbonate. With the return to the deposition of clastic sediments (caused by some climatic change) the decaying vegetation is covered up, and the supply of carbon dioxide cut off. Any reduction in the carbon dioxide in solution at this time would result in the precipitation of calcium carbonate. The loss of carbon dioxide may be due to an increase in temperature, or it may be used up by growing plants. The return to conditions allowing accumulation of plant debris free from clastic sedimentation marks the end of the cycle with the deposition of another coal seam.

Thickness.

No sections have been measured, and the low dip, and general absence of scarp forming members make barometric measurement of thickness difficult. Thus the thickness of that part of the formation exposed in the area studied is not known. However, a study of the logs of various bores put down in the area indicates a thickness of at least 500 feet.

Macro-Palaeontology and Age.

No macrofossils were collected from the formation during the present survey. Well preserved plant fossils and stems have been seen, but close jointing of the containing rock prevented collection of determinate fossils from the outcrops visited.

The palaeobotanical determinations listed by Willcox (1926) and Whitehouse (1955) indicate a probable Jurassic age for the formation.

An unpublished palynological report (de Jersey and Paten, 1963a) indicates a Middle Jurassic age for the "Walloon Formation" of Union Oil Development Corporation. This formation can be equated with some certainty on subsurface correlation with the Injune Creek Beds.

TERTIARY STRATIGRAPHY

BASALT.

Summary:

Massive, amygdaloidal and vesicular basalt with minor interbeds of feldspathic sublabile sandstone crop out in the northern part of the Taroom Sheet area, north from Gwambagwine. Other small areas of basalt were mapped, two near Injune on the Taroom Sheet area, one near Kennedy Peak and one near Mount Ox on the Mundubbera Sheet area.

Distribution and Topography.

Tertiary basalt crops out in the northern part of the Taroom Sheet area along the axial zone of the Mimosa Syncline from Gwambagwine Homestead, north onto the Baralaba Sheet area. In this area the topography over the unit is undulating. There is a maximum relief in the order of 100 feet, and an average of about 50 feet. Towards the northern edge of the mapped area, flat country covered with laterite has developed.

Apart from this quite large area there are two small areas of basalt cropping out about 10 miles north-east and 15 miles south-east of Injune, and two on the Mundubbera Sheet area near Mount Ox and Kennedy Peak.

Lithology

1. North of Gwambagwine the unit is made up of interbedded vesicular, amygdaloidal and massive basalts together with minor feldspathic sublabile sandstone.

The basalts are mineralogically similar, with laths of labradorite and granular augite together with abundant accessory iron oxide. The more massive rocks contain small phenocrysts which have been pseudomorphed by iddingsite, haematite and other hydrothermal minerals. Flow textures are well developed in some rocks and some contain small amygdules, up to 1/16" in diameter. Volcanic glass forms about five percent of the strongly vesicular basalt. Iron oxide is more abundant in these rocks too and forms up to 15 percent; vesicles form as much as 40 percent.

The vesicles and amygdules are lined with or filled with a blue opaline mineral. In the vesicles an apparently similar mineral has formed botryoidal masses in which the individual sub-spherical masses are up to 1/8" diameter. These individual hemispherical masses are composed of a series of up to ten very thin, brittle concentric layers separated from each other by a gap. This gap is between one and five times as wide as the layers themselves. This material is weathered and is strongly iron stained brown.

In one area near Moeburn Homestead, joints, up to six inches wide, filled with a green-yellow opaline material, were noted. These joints are discontinuous and vary rapidly in thickness.

Beds of sandstone within the unit are usually between two and four feet thick. These rocks are medium to fine grained feldspathic sublabile sandstone; they are often weathered and strongly iron stained. In places they are metamorphosed by the overlying basalt, with the iron material altered to haematite.

2. Near Injune there are two different types of basalt. The first, south-east of Injune, is weakly porphyritic with about five percent olivine in a groundmass of laths of plagioclase, granular augite and magnetite, and minor interstitial volcanic glass. The second basalt, north-east of Injune, is strongly porphyritic with olivine up to 20 percent of the rock. The groundmass is intergranular pigeonite, plagioclase and magnetite.

3. Near Kennedy Peak there is a small plug of Tertiary basalt which consists of about 15 percent olivine phenocrysts (up to 1/16" diameter), in an intergranular groundmass of pigeonite, euhedral and subhedral magnetite, and small laths of plagioclase. The rock is very fine grained, and flow orientation is poorly developed.

4. Near Mount Ox a narrow strip of Tertiary basalt crops out. This rock is massive and composed of fine grained plagioclase, augite and abundant accessory magnetite. It contains a few scattered phenocrysts of plagioclase.

Relationship with other units and thickness.

North of Gwambagwine the sequence of basalt and sandstone occupies a valley (probably a large valley), formed in the Hutton Sandstone. Hills of Hutton Sandstone stand up on the east and west of the area of outcrop of the basalt, and also Hutton Sandstone crops out in deep creeks cutting through the Tertiary unit.

The sandstone interbedded with the basalt is quite similar to the sandstone of the Hutton Sandstone. It appears as if the Hutton Sandstone was shedding considerable amounts of sand into the Tertiary valley during the period of volcanic activity.

Although no fossils were found in the unit it has been assigned a Tertiary age since it occupies a valley in the Jurassic sequence. Similar basalt flows have been mapped on the Baralaba Sheet area, which have also been assigned a Tertiary age.

The unit has a maximum thickness of about 150 feet, but the average thickness seen is about 50 feet.

The small masses of basalt near Kennedy Peak and near Injune are thought to be plugs. The area of basalt near Mount Ox is apparently the remnant of a small flow.

SEDIMENTS

Sediments, possibly of Tertiary age are found on the western part of the Mundubbera Sheet area. They are of two types: (a) clay, and (b) unconsolidated gravel.

Clay was found only near Gyranda Homestead where B.M.R. shallow drill hole No. 26 encountered about 60 feet of brown clay. The clay is overlain, at the surface, by about 30 feet of gravel.

The gravel is found also in the vicinity of Binda Weir, where it caps a hill about 40 feet high. It consists of pebbles and boulders up to one foot in diameter of silicified sedimentary rocks. Two rounded boulders contained Permian plant fossil impressions (Phyllotheca). Some of the pebbles were pieces of silicified fossil wood.

There is no direct evidence that these deposits are Tertiary. While they lie close to the Dawson River they are not part of the stream channel, nor is there any sign of ancient meanders in these areas. The silicification of the gravel might have been the result of the climatic effects which produced extensive laterite and silcrete cappings in Queensland. The clay is an older deposit than the gravel. Thus both deposits are tentatively assigned to the Tertiary.

SUBSURFACE STRATIGRAPHY

Lithological and electric logs of six of the wells drilled in the Taroom-Mundubbera area are now available and are presented for the sake of completeness in Enclosure 3. For the mostpart the important features concerning the strata penetrated have already been discussed in the relevant stratigraphic section in the text, and only explanatory notes will be added here.

Two of the wells were drilled on the eastern flank of the Mimosa Syncline and four on the western flank. Correlation within the Back Creek Group (Middle Bowen Beds) is expressed in terms of units A, B, and C of Dickins, Malone and Jensen (1962), because outcrop units in the Cracow area cannot be readily identified on the western limb of the Mimosa Syncline.

At the present time there is no obvious correlation between the Gyranda Formation of the Cracow area and any unit in the same part of the section in Planet Warrinilla No. 1. On the other hand, the Baralaba Coal Measures of the Cracow area are probably equivalent to coal measures in Planet Warrinilla No. 1 and in the Arcadia Wells, which have in the past been regarded as part of the Bandanna Formation.

INTRUSIVE ROCKS.

The most extensive area of intrusions has been mapped as the Auburn Complex, but a few small intrusions not obviously connected with the Complex have also been mapped. Details of the smaller intrusions are given in Table 7.

The small intrusions marked as Tb on the map

TABLE 7.

MISCELLANEOUS SMALL INTRUSIONS

1:250,000 Sheet and Photo Number	Location	Type of Intrusion	Topographic Expression	Lithology	Dimensions	Youngest Formation Intruded	Symbol on map
Mundubbera Run 8/71	¾ mile north-east of Kennedy Peak	Probably exposed volcanic neck	Good outcrop on small steep conical hill, less than 100 feet high, with aboriginal artifact quarry on top	Hard dark olivine basalt	Oval in plan, less than 600 feet maximum diameter	Evergreen Formation	Tb
Mundubbera Run 2/23	Beside Hilltop Homestead	Pipe-like intrusion	Red soil and poor outcrop on top of very small rise	Olivine basalt	Probably circular, 30 feet in diameter	Baralaba Coal Measures	Tb
Taroom Run 7/22	In quarry on eastern side of Taroom-Wandoan Road, ten miles south of Taroom	Small dyke-like intrusions filling joint spaces, possibly above small unexposed pipe	No topographic expression	Vesicular basalt	Less than two inches thick	"Injune Creek beds"	Not mapped
Taroom Run 9/08	Four miles south of Cheviot Homestead on Roma Road	Unknown, probably small pipe-like intrusion	Poor outcrop on very low, rounded, scrub covered hill	Hard, dark, olivine basalt	Oval in plan, less than 1400 feet maximum diameter	"Injune Creek beds"	Tb
Taroom Run 9/06	On Komine Road just west of Taringa Homestead	Unknown, probably small pipe-like intrusion	No outcrop - few boulders in flat country	Basalt	Unknown, probably very small	"Injune Creek beds"	Tb
Taroom Run 7/04	Two miles north-west of Warndoo Homestead	Probably exposed volcanic neck	Good outcrop on small steep hill, 30 feet high with twin conical tops	Hard, dark, olivine basalt	Circular, less than 50 feet in diameter	Hutton Sandstone	Tb
Taroom Run 2/26	Three miles WNW of Carringal Homestead	Small boss-like intrusion	Forms large rounded hill 200 feet above surrounding country with distinctive smooth photo pattern	Coarse-grained basic igneous rock - probably gabbro	Circular in plan, one mile in diameter	Hutton Sandstone	Mi
Mundubbera Run 3/77	Three miles NW Cracow township	Elongate boss ¾ mile long	Forms large rounded hill 150 feet above surrounding country	Coarse grained leucocratic basic igneous rock - gabbro	¾ mile x ¼ mile	Barfield Formation	Mi

(Enclosures 1 & 2) are regarded as pipes or feeders of basalt, extruded during the Tertiary vulcanism.

The two stocks labelled Mi are similar to one another in all aspects, and their intrusion was possibly synchronous. The youngest formation cut by them is Hutton Sandstone so they are certainly post-Lower Jurassic. They are therefore, thought to be Mesozoic although a Tertiary age is not impossible. The intrusion near Cracow has been sampled for radioactive age determination and results are awaited.

AUBURN COMPLEX

Summary

The Auburn Complex, consisting of granodiorite and minor diorite intruded by dykes of dacite and andesite, crops out along the eastern edge of the area mapped. The unit intrudes the Lower Permian Camboon Andesite and is unconformably overlain by Lower Jurassic units. Laterite has formed on the unit in places.

Distribution, Topography and Access.

The Auburn Complex crops out in the east of the mapped area and extends beyond the eastern, northern and southern boundaries. A few small inliers are present west of the main outcrop area on the Mundubbera 1:250,000 Sheet area, but none is present on the Taroom 1:250,000 Sheet area.

Topography over the Complex area includes a few small areas of rough hilly country, areas of undulating country and large areas of flat country. Outcrop is poor; weathering is deep and large areas are soil covered. Laterite has developed over the granodiorite in many places and is now represented by small hills and ridges up to 30 feet above the plain. Groups of relatively fresh tors are scattered about the plains, however deep creeks usually cut only soil or weathered granodiorite within a few hundred yards of the tors. Vegetation consists of brigalow scrub, thick timber or well grassed parkland. Roads and station tracks afford the only access through the Brigalow scrub and thick timber, of which very little has been cleared. The soil is relatively poor and supports quite a small population of cattle compared with areas farther west. Bores are always shallow and most are dry; others are poor producers and generally produce only stock water.

Nomenclature and Previous Investigations.

Jensen (1926a) was the first person to describe the plutonic rocks of the Auburn Range. He briefly listed the rock types that he notes and referred to the unit as the "Auburn Range Complex". Within this unit he includes the Undifferentiated Palaeozoic Metamorphics.

Denmead (1938) described the unit in more detail in his report on the Cracow Goldfield referring to it as the Auburn granodiorite and the Auburn granite. On his map (1938) he described the unit as "Plutonic Rocks, Granodiorite, Gabbro, etc." In his report (1938) he noted the occurrence of a "belt at least 30 miles wide" within which "there occur gneissic rocks , granodiorite and gabbro."

Laing (1955) briefly described a small part of the unit adjacent to Cockatoo Creek and referred to the unit as the Auburn Granite.

We propose to use the name Auburn Complex for the unit, although in the mapped area it consists of mainly granodiorite, recognising that it extends to the east where it contains other rock types.

Lithology.

In the mapped area the Auburn Complex consists of granodiorite and diorite with dykes of aplite, dacite and andesite.

Massive granodiorite forms at least 95 percent of the unit. It is mostly medium grained and allotriomorphic granular, but in places is fine grained and includes micro-granodiorite. Weakly porphyritic granodiorite, containing up to five percent phenocrysts of plagioclase (maximum size ½ inch diameter), is widely distributed. It is composed of plagioclase (50 to 80 percent), quartz (40 to 10 percent), biotite (up to 15 percent), hornblende (up to 15 percent), potash feldspar (up to 15 percent), and accessory iron oxide and sphene. Hornblende is completely lacking in some specimens. Also potash feldspar is present in very minor quantities in some specimens. The granodiorite in a few places is leucocratic containing only one or two percent mafic minerals. Generally, the percentage of biotite is high, averaging about 15 percent, and that of hornblende is commonly at least two or three percent. Myrmekite is very common and forms up to 70 percent of some granodiorite.

Much of the granodiorite cropping out is weathered and contains secondary alteration products of the primary minerals. Biotite and hornblende have been altered to chlorite and the feldspar to epidote, clay minerals and sericite. Some rocks are almost completely altered while in others only a small percentage of the primary minerals have been affected; others show preferential alteration of certain minerals.

Plagioclase occurs as anhedra in the granular mass of the rock, as phenocrysts and with quartz in myrmekite. It is commonly zoned and twinned, the twinning most commonly developing according to the Carlsbad-albite law. Many of the plagioclase crystals are iron stained giving them a pink colour in hand specimen.

Orthoclase occurs in some specimens but it is not common. It has developed as anhedra in the rocks and usually shows at least partial alteration to secondary minerals.

Both biotite and hornblende have been partially altered to secondary minerals in all the rocks examined. These two primary minerals often form as much as 25 percent of a rock. Biotite has formed as small flakes, as accumulations of small flakes, and as books up to one inch square by ½ inch thick, randomly scattered through the rocks. Hornblende occurs as tabular green crystals up to ½ inch long, some of which show simple twinning.

Quartz has developed as anhedral grains and in myrmekite. Muscovite appears to be completely lacking from all the rocks examined.

One sample of diorite was examined. It is mineralogically similar to the granodiorite except that it contains 15 percent hornblende and only about 5 percent quartz. Its texture is allotriomorphic intergranular with ragged hornblende crystals and slightly elongate crystals of plagioclase both tending to be weakly aligned. Quartz forms large poikilitic masses enclosing plagioclase and hornblende. The extent of this diorite is not known.

Dykes, primarily of dacite, intrude the granodiorite. This dacite is pale yellow-brown to pale green-grey and is generally porphritic with small stumpy laths of plagioclase (up to ¼ inch long), and flakes of biotite (up to 1/16 inch long); the groundmass is finely granular quartz, feldspar and micro-myrmekite. The minerals do not appear to have any preferred orientation.

Andesite dykes occur throughout the granodiorite but are not common. They are porphyritic with phenocrysts of plagioclase and hornblende, both up to 1/3 inch long in a fine grained, green chloritic groundmass.

Aplite dykes are rare and contain a normal mineral assemblage. These dykes are quite thin, all less than two feet thick. They do not appear to have any consistent direction of emplacement.

Xenoliths are less than 0.5 percent of the granodiorite; they are usually subrounded masses up to one foot in diameter and are dark coloured. The majority are microdioritic in composition and texture.

Lateritization.

Laterite has developed sporadically in the flat areas towards the eastern boundary of the mapped area. A maximum thickness of 60 feet of laterite was measured; this consists of an upper red ferruginous zone, 30 feet thick, containing small areas of mottling up to two feet in diameter, and grading down into a 30 feet thick mottled zone in which pallid material and ferruginous material are mixed together in apparently irregular fashion. Weathered granodiorite containing recognisable crystals of feldspar as well as quartz crops out beneath the laterite but the contact between the two was not exposed. In the laterite itself there were no structures to suggest the parent rock type.

Sink holes, up to 20 feet deep, connected by caves and tunnels occur in the ferruginous zone of some of the laterite outcrops.

Relationship with other units and age.

The Auburn Complex is intrusive into the Undifferentiated Palaeozoic Metamorphics and the Camboon Andesite (see section on Camboon Andesite), and is unconformably overlain by the Jurassic Precipice Sandstone and Evergreen Formation. This confines the age of the Auburn Complex to younger than Lower Permian and older than Lower Jurassic in the mapped area.

Farther east where gneisses are reported (Denmead 1938), the unit possibly includes older rocks so a Carboniferous to Triassic age is tentatively suggested for the Auburn Complex.

The Auburn Complex is comparable with the Urannah Complex, cropping out in the northern Bowen Basin. The Urannah Complex is thought of as occupying the axis of a south plunging anticlinal structure and the Auburn Complex as occupying the axis of a north plunging anticlinal structure. The axes of these two structures are parts of one structurally high trend, east of and parallel to the axial line of the Bowen Syncline and the Mimosa Syncline.

Six granodiorite samples were collected in 1963 from the Auburn Complex for radioactive age determination. So far no results are available. (See Appendix G).

STRUCTURAL GEOLOGY

For the ease of description the structure of the area mapped will be discussed commencing in the east and finishing in the west. Reference will be made to the Structural Sketch Map (Fig. 16), the aeromagnetic and gravity overlay (Fig. 15), and the seismic reflection contour map (Fig. 14).

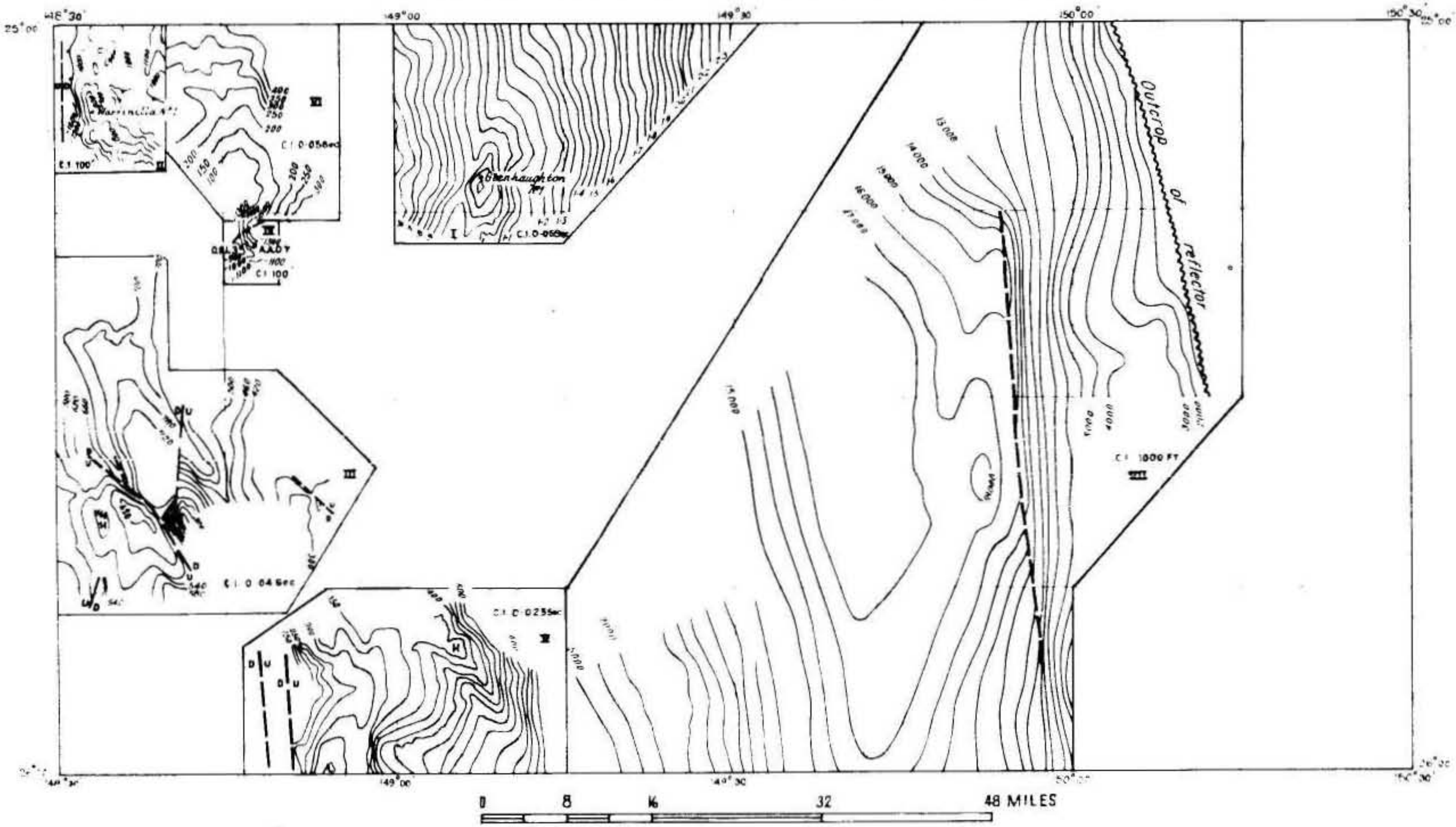
In the north-eastern part of the area the Permian sequence, partly intruded by the Auburn Complex, dips west at about 20°, and this dip azimuth is maintained by the Triassic sequence with some diminution of the dip value; from the seismic reflection contours the average dip of the Upper Permian (Baralaba) Coal Measures, is 10° westwards. The Permian-Triassic strata dip to the west to form the eastern limb of the Mimosa Syncline. Both the seismic and aeromagnetic results indicate a strong fault on the eastern limb of the Syncline, but there are no surface manifestations of this in the Jurassic sequence.

Unconformably overlying the Permian-Triassic sequence, and the Auburn Complex, the Jurassic sequence in the eastern part of the area also dips regionally to the west (or to be more exact, the south-west) but the dip is less than 5°. The Jurassic sequence has local folds and faults and these are shown on the structural sketch map, but the regional structure is clear from the outcrop pattern (Enclosures 1 & 2).

Part of the Permian-Triassic sequence appears in the north-western part of the structural sketch map as part of the western limb of the Mimosa Syncline. From the seismic reflections the western limb of the Syncline is calculated to dip about 5° east, and the Mimosa Syncline is therefore, asymmetric, the eastern limb being the steeper. The western limb of the Syncline is bounded by a north-plunging broad anticlinal ridge with a number of anticlinal culminations; one such is the Arcadia Anticline. The ridge and the contained culminations like the Mimosa Syncline, are asymmetric, the western limb dipping more steeply (15°) than the eastern limb.

Fig. 14

CONTOURS OF SEISMIC REFLECTIONS FROM WITHIN THE PERMIAN SEQUENCE
TAROOM-MUNDUBBERA SHEETS AREA



Reference

I. Bauhinia Downs Reflection Seismic Survey, A.T.P.89P for Marathon Petroleum Ltd. by United Geophysical Corp. (Completion Report), February 1963.

II. Rolleston Reflection Seismic Survey for Planet Expl. Co. by Austral Geo Prospectors, P.P.P. 710 and P.P.P. 712. Seismic Datum 600 feet; Map Datum sea level.

III. Merivale Area (A.T.P. 55/56 P) for Mines Administration by Austral Geo Prospectors, 1962. Ve = 8000 feet/sec.

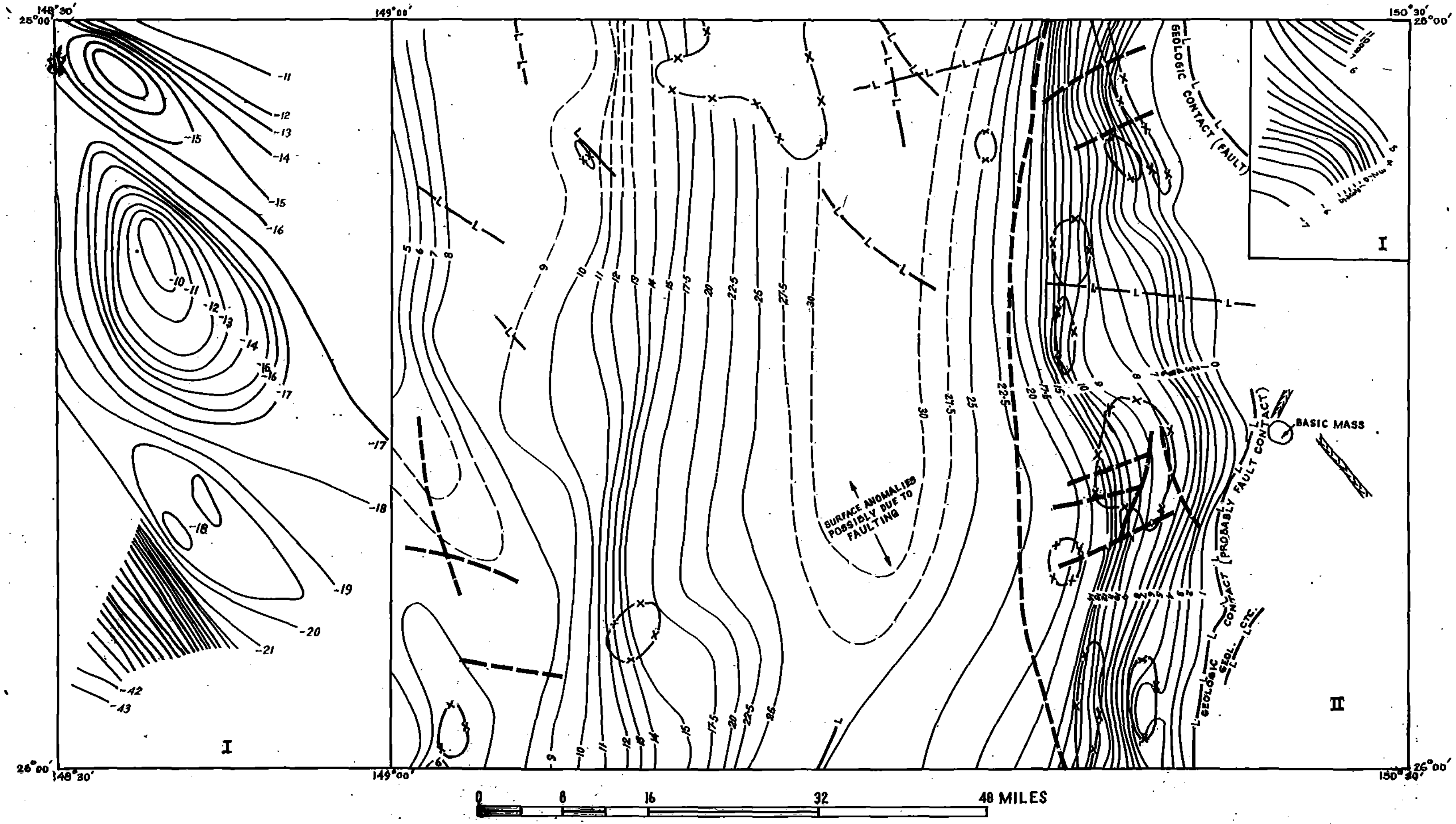
IV. Arcadia Anticline Seismic Survey, 1959.

V. Injune-Wallumbilla Seismic Survey, for Mines Administration and Associated Australian Oilfields by Geophysical Service International 1962.

VI. Purbrook-Arcadia Seismic Survey, Part I. Associated Australian Oilfields, 1962.

VII. Taroom-Theodore Seismic Survey. Queensland, 1961-1962. Union Oil Development Corp. Seismic Datum 800 feet.

RESULTS OF AEROMAGNETIC AND GRAVITY SURVEYS
TAROOM-MUNDUBBERA SHEETS AREA.



Reference

I. Regional Bouguer Gravity Map, takenfrom Bureau of Mineral Resources Record 1961/150, based on gravity survey by Mines Administration Pty.Ltd. Report Q/56 P/64 and Q/51 P/50. Contour interval 1 milligal.

II. Aeromagnetic map, showing depth to basement, by Adastra Hunting Geophysics Pty. Ltd. for Union Oil Company of California. Interpretation of the basement configuration by R.R. Hartman.

Contour intervals 1000feet.

—6— Contour and value.

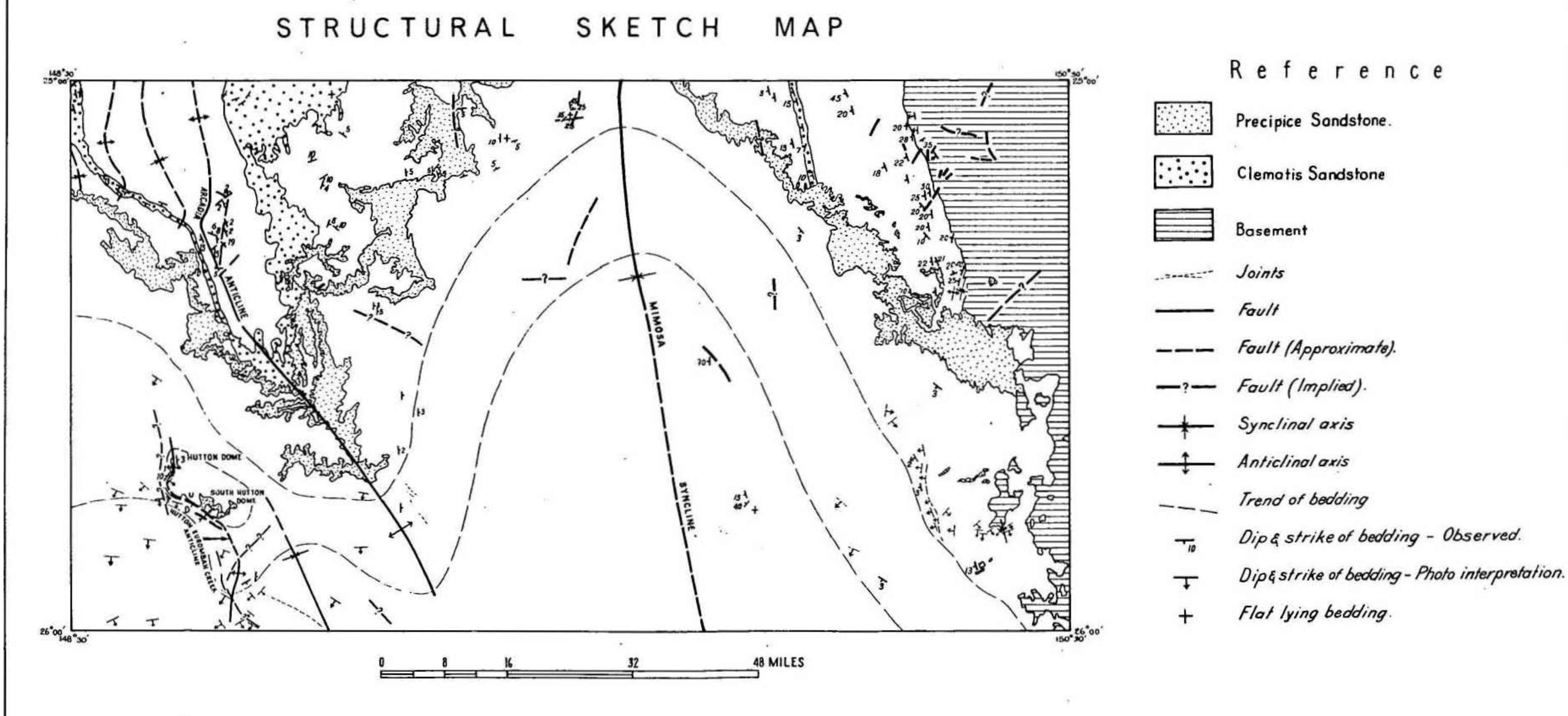
— — — Fault.

—L— Lineament (*Possibly a fault.*)

Zone of possible basement relief and/or sedimentary structure.

Near surface dyke or flow.

Fig. 16.



Bureau of Mineral Resources, Geology & Geophysics

To accompany Record 1964/61

G55/A8/1

G.M.

As noted in the section on the Rewan Formation, there is a slight angular unconformity towards the base of the Triassic sequence in the Arcadia area. It is possible that the degree of the unconformity increases greatly towards the south where, in the Hutton Creek area the Jurassic sequence rests directly on unit C of the Middle Bowen Beds. There is also the possibility that this situation has been bought about by a later folding movement, possibly in the Upper Triassic.

The structure of the Jurassic sequence reflects the Mimosa Syncline and the anticline to the west, although dips are not as great as those of the Permian-Triassic sequence. The structure is more complicated in the south-western portion of the area where the Jurassic sequence is folded and faulted. The Hutton-Eurombah Creek Anticline, the axis of which partly coincides with a fault, is associated with at least two domal structures, as already described in the section on the Evergreen Formation. This anticline is represented by a fault at depth as indicated by the seismic reflection contour map. This map also indicates that the simple south dip of the Jurassic sequence west of the Hutton-Eurombah Creek Anticline, does not reflect the more complex folds in the underlying Permian sequence.

The aeromagnetic map (Fig. 15), shows the basement in the centre of the Mimosa Syncline to be at 30,000 feet below the surface. This agrees well with the depth estimated by taking in most cases, the maximum thickness figure for each formation based on field evidence:

	Feet
Injune Creek Beds............	500
Hutton Sandstone.............	550
Evergreen Formation..........	540
Precipice Sandstone..........	400
Moolayember Formation........	5500
Clematis Sandstone...........	1000
Rewan Formation..............	12,000
Baralaba Coal Measures.......	800
Gyranda Formation............	1600
Flat Top Formation...........	1800
Barfield Formation...........	3000
Oxtrack Formation............	350
Buffel Formation.............	640
	28,680 i.e. about 28,500 feet.

GEOLOGICAL HISTORY

One can only speculate on the pre-Permo-Carboniferous history of the area. If the Auburn Complex was partly emplaced during the Carboniferous, like the Urannah Complex in the northern part of the Bowen Basin, then the undifferentiated Palaeozoic metamorphics may be the remnant of an older geosynclinal sequence. The known history of the area commences somewhere in the late Carboniferous or early Permian, with the deposition, in the east, of a thick pile of andesitic and dacitic volcanics and associated pyroclastics. This probably coincided with the formation, in the western part of the area, of a sequence of freshwater mudstone and coal known as the 'undivided freshwater beds' (Webb 1956).

When the vulcanism subsided and the erosion of the volcanic terrain had commenced, the sea covered most of the area. Epiglacial conditions probably obtained in surrounding land areas, and the sea supported a cold-water Eurydesma fauna. This was followed by a complete withdrawal of the sea, and, in all probability, some erosion took place. There is no evidence of folding at this time, and deposition seems to have been confined to the western and northern parts of the Bowen Basin with formation of unit B of Dickins, Malone and Jensen (1962).

A major marine transgression took place and the sea swept back to cover the whole area. This resulted in the deposition of unit C, which in the Cracow area comprises the Oxtrack, Barfield, and Flat Top Formations. Active vulcanism accompanied the deposition of the upper part of the Barfield Formation and the Flat Top Formation. For the last time in the Permian-Triassic depositional phase the sea receded, and the sediments of the Gyranda Formation and the Baralaba Coal Measures were deposited in a fluvial and paludal environment. Vulcanism ceased at the end of the Permian.

The close of the Permian saw some minor earth movements in the area, resulting in the slight angular unconformity in the Arcadia area. Although there is no apparent unconformity in the Cracow area, the basal conglomerate of the Rewan Formation may indicate uplift of the provenance areas at this time. This was followed by sinking in the area of the Mimosa Syncline, especially on the eastern side where a total of 18,000 feet of sediment (a post-compactions figure) was deposited during the Triassic. Folding of the Permian and Triassic sequence, and intrusion of the Auburn Complex, was completed by the end of the Triassic and the area was reduced to a peneplain. Climatic conditions were such as to produce very strong silicification of near surface rocks.

In the early Jurassic, a new drainage system from the south-west spread a blanket of quartz-rich sands over most of the area. The sediment received by the basin became finer and as the basin sank the limits of deposition were extended farther towards the east. This subsidence led to a short marine transgression, with the subsequent deposition of chamosite-rich sediments. With the withdrawal of the sea fluvial and lacustrine sediments were again deposited in the area, and in some places during the Middle Jurassic peat deposits were formed. It is possible that deposition in the area continued into the Cretaceous. There are no signs that it did, but this may be the result or erosion.

There has been some post-Middle Jurassic folding in the western part of the area, in response to movements on faults in the underlying Permian sequence. The broad synclinal structure of the Jurassic sequence over the Mimosa Syncline was probably produced by differential compaction rather than by a folding episode.

During the Tertiary there was scattered deposition of clay and gravel from rivers, and some lateritization. In the central part of the Mimosa Syncline basalt/was extruded, and this was subsequently lateritized in some places.

ECONOMIC GEOLOGY

(a) GOLD.

(1) The Cracow Goldfield.

The Golden Plateau Mine is the only major producer of gold in the Cracow Goldfield, and for many years, Golden Plateau and Mt. Morgan have been the only important gold producers in Queensland.

Gold was discovered in payable quantities on the field in 1931 by C. Lambert, working under an incentive from the Government. Many small mines operated in the early days of the goldfield and the mineral production figures are given in Table 8.

The mine was originally worked by glory-holding but eventually became an underground mine. The depth of the vertical shaft is 850 feet, and there are seven main haulage levels. The ore is won by shrinkage stoping, sublevel open stoping, rill stoping and breast stoping and the

TABLE 8

Table of Mineral Production

Taroom and Mundubbera West 1:250,000 Sheets.

Compiled from production figures recorded by the Mining Warden in the Annual Reports of the Department of Mines, Queensland.

(a) Coal production at Maranoa Colliery, Injune.

Period	Tons of coal	Value in £
First Production 1933		
1933 - 36	54,324	48,736
1937 - 41	92,205	93,774
1942 - 46	80,042	95,792
1947 - 51	70,201	114,141
1952 - 56	106,983	276,233
1957 - 61	113,831	365,309
1962	16,835	58,494
1963	7,650	26,778
Mine closed October, 1963		
Total, 1933 - 63	542,050	1,079,250

(b) Gold and silver production from Cracow Goldfield.

Period	Ore (tons)	Gold (fine oz)	Silver (oz)	Total Value £	Chief Producers
1932-36	110,225	94,080	7,322	790,213	GP, RP, D, LS
1937-41	357,794	130,460	111,215	1,233,372	GP, RP, RN, K
1942-46	138,377	34,610	37,236	343,165	GP, RP, K, GW
1947-51	116,417	32,415	43,183	306,834	GP, K, R, GM
1952-56	134,780	68,761	61,174	1,095,107	GP
1957-61	169,664	75,504	77,912	1,210,354	GP
1962	33,935	13,496	13,044	216,996	GP
1963	33,420	13,775	14,655	231,532	GP
TOTAL	1,094,600	463,100	365,740	5,427,600	GP

Abbreviations

GP = Golden Plateau
D = Dawn
LS = Lambert's Surprise
RP = Roses Pride
RN = Roma North
GW = Golden West
K = Klondyke
R = Rainbow
GM= Golden Mile

ore is raised in one ton trucks up the shaft to the ore crushing section on the surface.

The company employs between 80 and 100 men who live in the township of Cracow. Total production to date is 463,100 oz of fine gold and 365,740 oz of silver produced from over one million tons of ore. Average grade is just under eight dwt per ton.

The gold deposit occurs within chiefly andesitic volcanics of the Camboon Andesites close to their contact with the Auburn Complex intrusives. Several small lodes have been worked on the Cracow field, but gold deposition was confined mainly to the Golden Plateau lode system, which Brooks (in preparation) considers to form a faulted link between the White Hope lode on the west and the Golden Mile lode on the east. (see Fig. 17). Within the Golden Plateau lode, irregular tabular ore shoots have been mined discontinuously over a length of 2275 feet and widths of up to 50 feet, and to a depth of 825 feet. The lode system is terminated abruptly on the west by the north-north-west striking Golconda Fault (Denmead, 1946, p. 309) and on the east by a similar north-north-west striking fault. These faults were probably initiated prior to ore deposition but post-ore movement has also taken place.

The gold occurs as gold-silver alloy in a quartz gangue. Primary gold is seldom visible to the naked eye, even in high grade ore. Small amounts of sphalerite, chalcopyrite, pyrite, galena and bornite are present.

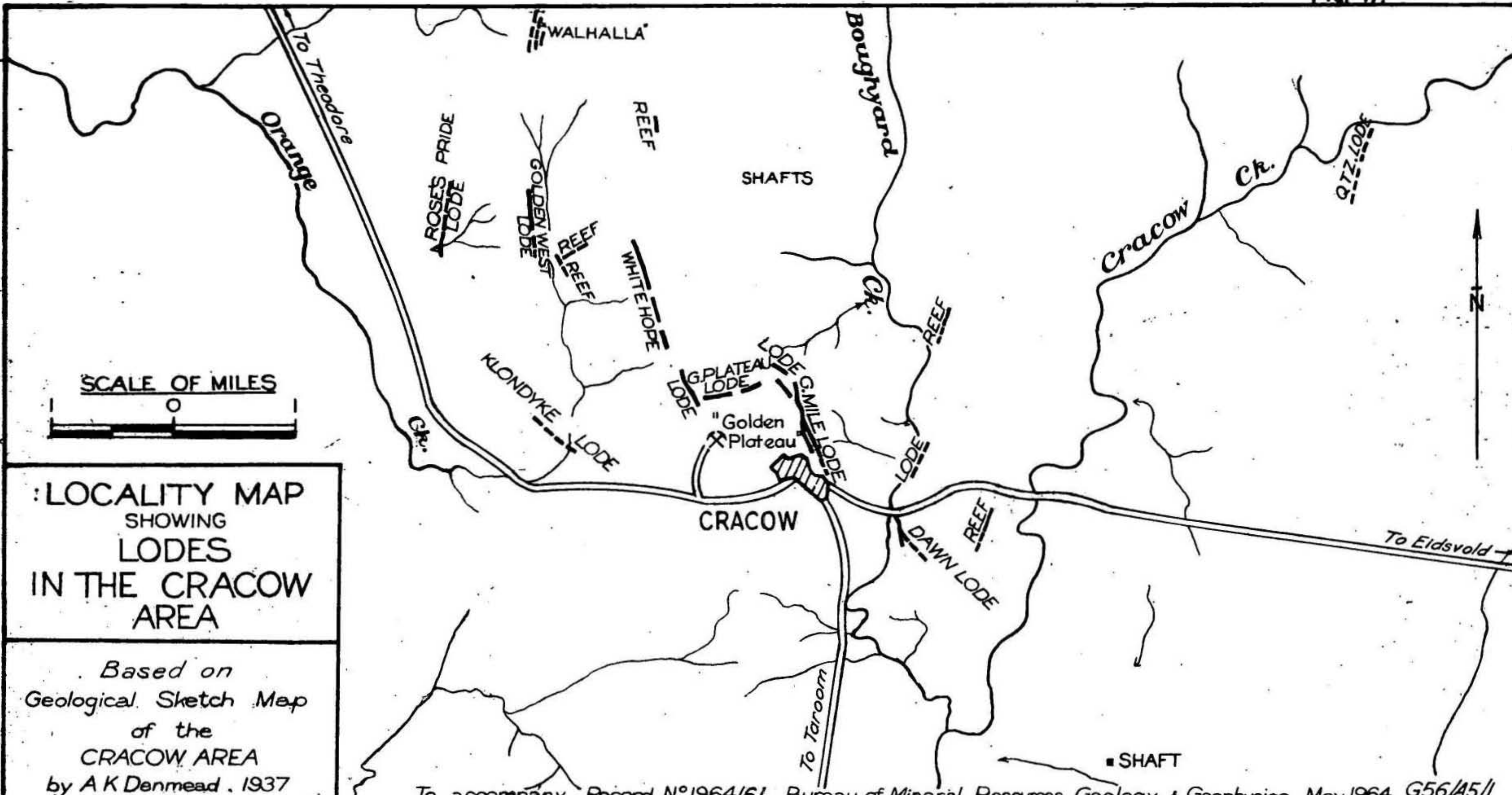
The Golden Plateau lode is regarded as a hydrothermal replacement deposit. Ore deposition seems to have been controlled by faults, and in many places, appears to be related to rhyolite dykes. Brooks (in preparation) notes that nearly all ore shoots have one wall defined by a fault plane or fault zone. In the eastern sections of the mine, ore shoots often occur adjacent to a rhyolite dyke, or they may have a fault marking one wall and a rhyolite dyke, the other.

Recent diamond drilling by the Queensland Department of Mines and Golden Plateau N.L. has located significant gold contents in lodes beyond the western and eastern limits of the present mine workings.

(2) Other Areas.

McTaggart (1959) noted that "some gold has been reported from the Mountain Creek area", and residents report showings of gold in quartz veins in the Red Range Creek area. Both of these areas occupy a similar geological position to the Cracow lodes, but no important lodes have been reported.

Fig. 17.



LOCALITY MAP SHOWING LODES IN THE CRACOW AREA

Based on Geological Sketch Map of the CRACOW AREA by A K Denmead. 1937

To accompany Record N° 1964/61 Bureau of Mineral Resources Geology & Geophysics May 1964 G56/A5/1

(b) COAL.

The occurrence of coal in the Injune area has been known at least since 1920, and it was probably first discovered in the early water bores in the area. Diamond drilling to test seams reported from water bores was reported on by Jensen (1923). He states "diamond drilling has proved the district extremely prolific in small coal seams, and in carbonaceous shales, many of which are low grade oil shales, but large and consistent seams do not occur".

Two prospecting areas were granted in 1924, and three shafts were sunk. The Mining Warden reported a 300 feet shaft in 1932, and the first production of 6408 tons from Maranoa Colliery was recorded in 1933. Coal was produced continuously for 30 years till the mine closed in October, 1963, after the production of 542,050 tons of coal valued at over one million pounds. Closure appears to be due to decrease in demand following the increasing use of diesel fuel by the railways, and utilisation of natural gas for power generation in Roma.

The Maranoa Colliery is situated approximately two miles south of Injune, which is at the terminus of a branch railway running 63 miles north from Roma. The colliery workings were all on one seam which has been worked from four cross-measure drifts, only one of which was in use when the mine closed. The greatest thickness of working seam reported by Mengel (1959) is 4 ft. 7 ins. The seam is divided by a persistent thick shale band into two sections both of which are normally worked. The coal is weakly coking, and of high volatile A to B bituminous rank.

Diamond drilling to assist the planning of new haulage systems and to prove reserves was requested by the owners and 12 holes were drilled by the Queensland Mines Department during 1955. Several small seams were penetrated above the worked seam, the most persistent lying 5-10 feet above the main seam. However its maximum thickness was less than two feet. The deepest hole was drilled to 261 feet and although it passed through eleven coal seams below the worked seam, none was sufficiently thick to warrant further testing. Characteristics of the main seam met in the holes are (Hawthorne, 1956):-

Fixed carbon (DMFB) = 42.6-51.1%

Calorific value (MMFB) = 13,550-14,640 BTU'S / lb (Parr Formulae)

Ash Content = 13.1-22.3%

Average core recovery in sections analysed = 97%.

Many small normal faults were encountered in the workings, and resulted in much loss of time and coal production because drives had to be regraded after penetration of each fault to allow hand wheeling methods to be employed. Maximum throw reported is 25 feet but a throw of 3-6 feet is typical of most faults. Hawthorne (1956) considered that the mine area is free from major faulting.

Reserves (Hawthorne, 1956). Measured reserves of 500,000 tons of workable coal with an average thickness of 3ft. 3½ins underlies an area of 95 acres. Indicated reserves of 80,000 tons in an area of 15 acres should also be available. (Reserves were calculated on data obtained during April-September, 1955. Production since this date is estimated at 165,600 tons).

Little is known of the coal resources of the Injune Creek Beds in the Taroom area. A summary of data on Queensland coalfields compiled by the Geological Survey of Queensland in 1951 briefly mentions the Taroom - Wandoan Area. It reports that coals of Jurassic age crop out, or have been met in bores and wells in this area. Some thick seams are reported, but little prospecting has been carried out, and no precise information as to composition and quality of the coal is available.

(c) IRON ORE.

(1) Mundubbera West Sheet.

The iron content of the oolitic limonite of the oolite member averages about 40% Fe. The considerable thickness developed in the Cockatoo Creek area (up to ten feet), its generally horizontal attitude, and the relatively thin cover of soft overburden over large areas suggests its possible utilisation as an iron ore.

An investigation of its potential as a source of iron ore was carried out by Consolidated Zinc Pty. Ltd. and reported on by Urquhart in 1962. An exploration programme over nine months included regional reconnaissance surveys and detailed geological mapping, and culminated in the drilling of 34 diamond drillholes to test the deposit from Mooranga Holding to Kilbeggan Holding (Mundubbera Sheet). As a result of this survey, ore reserves in the Dawsonvale-Cockatoo area were estimated at 139 million tons of iron ore, with an average thickness of 4.7 feet beneath an overburden averaging six feet in depth, and with an average grade of 37.5% iron (Urquhart, 1962). An additional reserve of 60 million tons was calculated to underly overburden averaging 22 feet in depth. The ore reserves were not calculated in the Pontypool-Geddesvale-Kilbeggan area, but Urquhart reports average of 13 feet of overburden in this area.

Samples of this ore were submitted to AMDL for beneficiation tests and results were reported by Bollen and Gooden (1963). The beneficiation tests carried out on the ore did not give concentrates of satisfactory grade with satisfactory recovery, "due to intimate association of the iron and gangue minerals". However Bollen and Gooden suggest further tests may be warranted, and note that an alternative to beneficiation is a direct reduction process which will treat a low grade siliceous iron ore.

2. Taroom Sheet.

The reappearance of the oolite member in the Hutton Creek Area indicates the possibility of locating further deposits of low grade iron ore in this area. However, thickness of ironstone in this area is much less than that in Cockatoo Creek area. The best area for testing thickness and grade of ore present would be in the O.K.-Hutton Park area. In this area, overburden is thin or absent over at least three square miles, the ironstone is flat lying, and analysis of a specimen of oolitic ore (T789) gave 41.1% iron.

(d) PHOSPHATE.

Analyses for phosphate have been made on specimens from the following formations. Detailed results are tabulated in Appendix (F).

1. Injune Creek Beds
2. oolite member
3. Barfield Formation

1. As a result of a local report in the Injune area that a weathered calcareous sandstone of the Injune Creek Beds was "pure fertiliser", samples were submitted for phosphate analysis. Highest assays gave 0.044% phosphorus.

2. Because of the common association of collophane with chamosite, several samples of oolitic rock from the oolite member were submitted for phosphate analysis. Highest grades were:-

Cockatoo Creek area	-	0.685% phosphorus
Hutton Creek area	-	1.51% phosphorus
Bore 29	-	0.6% P_2O_5

Urquhart (1962) reports analyses made of cores obtained from diamond drilling on the oolite member in the vicinity of Cockatoo Creek No. 1. Highest assay quoted over a one foot thick section was 5.84% P_2O_5 (= 2.55% phosphorus).

3. The Barfield Formation was previously thought to be a likely source of phosphate but results did not support this. Of five analyses the highest content was 1.0% P_2O_5.

(e) WATER

In the Taroom-Cracow area, water for stock and domestic use is obtained from perennial and non-perennial streams, spears in alluvium, and bores. Both artesian and non-artesian water is encountered in the bores. The information regarding underground water is presented in three sections: (1) collection and presentation of data; (2) occurrence of underground water, and (3) tables of data and drillers' logs (Appendix E).

(1) In the course of mapping the area the opportunity was taken to visit as many homesteads as possible to gather information on water bores. All the homesteads (about 70) in the Mundubbera west area were visited, but visits were made only to about half of the 160 homesteads in the Taroom Sheet area. In the Taroom Sheet area, information was gathered about 70 bores and wells which were not registered with the Irrigation and Water Supply Commission. In the Mundubbera west area, information concerning 165 bores was collected.

Data collected in the field including depth of bore or well, supply, and field number are presented in Appendix E. Drillers' logs are also supplied for some bores. All the information was gathered from land owners and drillers, and much of it is from their memory, as written records are seldom kept. Recent subdivision of large properties has caused information to be lost as the new property holders fail to take note of previous water information.

Many of the bores on the Taroom Sheet area, and some in the Mundubbera west area, are registered with the Irrigation and Water Supply Commission, and where possible the registered numbers are shown on the maps and in the tables. Some difficulty was experienced in relating bores found in the field with those plotted on I.W.S. maps, and in those cases where there was some doubt in identification a field number only is used.

(2) Underground water.

In general the prospects of finding good supplies of underground water in the Camboon Andesite and the Auburn Complex are poor, and in areas underlain by these units dams are probably a more economic proposition. However, some shallow bores in creek alluvium or in fractured rocks yield moderate supplies in areas underlain by these rocks. Prediction of this type of supply is not possible on the basis of regional mapping.

The Buffle and Oxtrack Formations have yielded good supplies of water, but as this is dependant on fracture or solution porosity, reliable prediction is not possible without detailed investigation. Of the remaining Permian units, only the basal part of the Gyranda Formation, or the sandstone of the Baralaba Coal Measures offer any hope for plentiful supplies. The Rewan Formation is generally tight, but the other Triassic Formations, the Clematis Sandstone and the Moolayember Formation should yield good supplies of water suitable for stock.

The lower Precipice Sandstone is a good aquifer and plentiful supplies of potable sub-artesian and artesian water are obtained in most areas underlain by the formation. Most bores supply sub-artesian water, but good artesian supplies are obtained in the Lesmortagh - Kintore - Yoorooga area at depths of 700 to 1000 feet. Many of the artesian bores in this area are never shut off, the reasons given being "rusted casing", "flows up round casing", or "valves won't shut off". The total loss from four of the bores in this area which are never shut off is estimated at 140,000 gallons per day. The excess water is not utilised, but fills unnecessary waterholes, or flows into creeks.

Springs are common in creeks cutting the Precipice Sandstone, and in many creeks the only permanent water is downstream from the springs. The Dawson River, Hutton Creek, Cockatoo Creek, and many smaller creeks are fed by springs. Mound springs occur in the Hutton Creek area, north-east of Injune. A great number of mound springs occur on a large flat area called Pigface Flat, near Hutton Creek. The mound springs are usually circular in plan, semi-oval in cross-section, and covered with a spongy mat of black organic mud, grass and reeds. Water bubbles up around the edges, becoming stronger after wet seasons, and contracting after dry spells. The water is often black in colour, but a sample tested in the laboratory showed no trace of hydrocarbons. The springs range in size from large mounds

30 feet in diameter to small mud volcanoes six inches across. Most of the springs in the area occur close to a small fault along the axis of the Hutton - Eurombah Creek Anticline. The artesian water is thought to be coming from shallow depth, from a small scale artesian structure developed in porous beds in the Precipice Sandstone, dipping off the South Hutton Dome.

The Evergreen Formation is, in general, an aquiclude. The Boxvale Sandstone Member, however, is a very useful aquifer in the Jurassic sequence on the western side of the Mimosa Syncline. Water is usually of good quality and sub-artesian; artesian supplies in the Hornetbank area are probably from the Boxvale Sandstone Member. Limited artesian supplies are also obtained from this unit along the Hutton - Eurombah Creek Anticline. One bore west of the Hutton Dome situated at the foot of a 10° dip slope in Boxvale Sandstone yields artesian water from a depth of 30 feet.

The Hutton Sandstone is not a good aquifer in general. Water obtained from it is erratic in occurrence and commonly brackish in quality, in places sometimes being unfit for stock. Because of the thick porous sandy soil developed, surface water is not plentiful in areas of Hutton Sandstone outcrop.

The Injune Creek Beds provide few useful aquifers. Water is often struck near coal seams, but it is generally brackish, and often unfit for stock. Deeper bores could be expected to strike potable water in the Boxvale Sandstone Member in the Injune area, and very deep ones (over 1000 feet) could expect sub-artesian supplies from the Precipice Sandstone in areas where the Injune Creek Beds outcrops on the eastern side of the Mimosa Syncline. (The Boxvale Sandstone Member is thin, or absent in this area).

Alluvium associated with most of the streams offer hope of good supplies of water.

(f) PETROLEUM

The results of drilling to date have been discussed in a previous section. In the present section the potential of the area will be discussed under (a) source rocks, (b) reservoir rocks, (c) structure, and (d) possible stratigraphic traps.

(a) Source rocks.

Without venturing into the problem of 'what constitutes a source rock', it appears that the Back Creek

Group and the Evergreen Formation offer the best changes of containing source rocks, because both are marine. Within the Back Creek Group, the Barfield Formation, consisting essentially of black pyritic mudstone, was possibly deposited in a reducing environment suitable for the production of petroleum.

The black mudstone of the Evergreen Formation associated with and lying above the oolite member is possibly marine and may have some claims as a potential source rock.

The undivided freshwater beds, encountered in wells in the western part of the Taroom Sheet area, were probably the source rocks of much of the carbon dioxide and methane found in O.S.L. No. 3 Arcadia. This unit may therefore be regarded as potential source of methane.

(b) Reservoir rocks.

Considering the Permian-Triassic sequence of the Mundubbera area, there are no good known reservoir possibilities in the Permian sequence, and the Clematis Sandstone is the only possibility in the Triassic sequence. The clay matrix common in the Clematis Sandstone reduces the porosity considerably, and makes it a doubtful reservoir for petroleum. Another possible disadvantage with this unit is its isolation from any possible source rocks.

On the other side of the Mimosa Syncline, units A and C of the Back Creek Group offer some hope of reservoir potential, as shown by the porosity of sands in those units encountered in O.S.L.3 Arcadia. As these are within a marine section there is a possibility of source rocks being close to the reservoir rocks. The methane in unit C probably had its origin within the Back Creek Group.

Considering the Jurassic sequence, the basal part of the Precipice Sandstone has obvious reservoir potential, and in places the Boxvale Sandstone may well have the same potential. The clay matrix of the Hutton Sandstone appears to rule it out as a likely reservoir rock, and the sandstone of the Injune Creek Beds is commonly cemented by carbonate, which considerably reduces the porosity.

(c) Structure.

The present discussion will be limited to the structure of those units with some reservoir potential. These are: the Back Creek Group in the western part of the area, the Clematis Sandstone, the Precipice Sandstone, and the Boxvale Sandstone.

The structure of the Back Creek Group in the western part of the area is favourable for the accumulation of petroleum. Folding has produced domes and anticlines such as those shown in the seismic reflection contour map (Fig. 14); some of these have been drilled but no accumulations have been found.

The structure of the Clematis Sandstone within the Mimosa Syncline is relatively simple. It is unlikely that there are any structural traps on the eastern limb except possibly immediately adjacent to the major fault shown in Fig. 14. It is possible that likely structural traps exist on the western limb of the Syncline, and in the western part of the area.

There is some possibility of favourable structures in the Precipice and Boxvale Sandstones in the Injune area. Structures such as the Hutton-Eurombah Creek Anticline have been developed over faults in the Permian. While not precluding the possibility of hydrodynamic entrapment, the abundance of artesian water within these units diminishes the chance of the accumulation of petroleum.

It is not known if structures exist within the Precipice Sandstone in the eastern part of the area mapped.

(d) The possibility of stratigraphic traps.

Reduction in porosity because of lithological variations is possible within each of the likely reservoir rocks mentioned. The only additional point to be noted here is the possibility of the accumulation of petroleum at the postulated pinchout of the Boxvale Sandstone (page 64).

(c) MISCELLANEOUS.

Oil Shale. There are numerous reports of oil shale and kerosene shale in the Injune Creek Beds, in the Injune area. Several assays have been carried out and the highest yield of crude oil by destructive distillation was 50 gal/ton.

Clays. No clay samples were submitted for tests of their suitability for pottery or brick making. Formations in which commercial clay deposits might be expected include the Injune Creek Beds and the Evergreen Formation. Whitehouse (1952) notes that the clays of the Injune Creek Beds are generally calcareous and non-kaolinitic. Such clays are generally unsatisfactory for ceramic use. However, he also states that the white clays of the lower part of the Evergreen Formation are kaolinitic clays. These are generally high temperature clays suitable for fire bricks, pottery, ceramics, and heavy clay industries.

The most likely source for clay is the Tertiary deposit, already described, on Gyranda Station near Cracow. It is at least 60 feet thick in one place; its dimensions and the quality of the clay are unknown.

Opal. The discovery of some veins of "potch opal" in Hutton Sandstone in the Kilbeggan area on the Mundubbera sheet suggests the possibility of the occurrence of precious opal in this formation. However, no trace of precious opal was found, and no potch has been seen elsewhere in the formation.

Basalt. None of the small basaltic intrusions is large enough to supply economically any substantial quantities of road metal or aggregate, but the basalt near Acacia Homestead may be a source of supply for Theodore.

Limestone. Limestone occurs in the Permian rocks in the Cracow area and has been reported from the Injune Creek Beds in the Injune area. However only very thin impure limestone beds have been seen in the Injune area, and the chance of locating workable deposits seems remote. Massive fossiliferous limestone occurs in the Cracow district, and it has already been used in the construction of Binda Weir. Both the Oxtrack and Buffel Formation could supply a large quantity of limestone but the quality is likely to vary appreciably along strike, and many quarries would be required

Laterite. Six samples of laterite were taken from a cliff of laterite overlying the Auburn Complex (q.v), 10 miles north of "Moocooroob a". The exposure sampled is just east of the mapped area; it covers an area of about one square mile. The six Samples were taken at vertical intervals of ten feet starting from the surface. Semi-qualitative analysis by emission spectroscopy for some of the main metals shows them to be of no economic interest as far as these metals are concerned. The results of the analysis are shown in Table 9.

TABLE 9.

Semi-Quantitative Analysis
by Emission Spectroscopy
parts per million

Sample Mark	Copper Cu	Lead Pb	Zinc Zn	Cobalt Co	Nickel Ni
T310/1	15	15	20	2	12
T310/2	20	15	30	3	12
T310/3	20	15	30	2	10
T310/4	20	12	40	2	10
T310/5	12	15	30	1	7
T310/6	15	12	40	2	8

Sample Mark	Chromium Cr	Vanadium V	Molybdenum Mo	Calcium Ca
T310/1	40	60	2	50
T310/2	40	40	3	40
T310/3	40	50	3	100
T310/4	20	40	1	20
T310/5	20	50	1	40
T310/6	15	70	2	50

CONCLUSIONS.

STRATIGRAPHY.

Permian

(i) The Cracow Volcanics, formerly thought to be Triassic, are part of the Lower Permian Camboon Andesite.

(ii) The Oxtrack Formation, as previously mapped, contains within it a significantly older unit which is herein differentiated and called the Buffel Formation.

(iii) The Orange Creek Formation, together with the Passion Hill and Acacia Formations, have been equated with the Barfield Formation.

(iv) The Mount Steel Formation has been equated with the Flat Top Formation.

Triassic

(i) The Isla Formation has been equated with the Rewan Formation. The Rewan Formation thins considerably from east to west, across the Mimosa Syncline.

Jurassic

(i) The Boxvale Sandstone previously recognized as a separate formation, is now regarded as a member of the Evergreen Formation;/it has been proved to wedge out to the east from the type area.

(ii) The Boxvale Sandstone Member is overlain by an oolite member, which probably represents a Lower Jurassic marine incursion into the Surat Basin.

ECONOMIC

Petroleum prospects

Both possible source and reservoir rocks are to be found in the Permian-Jurassic sequence. The best prospects for the combination of source rocks, reservoir rocks, and structures, is in the western part of the Taroom 1:250,000 Sheet area. The most likely reservoir rocks are Lower Jurassic, but the Permian Back Creek Group offers some hope.

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APPENDIX A

Mineragraphic Investigation of a Ferruginous Oolite from Mundubbera Sheet, Queensland

by

I.R. Pontifex

The sample was submitted by C. Gregory 24/10/63.

Field No. T686. Outcrop sample.

Minerals identified. Hydrated iron oxide, quartz, hematite, pyrite.

Approximate Fe grade. 45% Fe.

Macro description. The rock is essentially a homogeneous semi-indurated aggregate of limonite oolites. Dark brown irregular silicified bands are roughly parallel throughout, these vary in thickness from 0.5 mms. to 3 mms. Thin siliceous veins occur at random through the rock.

Micro description. The entire section consists of an aggregate of limonite oolites of both elliptical and spherical shape, these range in diameter from 0.3 mms. to 0.8 mms but generally they measure about 0.6 mms. across. Concentric layers are evident throughout the limonite which constitutes the bulk of each oolite, these however are poorly defined probably because of differential alteration of the original material and also because of the distribution of irregular but concentrically arranged leach cavities in the oolites. The outer crust of each oolite is generally not present in its entirety but where it is intact it is well defined, it consists essentially of hydrated iron oxide and attains a maximum thickness of 0.015 mms.

The leach cavities within the oolites are commonly lined by finely crystalline siliceous material and amorphous iron oxide. Interstices between the oolites are also filled with siliceous material and hydrated iron oxides, these form a weak binding cement. These components have been distributed through the aggregate after the formation of the oolites, probably by means of supergene agencies.

In the dark brown silicified bands the oolites have been thoroughly impregnated, almost completely replaced, by extremely fine crypto-crystalline silica simulating iron rich jasper.

Throughout the aggregate, exsolution-type needles of hematite occur in minor abundance in some oolites, they are about 0.003 mms. wide and extend across the diameter of the host oolite. These needles have a generalised common orientation almost perpendicular to the siliceous bands. The presence of these bodies is anomalous and their significance was not apparent.

Fine grains of pyrite, 0.002 mms. across are distributed at random through the aggregate in accessory abundance.

No other minerals are present.

Genesis. The mode of origin of this rock can not be conclusively determined from one specimen. The oolites may have been deposited originally as limonite pellets as they now exist. Oolites of this type however are not particularly common. Considering the mode of occurrence of this sample and the abundant evidence of supergene weathering in it it is thought more probable that it represents a completely oxidised oolite deposit of pre-existing iron minerals such as hematite, magnetite or chamosite. No evidence of primary oolites of this nature was observed however.

Approximate grade. The percent Fe content was not determined by any quantitative analytical technique. An approximation of this value can be estimated from the percent Fe in hydrated iron oxide and the amount of this mineral in the specimen.

Although the composition of hydrated iron oxide is variable the average percent Fe content given by Dana and Rutley is 60%.

Hydrated iron oxide makes up about 80% of the specimen.

Therefore the approximate grade of this rock is 45% Fe. Silica is the dominant impurity.

March 2nd, 1964.

Lab serial No. 1280.

APPENDIX B

PERMIAN MARINE MACROFOSSILS FROM THE MUNDUBBERA AND MONTO SHEET AREAS

by

J.M. Dickins

INTRODUCTION

The Permian marine faunas from the Mundubbera and Monto Sheet areas in the south eastern part of the surface expression of the Bowen Basin, have aroused considerable interest; and correlation of the rocks with those of other parts of the Bowen Basin has presented many difficulties, partly because of discontinuity of outcrop. The collections discussed in this report, add to our knowledge of these faunas and throw some light on the problems of correlation.

In recent years Hill (1950) has described Productinae from near Cracow Homestead, Maxwell (1954) has described Strophalosia from the area and Campbell (1961), species of Ingelarella and Notospirifer.

Some of the fossils recorded in this report were collected early in 1963, before the main collection was made, and the help of Dr. P.F. Howard and Mr. R. Appleby of Utah Development Co. who made this possible, is acknowledged. I am also grateful to Mr. R.E. Wass, now at Department of Geology of the University of Sydney, for discussion on the problems of this area and for access to his Honours Thesis on the Cracow area and to Dr. J.F. Dear of the Geological Survey of Queensland who is mapping the Permian rocks of the Monto Sheet area. Dr. Dear has supplied stratigraphical and palaeontological information and has kindly helped in collecting the reference material from the Monto area which is listed in this report.

The identifications are standardized with those used in other reports on fossils from the Bowen Basin. Many of the species identified are illustrated in the Permian Index Fossils of Queensland (Hill & Woods, 1964) and the names, in the main, correspond with those used in the Index.

CONCLUSIONS AND CORRELATIONS

The occurrence of the species is shown in the accompanying distribution chart and the correlation of the Permian sequence and its relationship with underlying and overlying formations is shown in the table. This table also appears in Dickins in Mollan, Exon & Kirkegaard (1964).

Two quite distinctive faunas are found in the marine Permian of the western part of the Mundubbera Sheet area. These two faunas are also found in the western part of the Monto Sheet area, immediately to the north.

The older fauna, found in the Buffel Formation, appears to be a Fauna II. (Faunas I, II, III and IV, in this stratigraphical order, were first recognized in the northern part of the basin. (Dickins, in press; Dickins, Malone & Jensen, in press). This scheme has been subsequently applied in other parts of the basin and is now employed for the southern part.) Like Fauna II elsewhere, it contains Eurydesma, Deltopecten, Anidanthus, Taeniothaerus and Neospirifer (Grantonia), which are not known above Fauna II in the Bowen Basin. It contains, as well, distinctive species of wider ranged genera or subgenera. Only a single species found in the older fauna, is known to occur in the overlying Oxtrack Formation. Species characteristic of Fauna I have not so far been identified and, therefore, the occurrence of Keeneia suggests that only the lower part of the beds with Fauna II (Unit A of Dickins, Malone & Jensen) is represented.

The younger fauna is found in the Oxtrack, Barfield and Flat Top Formations. The assemblages in the three formations are closely related and some of the differences reflect different environments and conditions of accumulation. For example Parallelodon sp.nov. B is found in the Oxtrack Formation. It is not recorded from the dark fine-grained sediments of the Barfield Formation but reappears in the Barfield Flat Top transition beds. On the other hand, Glyptoleda, a mud-burrowing form, is found in the Barfield Formation but not in the other two formations.

The presence of Fauna IV in the Oxtrack, Barfield and Flat Top Formations is shown particularly by the occurrence of Parallelodon sp. nov. B., Terrakea solida, Strophalosia ovalis and Neospirifer sp. B in the Oxtrack Formation, Myonia carinata, Platyteichum coniforme, Terrakea solida, Neospirifer sp. B, and Licharewia sp. nov. in the Barfield Formation and Parallelodon sp.nov.B, Myonia carinata, Atomodesma bisulcatum, Schizodus sp.nov.C, Terrakea solida, Strophalosia ovalis, Neospirifer sp.B, Licharewia sp.nov., Notospirifer minutus and Streptorhynchus pelicanensis in the top part of the Barfield Formation and the Flat Top Formation. This is consistent with the conclusion made by J.F. Dear that the Barfield Formation contains Fauna IV (unpublished file report).

The details of correlation with other parts of the Bowen Basin are discussed in later sections but it appears that the Oxtrack Formation is close to the base of the beds with Fauna IV (Unit C of Dickins, Malone & Jensen) and is younger than the Ingelara Formation of the Springsure area. The upper part of the Barfield Formation and the lower part of the Flat Top are equivalent, in a general way, to the Mantuan Productus Bed and to the stratigraphical interval containing the Big Strophalosia Zone and the Streptorhynchus pelicanensis Bed in the northern part of the basin.

No indication of Fauna III from Unit B is found in the western parts of Mundubbera and Monto areas and Unit B and most of Unit A of other parts of the basin are represented by an hiatus. This hiatus may be both depositional and erosional.

Evidence for the age of the faunas in discussed elsewhere (Dickins, MS.). The Buffel Formation is of Lower Permian (late Sakmarian or early Artinskian) age and the Oxtrack, Barfield and Flat Top Formations are probably of lower Upper Permian (Kazanian) age.

ENVIRONMENT OF DEPOSITION

Most of the sequence with the younger fauna (Fauna IV) was apparently laid down in an off-shore environment. This is suggested by a lack of coarse land-derived detritus, found in formations elsewhere in the basin regarded as equivalent in age, and the fineness of the sediments, the development of limestones in the Oxtrack Formation and the calcareous nature of the Upper Barfield and Lower Flat Top. It is suggested also by the poor representation of robust shelly fossils characteristic of the turbulent marginal area of the sea and in the Oxtrack Formation by large numbers of corals, crinoids and delicate bryozoans which might be expected to live in relatively calm bottom water. The Barfield is particularly characterised by mud-burrowing pelecypods.

The Buffel Formation on the other hand has large numbers of robust shells. In places it has many fragments of conglomerate/size and lacks any indication of turbidity current action: it was probably laid down closer to the shore. The development of limestone here may indicate a restricted supply of land-derived clastic material. Much of the coarse material in the Buffel Formation seems to be derived from the underlying Camboon Andesite. As this detritus is not found in the younger marine formations, the Camboon Andesite was apparently covered by the sea and not being actively eroded in this area when the Oxtrack, Barfield and Flat Top Formations were being laid down.

IDENTIFICATIONS

Mundubbera Area

Buffel Formation

T 1. Mt. Ox, 2 miles north of Cracow-Theodore road crossing of Oxtrack Creek.

Brachiopods

Cancrinella cf. farleyensis (Etheridge & Dun) 1909
Anidanthus springsurensis (Booker) 1932.
Strophalosia preovalis Maxwell 1954.
Neospirifer (Grantonia) cf. hobartensis (Brown) 1953.
Neospirifer sp.A
Ingelarella cf. ovata Campbell 1961 (sulcus wide in some specimens as in I. plana and, in some, adminicula in pedicle valve long and parallel)
Pseudosyrinx sp. (high area as in species from Fauna II and possibly Ingelara Fm. Surface with striations and pustules.)
Spiriferellina sp. (punctate, with septum in pedicle valve).

T 118. 0.8 miles west-north-west of Cracow Homestead.

Pelecypods

Eurydesma hobartense (Johnston) 1887.
Deltopecten limaeformis (Morris) 1845(perhaps costae more numerous than typical).

Gastropods

Keeneia sp. (these specimens show considerable variation in the shape of the whorl cross-section and the height of the spire. One shows faint revolving ornament. A shallow external umbilicus is present but none have an open umbilicus).
Peruvispira sp. ind. (whorls relatively rounded, spire of moderate height).
Indeterminate pleurotomarians

Brachiopods

Cancrinella farleyensis (Etheridge & Dun) 1909
Terrakea pollex Hill 1950
Terrakea sp. (as at locality B686 of South Bowen Sheet area)
Anidanthus springsurensis (Booker) 1932.
Strophalosia preovalis Maxwell 1954
Taeniothaerus sp. (close to T. subquadratus sensu stricto of Hill, 1950)x

* The specimens of Taeniothaerus from the Mundubbera area have been compared with those from the Springsure Sheet area (SP 720 and Sp 732 from the "Eurydesma Limestone") and with those from the Homevale area and from the Mt. Coolon Sheet area (MC 485). Considerable variation is shown in width, development of the umbonal shoulders and length of trail, as indicated by Hill (1950). At Cracow and in one horizon at Homevale, forms with well-developed umbonal shoulders and long trails predominate. Hill has referred these to T. subquadratus var. cracowensis. In other horizons at Homevale, however, forms can be referred to T. subquadratus var. acanthophorus Fletcher 1945 and T.subquadratus s.s. These differences seem to represent different ecological and accumulation environments rather than different geographical races and in these circumstances it seems better to refer the different groups to different varieties rather than to subspecies or species. Considerable variation is shown in the development of the cardinal area of the pedicle valve and it is doubtful whether the differences from Aulosteges are sufficient to warrant even subgeneric separation.

Lissochonetes sp.
Neospirifer (Grantonia) cf. hobartensis (Brown) 1953
Ingelarella ovata Campbell 1961 (some specimens approach I. plana in shape).
Ingelarella denmeadi Campbell 1961
Bryozoans
Large branching forms

T 133a. ¼ mile west of Rose's Pride Mine
Pelecypods
Eurydesma hobartense (Johnston) 1887
Deltopecten cf. limaeformis (Morris) 1845
Brachiopods
Anidanthus springsurensis (Booker) 1932
Strophalosia preovalis Maxwell 1954
Taeniothaerus sp. (mainly T.subquadratus var. cracowensis Hill 1950).
Neospirifer (Grantonia) cf. hobartensis (Brown) 1953
Notospirifer hillae Campbell 1961
Streptorhynchus sp.(similar or same as species found at Sp 720 and Sp 732 from "Eurydesma Limestone" of Springsure area)

T 201. On ridge, ½ mile north-west of Rose's Pride Mine
Gastropods
Keeneia? sp. - these specimens are higher spired than those

at T118. They also lack an umbilicus. The whorl cross-section varies from oval to distinctly carinate.

Brachiopods

Anidanthus springsurensis (Booker) 1932

Fenestellid Bryozoans

T 205. 1.3 miles north-west of Cracow Homestead.

Brachiopods

Taeniothaerus sp. (close to T. subquadratus s.s. of Hill, 1950).

Relationships

The Buffel Formation was originally included by Derrington & Morgan (in Hill & Denmead, 1960, p.205) in the Oxtrack Formation. Dorothy Hill, in unpublished work, suggested the Oxtrack Formation of Derrington & Morgan contained two distinctive faunas. The Buffel Formation was first mapped separately by Wass in his unpublished work (1962). Wass also showed that it contained a quite distinct fauna, older than that of the Oxtrack Formation. These conclusions are confirmed by the work of J.F. Dear on the Monto Sheet and by the present examination. Except for Neospirifer sp. A, none of the species definitely identified from the Buffel Formation are found in the Oxtrack or higher formations in the Mundubbera or Monto areas. With a few exceptions, all the species are found only in Faunas I and II. T 118, T133a, T201 and possibly T 205 appear to be in a similar stratigraphical position, low in the Buffel Formation. Species characteristic of Fauna I are absent, but Keeneia sp. suggests the Buffel Formation contains an early Fauna II i.e, the Buffel Formation is in a stratigraphical position similar to the "Yatton Limestone" which is at the base of the Middle Bowen Beds of the St. Lawrence area. Lithologically the Buffel Formation resembles the "Yatton Limestone" in containing dark coquinitic limestone with much andesitic detritus. The significance of I. denmeadi at T118 is not clear, as the species is not known from elsewhere.

T 1, which may be slightly higher stratigraphically than the other localities from the Buffel Formation, has only a relatively few species, but clearly these represent a Fauna II. The Oxtrack Formation contains Fauna IV, so that most of the basal unit of the Middle Bowen Beds to the north (Unit A) as well as Unit B is missing in the Mundubbera area and Unit C with Fauna IV rests directly on the lower part of Unit A.

Oxtrack Formation

T 23. 0.5 miles north-east of Cracow-Theodore road crossing of Oxtrack Creek.

Brachiopods

Terrakea cf. *solida* (Etheridge & Dun) 1909
Strophalosia clarkei var. *minima* Maxwell 1954.
Neospirifer sp. B
Ingelarella sp. ind.

T 24. 0.6 miles south-east of Cracow-Theodore road crossing of Oxtrack Creek.

Brachiopods

Terrakea solida (Etheridge & Dun) 1909
Ingelarella mantuanensis Campbell 1960

Branching Bryozoans

Angular pebbles of fine-grained greenish cherty material up to 1" across.

T 126. 2.8 miles south-west of Cracow Homestead.

Brachiopods

Ingelarella mantuanensis Campbell 1960

T 133b. ¼ mile west of Rose's Pride Mine, about 50 yds west of T133a - N.B. the difference in faunas between the two. T. 133a and T.133b are separated by an area of non-outcrop.

Brachiopods

Terrakea solida (Etheridge & Dun) 1909
Strophalosia clarkei (Etheridge Snr.) 1872
Strophalosia clarkei var. *minima* Maxwell 1954
Neospirifer sp.B
Ingelarella mantuanensis Campbell 1960.

Branching Bryozoans
Single Corals
Crinoid Stems

T 134. 2.5 miles south-west of Cracow Homestead.

Pelecypods

Parallelodon sp.nov. B (Fauna IV type)
Conocardium sp.

Brachiopods

Terrakea solida (Etheridge & Dun) 1909

Bryozoans

T 135a. 3 miles south-west of Cracow Homestead, on west limb of syncline.

Pelecypods

Parallelodon sp. nov. B

Volsellina? mytiliformis (Etheridge Jnr.) 1892.

Atomodesma (Aphanaia) sp.

Streblopteria sp.

Brachiopods

Cancrinella cf. magniplica Campbell 1953*

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* R.E. Wass, in his unpublished thesis, considers this to be distinct specifically from C. magniplica from the Ingelara Formation. In this report, the species is referred to provisionally as C. cf. magniplica - it is found in the Oxtrack, Barfield and Flat Top Formations of the Mundubbera and Monto Sheet areas.

Strophalosia clarkei var. minima Maxwell 1954

Strophalosa ovalis Maxwell 1954

Neospirifer sp.ind.

Ingelarella mantuanensis Campbell 1960

Dielasmatid

T 135b. 3 miles south-west of Cracow Homestead, on east limb of syncline, about 100 yds from 135a.

Pelecypods

Volsellina? mytiliformis (Etheridge Jnr.) 1892.

Atomodesma (Aphanaia) sp.

Streblopteria sp.

Plagiostoma? sp.nov.

Gastropods

Peruvispira sp.

Brachiopods

Terrakea cf. solida

Strophalosia clarkei var. minima

Neospirifer sp. B

Ingelarella mantuanensis

Fenestellid Bryozoans

Single corals

Crinoid Ossicles

T 152. 1.6 miles north-north-west of Cracow-Theodore road crossing of Oxtrack Creek.

Pelecypods

Volsellina? mytiliformis (Etheridge Jnr.) 1892.

Brachiopods

Terrakea solida (Etheridge & Dun) 1909

Neospirifer sp. B.

Relationships

The Oxtrack Formation is a persistent unit found in the Mundubbera and Monto areas below the Barfield Formation. In some places it overlies the Buffel Formation but more commonly it lies directly on the Lower Bowen Volcanics (Camboon Andesite). In outcrop, it has been recognized only along the eastern side of the Basin and is not known to persist farther north than the Thuriba area, on the southern part of the Duaringa Sheet.

Parallelodon sp.nov. B, Terrakea solida, Strophalosia ovalis and Neospirifer sp.B indicate that the fauna of the Oxtrack Formation represents a Fauna IV. None of these species have been found in Fauna III. Parallelodon sp.nov. B and Neospirifer sp.B are particularly characteristic of the Big Strophalosia Zone and overlying beds but probably Terrakea solida and Strophalosia ovalis occur lower down, in the basal part of Unit C as well (the material unfortunately isn't quite satisfactory for definite identification).

In the Springsure area, the four species seem to be absent from the outcrop of the Ingelara Formation and Catherine Sandstone as restricted by Mollan, Kirkegaard and Exon (1964), and have not been found below the Mantuan Productus Bed. In Glentulloch No. 1 Well however, Terrakea solida and Strophalosia ovalis are identified by Dear (1962), below the level of the Mantuan Productus Bed in a stratigraphical position regarded as equivalent to the Oxtrack Formation - see Dickins in Mollan et al. (1964) and also later discussion.

The fauna of the Oxtrack Formation is found essentially unchanged in the overlying Barfield and Flat Top Formations. In the Barfield Formation additional species appear, so that the fauna appears closer to that of the Ingelara Formation, but this is clearly ecological, as with the possible exception of Cancrinella magniplica, all the species which suggest relationship with the Ingelara are known to occur in both Fauna III and Fauna IV (see Dickins 1962; Dickins in Mollan et al., 1964, and in press). If indeed C. magniplica occurs in the Oxtrack Formation and above, the evidence considered in this report suggests that it also ranges from Fauna III into Fauna IV.

Barfield Formation

T 31b. 3.3 miles south of "The Braes" Homestead and about 2 miles south of Back Creek.

Pelecypods

Chaenomya? cf. *carinata* Etheridge Jnr. 1892

T 109. 2.3 miles north-north-west of Cracow-Theodore road crossing of Delusion Creek.

Brachiopods

Cleiothyridina sp.

Corals

Thamnopora sp.

Cladochonus sp.

Crinoids

Calceolispongia sp. nov. (same as in Barfield Formation near Baralaba).

Other plates

T 110. 2.3 miles north-north-west of Cracow-Theodore road crossing of Délusion Creek, about 200 yds west of T 109.

Pelecypods

Myonia carinata (Morris) 1845

Streblopteria sp.

Brachiopods

Neospirifer sp.B

Licharewia sp.nov.*

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* Previously referred to *Pseudosyrinx* sp. In a strict sense this species is close to *Licharewia* as used by Slusareva (1960) although possibly *Licharewia* could be regarded as a subgenus of *Pseudosyrinx*. The species is quite distinct from that found in the Buffel Formation (Fauna II) which is closer to *Pseudosyrinx* s.s.

Fenestellid and Branching Bryozoans

Single Coral

Crinoids

Calceolispongia sp.nov.

Glendonites

T 111. 2.1 miles north-north-west of Cracow-Theodore road crossing of Delusion Creek, about ¼ mile west of T 110.

Pelecypods

Chaenomya? cf. carinata Etheridge Jnr. 1892. (left valve may lack a carina)

Atomodesma sp.ind.

Streblopteria? sp.ind.

Gastropods

Platyteichum coniforme (Etheridge Jnr.) 1892. - has a consistently greater apical angle than found in P. costatum Campbell 1953 from the Ingelara Formation.

Brachiopods

Cancrinella cf. magniplica Campbell 1953

Terrakea sp. (non-geniculate, as in basal Fauna IV)

Strophalosia cf. typica (Booker) 1929 - same as in basal Fauna IV in northern part of Basin - probably different species to S.typica.

Lissochonetes sp. (regarded by Wass as distinctive from L. semicircularis Campbell 1953 from Ingelara Formation).

Neospirifer sp.ind.

Licharewia sp.nov! (surface lacks pustules but has fine lamellae).

Ingelarella mantuanensis Campbell 1960 (some approach I.ingelarensis in shape).

Ingelarella cf. isbelli Campbell 1961.

Cleiothyridina sp.

Plekonella sp.

Attenuatella sp.

Serpulid Worms

T 117. 1 mile south-south-west of Cracow-Theodore road crossing of Oxtrack Creek.

Pelecypods

Cyrtorostra? sp.ind.

Brachiopods

Ingelarella mantuanensis Campbell 1960

Single Corals

T 129. 200 yds west of T 129, 1.8 miles north-west of Gyranda road turn off from Cracow-Theodore road.

Pelecypods

Chaenomya sp. (seems closest to specimens from Mantuan Productus Bed)

Streblopteria sp.

Gastropods

Platyteichum coniforme (Etheridge Jnr.) 1892.

Brachiopods

Terrakea sp. (as at T 111, differs from specimens in Catherine Sandstone).

Ingelarella mantuanensis Campbell 1960 (some approach I. ingelarensis in depth of sulcus).

Corals

Thamnopora sp.

Glendonites

T 130. 100 yds upstream (east) of T 130. Small Creek 1 mile north of Mt. Steel.

Pelecypods

Glyptoleda glomerata Fletcher 1945

Brachiopods

Cancrinella cf. magniplica Campbell 1953.

Terrakea solida (Etheridge & Dun) 1909

Lissochonetes sp.

Ingelarella mantuanensis Campbell 1960

Corals

Thamnopora sp.

Cladochonus sp.

Single Corals

Smooth Conulariid

Relationships

Further evidence for assigning the fauna of the Oxtrack, Barfield and Flat Top Formations to Fauna IV is afforded by the occurrence of Myonia carinata, Platyteichum coniforme and Licharewia sp.nov. in the Barfield Formation. These three species are found also in the overlying Flat Top Formation. Evidence suggesting that the coquinites of the upper part of the Barfield and the lower part of the Flat Top Formation are equivalent to the interval in the northern part of the basin containing the Big Strophalosia Zone, and the Streptorynchus pelicanensis Bed is considered later in this report.

Flat Top Formation

T 274. 2.3 miles south-west of "The Braes" Homestead

Pelecypods

Myonia carinata (Morris) 1845

Chaenomya? cf. carinata Etheridge Jnr. 1892 (in two shells, left valves carinate and right valves rounded).

Atomodesma sp.

Gastropods

Warthia sp.

Platyteichum cf. coniforme (Etheridge Jnr.) 1892.

The Flat Top Formation is poorly fossiliferous in the Mundubbera area, so that identifications from three localities in Monto 1:250,000 Sheet area, are added to allow a more complete understanding of the fauna.

0.13: Quarry on Lonesome Creek (Theodore-Banana) road, 7.6 miles from Theodore Post Office and 3 miles from junction with Camboon-Banana road (ref. 304, 908 Monto 4-mile Sheet)*

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* Whether this locality is at the top of the Barfield Formation or at the base of the Flat Top has been open to question. J.F. Dear is now of the opinion (letter of 20th April 1964) that it is in the uppermost part of the Barfield Formation and that the base of the Flat Top Formation is approximately 100 yards west of the quarry. For convenience, in the present report, it is regarded as being in the Barfield-Flat Top transition beds.

Pelecypods

Nuculopsis (Nuculopsis) sp.

Parallelodon sp.nov. B

Myonia carinata (Morris) 1845

Pyramus sp. (very narrow, elongated, produced further in front than Ingelara form, close to species from Ba 321, Baralaba area and CL 12/2 and Cl 14, Clermont area)

Chaenomya? cf. carinata Etheridge Jnr. 1892.

Chaenomya sp. (squashed but seems similar to Fauna IV species)

Volsellina? mytiliformis (Etheridge Jnr.) 1892.

Atomodesma bisulcatum Dickins 1961

Aviculopecten sp.

Pseudomonotis? sp.

Cyrtorostra? sp.

<u>Plagiostoma</u>? sp.nov.
<u>Stutchburia costata</u> (Morris) 1845
<u>Schizodus</u> sp.nov. C (Fauna IV type)
<u>Conocardium</u> sp.
Gastropods
<u>Stachella</u> sp.
<u>Mourlonia</u> (<u>Mourlonopsis</u>) cf. <u>strzeleckiana</u> (Morris) 1845
Brachiopods
<u>Cancrinella</u> cf. <u>magniplica</u> Campbell 1953
<u>Terrakea solida</u> (Etheridge & Dun) 1909 *

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* Considerable latitude has been used in assigning specimens to this species. The specimens exhibit distinct umbonal thickening, are not particularly geniculate, and have a similar spine pattern. They vary considerably in size, overall dimensions and in the development of the muscle platform. Discrete groupings within that used are difficult to separate out. Most, if not all, the variations can be matched in specimens referred to <u>T</u>. <u>solida</u> from Fauna IV localities elsewhere in the basin.

<u>Lissochonetes</u> sp.
<u>Strophalosia</u> sp.ind.
<u>Neospirifer</u> sp.B
<u>Licharewia</u> sp.nov.
<u>Ingelarella</u> <u>mantuanensis</u> Campbell 1960 (includes some specimens of <u>I</u>. <u>pelicanensis</u> type)
<u>Notospirifer</u> <u>minutus</u> Campbell 1960
"<u>Martinia</u>" sp.
<u>Streptorynchus</u> <u>pelicanensis</u> Fletcher 1952
Fenestellid Byrozoans

D 43. Barfield-Banana Road, quarry approximately 2 miles north-north-east of Mt. Flat Top (ref. 316945 Monto 4-mile Sheet).

Pelecypods
<u>Myonia</u> <u>carinata</u> (Morris) 1845
<u>Chaenomya</u>? cf. <u>carinata</u> Etheridge Jnr. 1892
Gastropods
<u>Platyteichum</u> sp.ind.
Brachiopods
Productidae gen., sp.nov. (known only from Flat Top Formation)
<u>Strophalosia clarkei</u> var. <u>minima</u> Maxwell 1954
<u>Strophalosia</u> <u>ovalis</u> Maxwell 1954
<u>Lissochonetes</u> sp.

Licharewia sp.nov.
Ingelarella mantuanensis Campbell 1960 (includes specimens which in shape are similar to I. pelicanensis)
"Martinia" sp.
Plekonella sp.

D 52. North-side Banana-Biloela road; approximately 4 miles north-east of Banana (ref. 310, 956, Monto 4 mile Sheet).

Pelecypods
Aviculopecten sp.
Gastropods
Walnichollsia? sp (like Walnichollsia but carinate at all growth stages).
Brachiopods
Ingelarella mantuanensis Campbell 1960
"Martinia" sp.

This represents a small selective collection made from a much larger fauna.

Relationships

The fauna from the Flat Top Formation and that from the quarry on the Lonesome Creek Road is especially closely related to the faunas from the Streptorhynchus pelicanensis Bed of the Bowen area, the pelecypod bed of the Clermont area and the Mantuan Productus Bed of the Springsure area. This is indicated by the occurrence of Atomodesma bisulcatum, Notospirifer minutus and Streptorhynchus pelicanensis (perhaps somewhat remarkably, lithologies associated with the Streptorhynchus pelicanensis Bed and the pelecypod bed are similar to those of the Flat Top Formation). The fauna is also similar to that of the Big Strophalosia Zone of the Bowen area and the clarkei-bed of the Clermont area which appear to contain N.minutus but so far lack Atomodesma bisulcatum and Streptorhynchus pelicanensis. For reasons already set out, the fauna is a Fauna IV. This is confirmed by the occurrence of Schizodus sp.nov. C, Atomodesma bisulcatum and N. minutus.

Productidae gen., sp.nov. and "*Martinia*" sp.* have not been identified from other parts of the basin. They make up only a small proportion of the species present, however, and seem to reflect local condition rather than have any special age significance. The upper part of the Barfield Formation and the lower part of the Flat Top Formation, therefore, appear to represent the stratigraphical interval in the northern part of the basin extending from the Big *Strophalosia* Zone to the *Streptorhynchus pelicanensis* Bed, and the upper part of the Peawaddy Formation of the Springsure Sheet area. The alternative explanation that the Oxtrack Formation is to be equated with the Mantuan *Productus* Bed and its equivalents and that the Flat Top Formation is therefore, younger, is not as acceptable on faunal grounds. It is also less acceptable on regional stratigraphical evidence which includes some indication from drilling that the Flat Top Formation is the lateral equivalent of the lower part of the Bandanna Formation.

* In these collections "*Martinia*" sp. was not found below the upper part of the Barfield Formation. Since the examination of these specimens was completed, however, R.E. Wass has informed me that he has found "*Martinia*" sp. in the Oxtrack Formation, north-west of Cracow Homestead. This necessitates some modification of the data presented in the palaeontological report on the Baralaba Sheet area (Dickins, 1964).

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Fig. B1.

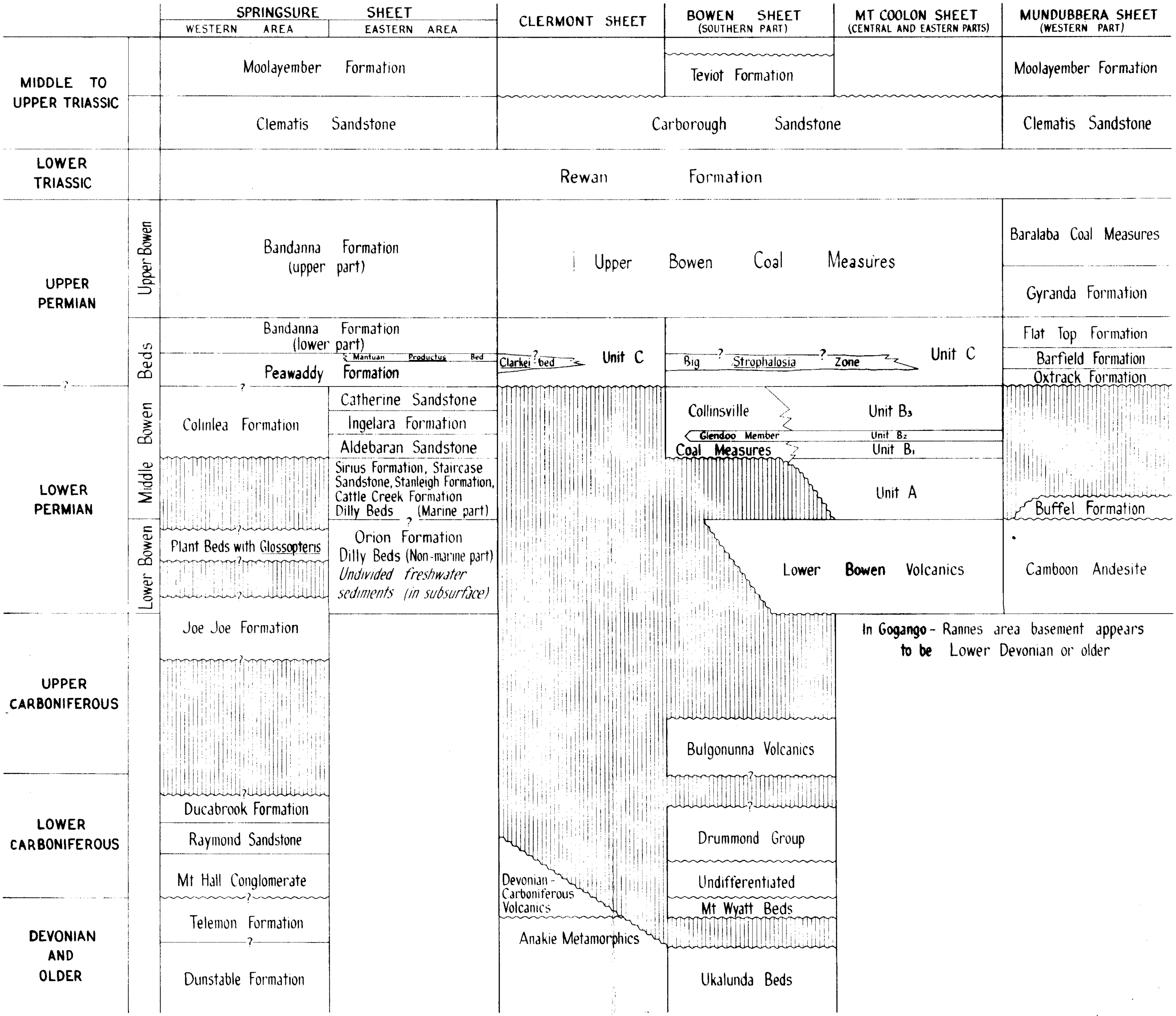
SPECIES DISTRIBUTION CHART

MUNDUBBERA AND MONTO SHEET AREAS

SPECIES	Buffel Formation (Fauna II)	Oxtrack Formation (Fauna IV)	Barfield Formation (Fauna IV)	Barfield - Flat Top Transition and Flat Top Formation (Fauna IV)
Notospirifer hillae	●			
Cancrinella farleyensis	●			
Anidanthus springsurensis	●			
Strophalosia preovalis	●			
Neospirifer (Grantonia) cf. hobartensis	●			
Ingelarella ovata	●			
Pseudosyrinx sp.	●			
Spiriferellina sp.	●			
Eurydesma hobartense	●			
Deltopecten limaeformis	●			
Keeneia sp.	●			
Indeterminate pleurotomarians	●			
Terrakea pollex	●			
Taeniothaerus subquadratus	●			
Ingelarella denmeadi	●			
Streptorhynchus sp.	●			
Peruvispira sp.	●	●		
Neospirifer sp. A	●	●	●	●
Terrakea sp.	●		●	
Lissochonetes sp.	●		●	●
Atomodesma (Aphanaia) sp.		●		
Dielasmatid		●		
Streblopteria sp.		●	●	
Neospirifer sp. B		●	●	●
Ingelarella mantuanensis		●	●	●
Cancrinella cf. magniplica		●	●	●
Terrakea solida		●	●	●
Strophalosia clarkei		●		●
Strophalosia clarkei var. minima		●		●
Strophalosia ovalis		●		●
Parallelodon sp. nov. B		●		●
Conocardium sp.		●		●
Volsellina? mytiliformis		●		●
Plagiostoma? sp. nov.		●		●
Cleiothyridina sp.			●	
Thamnopora sp.			●	
Cladochonus sp.			●	
Calceolispongia sp. nov.			●	
Strophalosia cf. typica			●	
Ingelarella cf. isbelli			●	
Attenuatella sp.			●	
Serpulid worms			●	
Glyptoleda glomerata			●	
Chaenomya? cf. carinata			●	●
Myonia carinata			●	●
Licharewia sp. nov.			●	●
Atomodesma sp.			●	●
Platyteichum coniforme			●	cf
Plekonella sp.			●	●
Chaenomya sp.			●	●
Aviculopecten sp.				●
Atomodesma bisulcatum				●
Warthia sp.				●
Nuculopsis (Nuculopsis) sp.				●
Pyramus sp.				●
Pseudomonotis? sp.				●
Cyrtorostra? sp.				●
Stutchburia costata				●
Schizodus sp. nov. C				●
Stachella sp.				●
Mourlonia (Mourlonopsis) cf. strzeleckiana				●
"Martinia" sp.				●
Notospirifer minutus				●
Streptorhynchus pelicanensis				●
Productidae gen., sp nov.				●
Walnichollsia? sp.				●

Bureau of Mineral Resources, Geology and Geophysics. June 1964. *To accompany Record No.1964/61.* G56/1. EJ

Fig. B2



Bureau of Mineral Resources, Geology and Geophysics. June 1964.

To Accompany Record No. 1964/61

MS/31

Appendix C

Shallow Drilling and Coring Programme.

Eight shallow holes were drilled on the western part of the Mundubbera Sheet area (fig.C1), by Geophysical Services International for the Bureau of Mineral Resources as part of a programme to extend the results of the regional mapping in the Bowen Basin. Cuttings and cores obtained by this drilling provide valuable material for palynological and petrological studies, which are still in progress. The results of some palynological work on bore 29 are given in ~~Appendix C~~, B.M.R. RECORD 1964/91

The following is a description of the holes as logged at the bore site.

B.M.R. Taroom No. 24

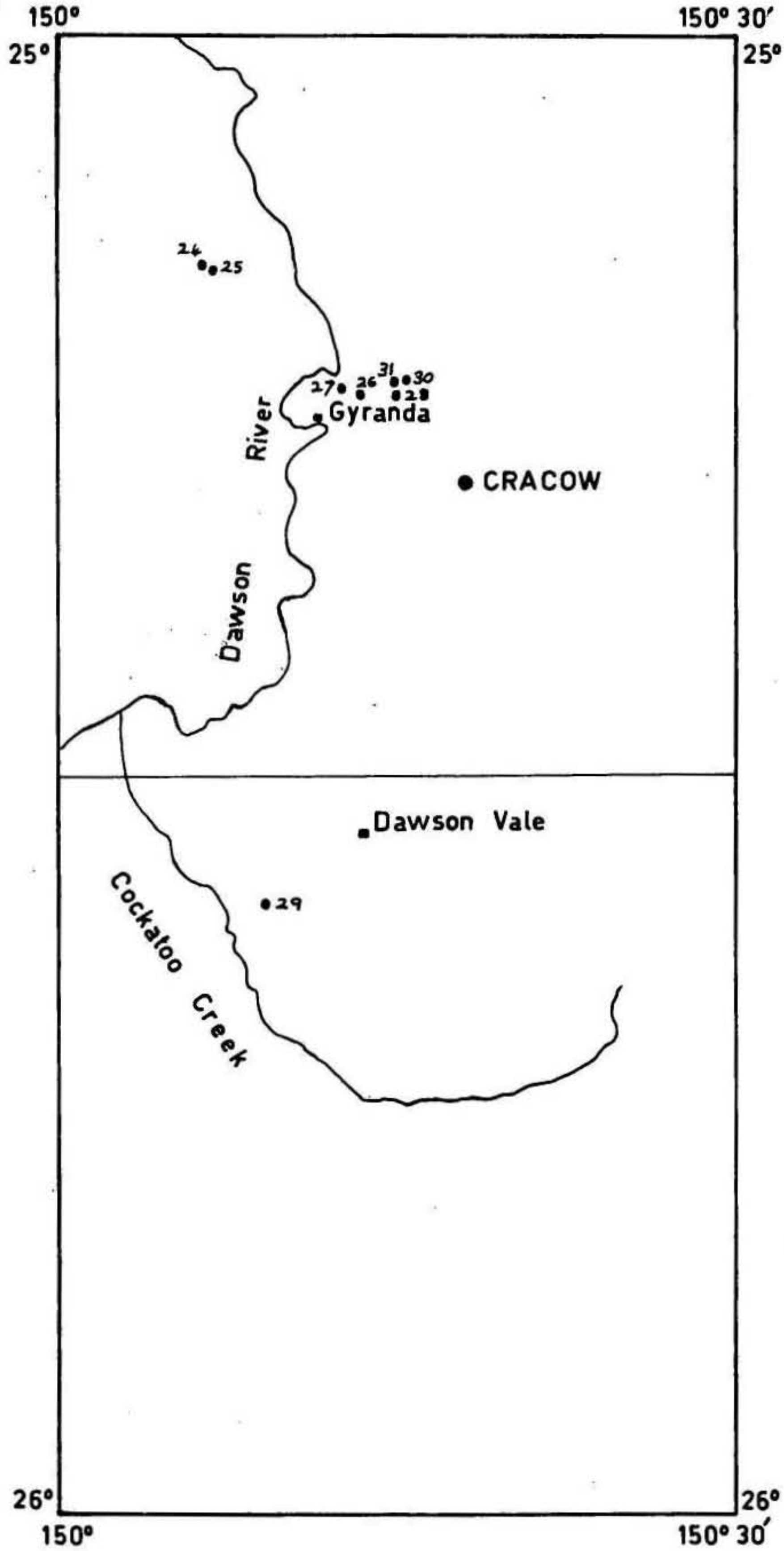
Location	Pt. 277, Photo 5023, Run 2, Mundubbera 1:85,000 photos. Beside the South End Yard turnoff from the Theodore to Cracow road via Delusion Creek.
Stratigraphic Description	Near base of the Rowan Formation.

Log

0' - 5'	Sandy soil.
5' - 20'	Mainly weathered lithic sandstone with some hard bands.
20' - 80'	Interbedded chocolate-brown mudstone, medium hard dark green-grey mudstone, and medium hard green-grey lithic sandstone.
80' - 85'	Cored. 5' recovered.
80' - 83'	Greenish-black soft, massive mudstone with conchoidal fracture.
83' - 84'	Grey, medium-grained, feldspatho-lithic sandstone, slightly calcareous, with dark mudstone laminae.
84' - 85'	Greenish-black mudstone with carbonised plant remains.
85'	Total Depth

Cuttings Samples	20' - 30'; 30' - 40'; 40' - 50'; 50' - 60'; 60' - 70'; 70' - 80'.
Core	80' - 85' 5' Recovered.

Fig. C1.



LOCALITY MAP

showing

B.M.R. DRILL HOLES

Cores and cuttings stored at Bureau of Mineral Resources Core and Cuttings Laboratory.

Scale 1:500,000.

To accompany Record No. 1964/61

Bureau of Mineral Resources, Geology & Geophysics. April, 1964. G56/A5/5

16 2)

B.M.R. Taroom No. 25

Location	Pt. 278, Photo 5023, Run 2, Mundubbera 1:85,000 Photos. ½ mile east of B.M.R. Taroom No. 24.
Stratigraphic Description	Spudded near Rowan Formation/Upper Bowen Coal Measures contact. Bottomed in Upper Bowen Coal Measures.

Log

0' - 10'	Sandy soil and weathered rock.
10' - 30'	Mainly weathered grey-brown ? tuff, with some brown sandy mudstone.
30' - 53'	Mainly brown mudstone, sandy in part and with carbonaceous streaks and laminea.
53' - 78'	Mainly medium hard grey-green lithic sandstone with some dark mudstone. Brown soft sandy mudstone at 72'.
78' - 80'	Pebble conglomerate.
80' - 85'	Cored. Recovered 5'.

Volcanic pebble conglomerate and conglomeratic sandstone, pebbles up to 2" across, mainly well rounded volcanics. Pyritic in part. Sandstone cemented by white clay.

85' Total Depth.

Cuttings Samples	20' - 30'; 30' - 40'; 40' - 50'; 50' - 60'; 60' - 70; 70' - 80'.
Core	80' - 85'. Recovered 5'.

B.M.R. Taroom No. 26

Location	Pt. 279, Photo 76, Run 3, Mundubbera 1:85,000 photos. Beside the Gyranda Hs. track, about 1½ miles from the Theodore to Cracow Road.
Stratigraphic Description	Spudded and drilled in the upper part of the Flat Top Formation.

Log

0' - 5'	Clayey soil.
5' - 20'	Weathered tough claystone, a little silicified, ? by pre-Jurassic weathering.
20' - 60'	Mainly tough dark grey mudstone, weathering to a buff colour near top. Hole commenced making water at 55'.
60' - 70'	No cuttings.
70' - 80'	Very hard, banded grey-brown, green rock, looks slightly oolitic in part. Possibly a silicified fossiliferous sediment.

80' Total Depth

Cuttings Samples	20' - 30'; 30' - 40'; 40' - 50'; 50' - 60'; 60' - 70'; 70' - 80'.

Core — No core.

Water flow at 55'. Strong flow, possibly up to 500 gals. per hour.

B.M.R. Taroom No. 27

Location — Pt. 280, Photo 76, Run 3, Mundubbera 1:85,000 photos.
Beside Gyranda Hs. road, about 1¾ miles from Theodore-Cracow road.

Stratigraphic Description — Tertiary sediments.

Log

0' - 5' Sandy and clayey soil

5' - 60' Brown clay, slightly damp.

60' Total depth. Clay was too damp to drill with air.

Cuttings Samples — 1 sample clay, 50' depth.

B.M.R. Taroom No. 28

Location — Pt. 281, Photo 76, Run 3, Mundubbera 1:85,000 photos.
Beside Gyranda Hs. road, ¼ miles west of Theodore to Cracow road.

Stratigraphic Description — Middle of the Barfield Formation.

Log

0' - 5' Red soil.
5' - 40' Friable and crumbly reddish mudstone with some lumps of solid mudstone.

40' - 80' Mainly grey-brown mudstone, greenish in places.

80' - 100' Black mudstone with some red and green grains.

100' - 105' Cored. 5' recovered.

Black or purplish black, mudstone with some claystone pods. Some specks of ? bornite.

Cuttings Samples — 40' - 50'; 50' 60'; 60' - 70'; 70' - 80'; 80' - 90'; 90' - 100'.

Core — 100' - 105' 5' recovered.

B.M.R. Taroom No. 29

Location Pt. 282, Photo 11, Run 6, Mundubbera 1:85,000 photos.
Beside the Nathan Road, 4.5 miles south of the Cracow to Taroom Road.

Stratigraphic Description Spudded above or in Evergreen Formation.

Cored above "oolite" horizon, penetrated oolite horizon and cored in Evergreen Formation below the "oolite" horizon.

Log

0' - 10' Sandy soil and ferruginous hardcap.

10' - 60' Mainly dark grey, purplish to black mudstone and sandy mudstone with brown laminae in places, weathered near top.

60 - 70' Cored. 9' recovered.

Black mudstone with coaly plant fragments. Some small veins of pyrite.

70' - 90' Mainly dark grey mudstone, some hard sandy mudstone and purplish ? glauconitic sandstone. Many oolitic layers.

90' - 140' Mainly hard, grey to dark grey mudstone, sandy in places and some grey fine sandstone. Some oolites near 100'.

140' - 145' Cored. Recovered 5'

Grey-green, fine to medium grained, micaceous silty lithic sandstone.

145' Total Depth.

Cuttings Samples 20' - 30'; 30' - 40'; 40' - 50'; 50' - 60'; 70' - 80'; 80' - 90'; 90' - 100'; 100' - 110'; 110' - 120'; 120' - 130'; 130' - 140';

Core 60' - 70' 9' recovered. 140' - 145' 5' recovered.

B.M.R. Taroom No. 30

Location Pt. 283, Photo 76, Run 3, Mundubbera 1:85,000 photos.
½ mile east of Theodore to Cracaw road, nearly opposite Gyranda Hs. turn-off.

Stratigraphic Description Near base of Barfield Formation.

Log

0' - 15' Red sandy soil, gravel and crumbly weathered mudstone.

15' - 25' Weathered mudstone. Poor cuttings recovery due to slight water flow.

25' - 80' Purplish-black mudstone, containing some ferruginous nodules in places.

80' - 82' Cored. Recovered 2'.

Greenish-black mudstone with some small patches of ? chalcopyrite.

Cuttings Samples — 25' - 40'; 40' - 50'; 50' - 60'; 60' - 70'; 70' - 80;

Core — 80' - 82' Recovered 2'.

B.M.R. Taroom No. 31

Location — Pt. 284, Photo 76, Run 3, Mundubbera 1:85,000 photos. 150 yards west, across strike, from B.M.R. Taroom No. 30.

Stratigraphic Description — Lower part of Barfield Formation.

Log

0' - 10' Sandy soil.

10' - 30' Weathered dark grey to brown mudstone.

30' - 80' Dark purplish-grey to purlish black mudstone, medium hard in places.

80' - 85' Cored 5' recovered.

Massive black mudstone, with minor pyrite. Scattered marine fossils throughout, including crinoid stems, brachiopods, pelecyods.

85' Total Depth.

Cuttings Samples — 20' - 30'; 30' - 40'; 40' - 50'; 50' - 60'; 60' - 70'; 70' - 80'.

Core — 80' - 85' Recovered 5'.

APPENDIX D.

Collection of samples for Radioactive Age Determination

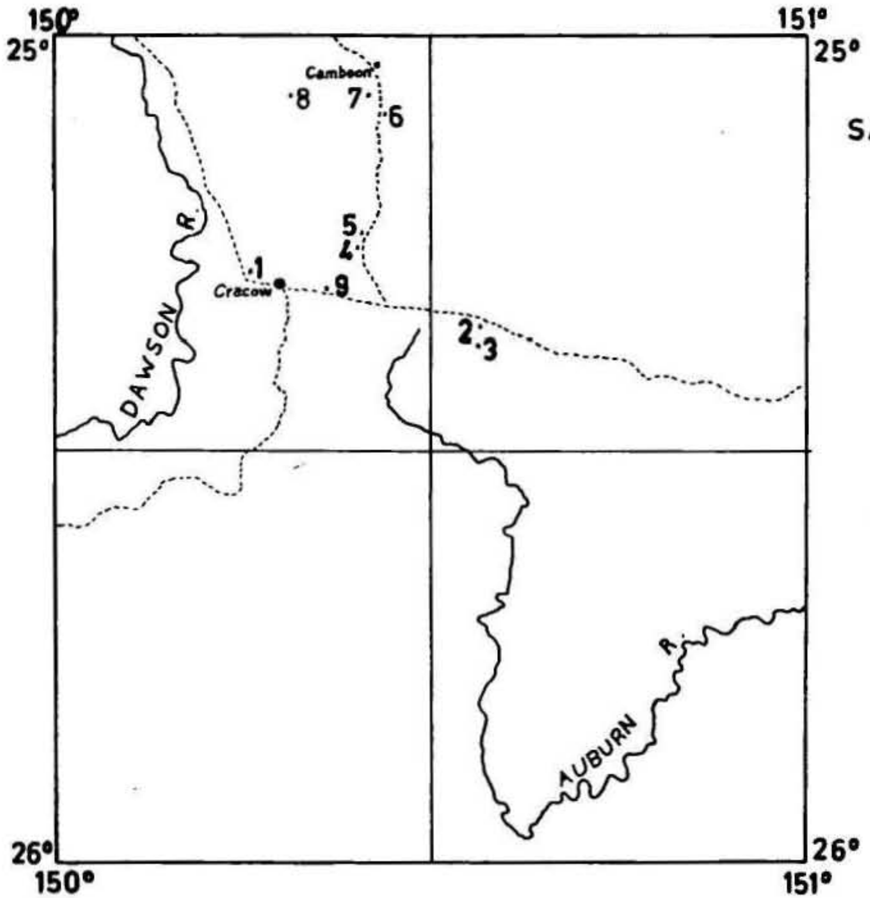
Nine samples for radioactive age determination were collected from the Mundubbera Sheet area; none was collected from the Taroom Sheet area. Details of these samples are summarized in Table and text figure 1. At the time of preparation of this record only four samples, G56/5/4, 5, 7, and 9, have been sectioned; none has been processed further towards determination of their absolute age.

TABLE

Samples for radioactive age determination

Sample Number	Position Run	Position Photo	Position Point	Unit	Lithology
G56/5/1	3	76	58	Messazoic Intrusive	Gabbro
G56/5/2	3	81	444	Auburn Complex	Granodiorite
G56/5/3	3	81	445	" "	"
G56/5/4	3	78	446	" "	"
G56/5/5	2	19	390	" "	"
G56/5/6	1	50	301	" "	"
G56/5/7	1	50	447	" "	"
G56/5/8	1	52	448	Camboon Andesite	Dacite
G56/5/9	3	78	382	" "	"

Fig. D1.



SAMPLES for RADIOACTIVE AGE DETERMINATION

LOCALITY MAP

Reference

·3 Sample site and abbreviated number.

All sample numbers should be prefixed with G56/5/ .

Scale 1:1,000,000.

APPENDIX E - TABLE E1

TABLE OF UNREGISTERED BORES, TAROOM SHEET AREA

Field	General Location	Type	Total Depth (feet)	Depth to Water (feet)	Supply (g.p.h.)	Quality
W37	"Cheviot"	bore	330	220		
W38	"	"	1000			
W39	"	"	580	260		
W40	"	"	500	80		
W41	"	"	300			
W42	"Amersham Hill"	"	280	60		
W43	" "	"	330	165		
W44	"Hutton Park"	"	300	60		
W45	"Kovington"	"	160	100		
W46	"O.K."	"	220	120		
W47	"	"	220	80		
W48	"	"	500	400		
W49	"	"	516	300		
W50	"Mt. Hutton"	"	300			
W51	"Euroa"	"	600	150	300	
W52	"	"	150			salty
W53	"	"	800			
W54	"Warndoo"	"	254			
W55	"	"	264			
W56	"	"	276			
W57	"	"	32			
W58	"	"	128			
W59	"Ridgelands"	"	90			
W60	"Kia-Ora"	"	300			
W61	"Doboy"	"	256	100		
W62	"Omeo"	"	200	60		
W63	"	"	200	60		
W64	"	"	190	50		
W65	"Taringa"	"				salt
W66	"	"	630	300		salt
W67	"	"	1280	350		good
W68	"Barramundi"	"	1000			
W69	"	"	300			
W70	"	"	500			
W71	"	"	677			
W72	"Moscow Downs"	"	290		1500	good
W1	"Coorada"	"	403		720	
W2	"	"	545	260	500	good
W3	"	"	98			
W4	"	"	853	320	720	good
W5	"	"	770		dry	
W6	"	"	260			
W7	"Roeburne"	"	300			
W8	"	"	150			
W9	"	"	100			
W10	"Gwambagwine"	"	335	128	486	
W11	"	"	579	45	624	
W12	"Fairhalme"	"	201		500	good
W13	"Glenbar"	"	95		500	good
W14	"	well	25			
W15	"Hornet Bank"	bore	1000	250	600	good
W16	" "	"	600	150	600	"
W17	" "	"	650	250	800	"
W18	"Currawong"	"	2100			
W19	"Hornet Bank"	"	450	200		good
W20	"Baroordah"	"	700	250		salty

Field	General Location	Type	Total Depth (feet)	Depth to Water (feet)	Supply (g.p.h.)	Quality
W21	"Baroordah"	bore	400			
W22	"Pony Hills"	"	200	45		good
W23	" "	"	600	400		good
W24	" "	"	210	12		good
W25	" "	"	300	170		good
W26	"Waddy-brae"	"	400			
W27	" "	"	946			
W28	"Pony Hills"	"	400	125		
W29	"Cheviot"	"	416	300		
W30	"	"	533	400		
W31	"	"	533			
W32	"Hutton Park"	"	300			
W33	"Moscow Downs"	"	330			
W34	"Cheviot"	"	300	50		
W35	"	"	360	280		
W36	"	"	600	320		

APPENDIX E - TABLE E2

TABLE OF BORE AND WELL INFORMATION - MUNDUBBERA WEST AREA

No. on Map	Property Name	Bore Name	Type	Depth (feet)	Supply (g.p.h.)	Main Aquifer depth (feet)	Quality	Aquifer Type	Drillers Log Available	I.W.S. Reg. No.
1	Gyranda	Dingo Head	Bore	220	800	180	Stock		No	
2	"		"	380	60	55			"	
3	"		"	150	25	85			"	
4	"		"	213		100			"	
5	Acacia		"		100	70	fair		"	
6	"		"		150	75	Salty		"	
7	Whitefield		"		good	80	fair		"	
8	Lucknow		"	40	400	15			"	
9	The Braes	Long Gully Bore	Well & Bore	54	good		good		"	
10	Lawson Park	Horse-paddock Bore	Bore	74	400	50	fair		"	
11	Hillview		"	250	300	150	good	?Sandy tuff	"	
12	Lawson Park		"	650	fair		too salty		"	
13	" "		"	305	200	230	salty		"	
14	Clare		"	32	good		good		"	
15	"		Well	25	Sufficient		"		"	
16	"		Bore	65	"		"		"	
17	The Braes	Back Creek Mill	Well & Bore	58	poor		"		"	
18	" "	Bald Hill Bore	Bore	324	150	204	"	Sandstone	"	9261
19	Luck now		"	90	800				"	9262
20	" "		"	120					"	13216
21	Camboon	Town Bore	"	60	800		good		"	
22	"	Lambing Gully Bore	"	68	800		"		"	
23	"	Moon Camp Well	Well	40	800		"		"	
24	"	4-Mile Creek Bore	Bore	65	800		"		"	9265
25	"	Fighting Hat Bore	"	82			"		"	
26	"	Brigalow Bore	"	120					"	
27	Alandale	Middle Creek Bore	"	57	500		fair		"	
28	"		"	45	300		"		"	
29	"		Well & Bore	180	Sufficient		good		"	
30	Mt. View		Bore	40	"	20	"		"	
31	Glenview		Well	42	"		fair		"	
32	"	Middle Well	"	68	"		"		"	
33	"	Round Well	"	22	"		"		"	
34	"		"	45	fair		"		"	
35	"		"	40	"		"		"	
36	"	Bottom Well	"	20	good		"		"	
37	"		"	25	"		good		"	
38	"		"	20	"		fair		"	
39	"		"	30	"		"		"	
40	"		"	25					"	
41	Red Range		Bore	50	160		stock only		I.W.S	11893
42	" "		"	300	10				No	
43	" "		"	140	200				I.W.S. Yes	11892
44	" "		"	210	good	138	good		I.W.S.	11891
45	" "		"	130		110			No	
46	" "		"	410	6				"	
47	" "		"	160	dry				"	
48	" "		"	140					"	
49	" "		Well	40	60				"	
50					Sufficient		fair		"	
51	Rocky Creek		Bore	193	1000	190	"		"	
52	The Bentley		"	900	flowing		good	Sandstone	"	
53	Bentore		"	715	flowing		fair		"	
54	"		"	775	"		"	Sandstone	I.W.S.	11073
55	The Globe		"	267	"		good	"	Yes I.W.S.	10872
56	" "		"	278	400	265	"	"	Yes I.W.S.	10876
57	" "		"	73	1800	60	"	"	Yes	
58	Springvale		"	180	500	175	"	"	"	11010
59a	"		"	216	1200		fair	"	Yes I.W.S.	10873
59b	"		"	150	1200	42	"	Coal	No	
60	"	Paradise Bore	"	470					"	
61	"								Yes	
62	Kilbeggan		"	580	50				No	
63	"		Well	23	poor		fair	granite	"	
64	"		Bore	160	50		"	Sandstone	"	
65	"		"						"	
66	"		"	350	poor		fair	granite	"	
67	"		"	450	600		poor	Sandstone	"	
68	Dawson Vale		"	200	good		hard		"	
69	" "		"	200			good		Yes	
70	" "		"	640	520	575		Sandstone	"	10468
71	Yoorooga		"	560	90	500	good		"	
72	"		"	200			salty		I.W.S.	10863
73	"		"	520	1600		good	Sandstone		

No. on Map	Property Name	Bore Name	Type	Depth (feet)	Supply (g.p.h.)	Main Aquifer depth (feet)	Quality	Aquifer Type	Drillers Log Available	I.W.S. Reg. No.
74	Gunderland		Bore	480	300			Sandstone	No	
75	Springvale	Crocket Gully Bore	"	200	good		good		I.W.S.	10874
76	"		"	400	poor		fair		No	10594
77	Mooranga		"	380	flowing				"	11033
78	"		"	303	1200				I.W.S.	12238
79			"						No	
80	Ruskin		"	1100					"	
81	Multy	Jimmy's Gully Well	Well	40	Sufficient	40	fair		"	
82	"		"	40					"	
83	"		"	25					"	
84	"		Bore	60					"	
85	Ravenscraig		Well	48	good				"	
86	"		"	25					"	
87	Fairylands		"	25					"	
88	Doarne		Bore	158					"	
89	"		"	565	good	320	good	Sandstone	"	
101	Ruskin		"	900	1900				I.W.S.	12882
102	Glenhaven		"	700	1500	696			No	
103	"		"	300		180	too salty		"	
104	Bentley Park		"	171		140	poor		I.W.S.	15053
105	" "		"	1094			good		I.W.S.	11306
106	" "		"	210	900				No	
107	Morungulan		"	350	910	300	good		Yes	
108	"		"	750	1000		salty		I.W.S.	11692
109	Cockatoo		"	490	700	400	good		No	
110	"		"	300	600		"		"	
111	"	Nine Mile Bore	"	300	1200	260	good		Yes	
112	"	Cheney Gully Bore	"	625	1100		"		Yes	
113	"		"	52	1500	32	"		No	
114	Biloela		"	500	800	450			I.W.S.	11878
115	Wallakatoo		"		flowing				No	
116	Bongalla		"	1220			good		No	
117	"		"	768	flowing		"		"	
118	Biloela		"		Sufficient				"	
119	Portypool	8-Mile Bore	"	1000	800	1000	good		I.W.S.	10719
120	"		"	1295	good	1195	"		"	13180
121	"		"	693	fair	270			No	8440
122	"	The Old Bore	"	1150	good		good		"	
123	Knockbine		"	958	"		"		"	
124	"		Well	75	440		"		"	10592
125	"	Georges Bore	Bore	1276	427	1200	"	Sandstone	"	
126	"	Black Tank Bore	"	1395	520	1376	"		Yes	
127	"	Windmill Bore	"	151	300			Sandstone	No	
128	Ioonya		"	211	1000	170	poor	Sandstone	Yes	
129	"		"	270	600	250	"		No	
130	"		"	420	1000		good		"	
131	Longvale		"	176	400		Stock only	Sandstone	"	
132	"		"	400	800	360	poor	Sandstone	"	
133	The Rock		"	84	400	80		"	"	
134	" "		"	400	400	300			"	
135	" "							Sandstone	"	
136	Glenelg		"	500	600		good		"	8442
137	"		"	506	600	490	poor	Sandstone	"	
138	"		"	105	1000		"	"	"	
139	"		"	500	700	370	fair		"	
140	"		"	300	poor	60	good		"	
141	Bungaban		Well				fair		"	
142	"	Battle Plain Bore	Bore	860	dry				"	
143	"	Top Bore	"	500	100		poor		"	
144	"	Cockatoo Bore	"		500		good		"	
145	"	Jones Bore	"		400		fair		"	
146	"	9-Mile Bore	"				poor		"	
147	"	7-Mile Bore	"		400		"		"	
148	Scotia		"	600			"		"	
149	Juandah Plains		"	600			"		"	
150	Juandah Plains		"	450	good		"			
151	Woodroyd		"	670	450		fair	Sandstone	"	
152	"		"	644	500	400			"	
153	"	Bore "56"	"	570	300		poor		"	
154	"		"	850	1300		fair	Sandstone	"	
155		Bottle Tree Bore	"	315	600		"	"	"	
156	Glendoan	Goanna Park Bore	"	570	500			"	"	
157	"	Starlight Bore	"	900	600	300	fair	"	"	
160	Avalon		"	160			"		"	
161	"		"	250			"	Sandstone	"	
162	"		"	340			poor		"	

No. on Map	Property Name	Bore Name	Type	Depth (feet)	Supply (g.p.h.)	Main Aquifer depth (feet)	Quality	Aquifer Type	Drillers Log Available	I.W.S. Reg. No.
163	Daldownie		Bore	590	600		good		No	10466
164	"		"	1966	2500	1800	good		at I.W.S.Qld.	
165	"		"	400	200	250	poor		No	
166	Rossman Downs		"	860					"	
167	Keatanui		"	780	800	380	good	Sandstone	"	
168	"		"	370	1200	257	"	"	"	
169	Bentley Park		"	420	570		"	"	"	
170	Campo Santo		Well	53	50	39	"	"	"	
171	" "		Bore	360	600		fair	"	"	
172	" "		"	511	600	120	good	"	"	
173	" "		"	405	600		"	"	"	
174	Kyamba		"	260	500		fair	"	"	
175	"		"	450	400	400			Yes	
176	Bungaban		"	600					No	
201	Cracow		"	900			fair		"	

DRILLERS LOGS OF BORES ON MUNDUBBERA-WEST SHEET AREA

Field No. 44

(feet)	
0 - 120	soil
120 - 138	sand (water at 138 ft.)
138 - 158	shale
158 - 210	sand
210	granite

Field No. 56

0 - 2	sandy loam
2 - 4	sandstone boulders
4 - 10	sandstone
10 - 12	yellow and grey clay
12 - 34	sandstone
34 - 38	brown sandy clay
38 - 62	soft sandstone and grey clay
62 - 63	coal
63 - 73	black and brown shale
73 - 85	black and grey slate
85 - 87	grey clay bars and sandstone
87 - 118	black and grey shale
118 - 160	grey sandy clay
160 - 168	grey and black shale
168 - 198	grey sandy clay
198 - 202	grey and brown clay
202 - 213	grey sandy clay
213 - 221	sandstone (water)
221 - 226	black shale and sandstone
226 - 233	dark grey sandstone
233 - 249	black shale
249 - 261	grey shale
261 - 265	sandstone and coal (water)
265 - 270	grey shale.

Field No. 57

0 - 3	soil
3 - 5	hard conglomerate
5 - 9	sandstone
9 - 14	sandy and yellow clay
14 - 16	hard boulders
16 - 37	sandy, grey, yellow and brown clay
37 - 46	black and grey shale and sandy shale
46 - 47	clay with bars of sandstone (water)
47 - 49	brown shale with bars of coal
49 - 53	grey shale
53 - 55	grey sandy clay
55 - 61	grey rock and grey shale
61 - 67	hard grey rock)
67 - 69	grey clay) (water)
69 - 72	grey rock)
72 - 73	grey shale

Field No. 58

0 - 2	soil
2 - 5	clay and rocks
5 - 11	rotten sandstone
11 - 28	grey, yellow and black clay
28 - 29	coal (water)
29 - 35	black and grey clay
35 - 37	grey sandy clay

Field No. 58 (Contd.)

37 - 47	grey sandstone with bars of clay
47 - 67	black and grey shale
67 - 75	grey sandstone with bars of clay
75 - 77	black and grey clay
77 - 79	grey sandstone
79 - 107	black and grey shale
107 - 111	grey sandy clay
111 - 121	black shale
121 - 124	grey sandy clay
124 - 126	grey sandstone (water)
126 - 130	black shale
130 - 140	grey sandstone
140 - 144	black shale
144 - 149	grey sandstone (water)
149 - 161	black shale with bars of sandstone
161 - 163	grey sandy clay
163 - 170	black shale with bars of sandstone
170 - 175	dark grey sandstone (water)
175 - 180	light grey sandstone (water)

Field No. 59a

0 - 3	soil
3 - 8	black clay
8 - 10	grey clay
10 - 12	yellow sandstone
12 - 17	yellow and black clay
17 - 19	hard yellow sandstone
19 - 31	yellow and grey sandy clay
31 - 37	grey sandstone
37 - 41	blue clay
41 - 43	black shale
43 - 49	blue clay
49 - 54	grey clay, bars of sandstone (very salty water)
54 - 62	black shale
62 - 74	grey sandy shale
74 - 78	grey clay
78 - 90	grey sandy shale
90 - 100	grey clay with bands of sandstone
100 - 101	hard grey rock
101 - 116	grey sandy shale
116 - 118	grey rock
118 - 136	grey sandy shale
136 - 140	black shale
140 - 141	grey rock
141 - 151	grey sandy shale
151 - 157	blue-grey shale
157 - 158	grey rock
158 - 166	hard grey sandy rock, (water)
166 - 170	grey and blue shale
170 - 216	hard grey rock with bands of shale, (water)

Field No. 59b

0 - 2	soil
2 - 3	clay
3 - 5	ironstone conglomerate
5 - 9	soft brown sandstone
9 - 13	grey clay
13 - 17	yellow sandstone
17 - 23	ironstone conglomerate
23 - 25	grey clay
25 - 31	yellow sandy clay
31 - 39	grey sandy clay
39 - 41	grey sandy clay with some coal
41 - 42	coal (water)

Field No. 59b (Contd.)

42 - 51	grey sandy clay
51 - 71	black clay
71 - 75	sandy grey clay
75 - 77	black shale with traces of coal
77 - 81	grey sandy clay
81 - 93	hard black and grey shale
93 - 95	sandy grey clay
95 - 97	black shale
97 - 99	sandstone and clay
99 - 102	hard grey rock
102 - 112	brown and black shale
112 - 120	sandstone and clay
120 - 135	black, grey, and sandy shale
135 - 140	water bearing sandstone
140 - 150	grey and black sandy shale

Field No. 62

0 - 25	black and grey shale
25 - 35	grey sandy shale
35 - 52	grey silty shale
52 - 80	brown clay
80 - 95	grey sandy clay
95 - 101	grey clay and dirty sandstone
101 - 120	sandy shale, coal
120 - 127	light grey clay
127 - 151	grey clay and sandstone with $\frac{1}{8}$" pebbles
151 - 153	grey clay and fine sandstone
153 - 155	grey coaly shale and fine clayey sandstone
155 - 167	grey clay and silt
167 - 171	grey coaly shale
171 - 174	grey fine clayey sandstone
174 - 207	grey coaly shale
207 - 218	very coaly shale
218 - 220	grey shale and silt
220 - 237	grey clay and silt
237 - 275	light grey shale and silt
275 - 318	grey brown shale
318 - 320	dirty sandstone
320 - 370	grey sandy shale and sandstone
370 - 375	very coaly shale
375 - 385	light grey clayey sandstone
385 - 454	light grey clay
454 - 478	light grey clayey sandstone
478 - 484	light grey coarse sandstone
484 - 580	pink granite

Field No. 70

0 - 3	soil
3 - 9	yellow clay
9 - 15	soapy sandstone
15 - 93	grey and black shale, (some water)
93 - 119	brown shale
119 - 169	grey sandy shale
169 - 176	yellow sandstone
176 - 195	grey sandy shale
195 - 226	black shale
226 - 247	grey shale
247 - 265	black shale
265 - 295	hard grey shale
295 - 314	black shale
314 - 355	grey shale
355 - 362	sandstone, (salt water)
362 - 417	sandstone
417 - 419	sandstone, (salt water)

Field No. 70 (Contd.)

419 - 430	sandstone
430 - 442	shale
442 - 510	sandstone, (water)
510 - 530	black mineral sandstone
530 - 575	sandstone, (water)
575 - 586	hard grey shale
586 - 587	white shale
587 - 640	basalt

Field No. 107

0 - 3	black soil
3 - 30	yellow clay
30 - 50	pipe clay
50 - 108	grey shale
108 - 110	brown shale
110 - 136	grey shale
136 - 176	white sandstone
176 - 194	hard sandstone
194 - 243	grey shale
243 - 278	white sandstone
278 - 300	grey brown shale (water)
300 - 350	white sandstone

Field No. 111

0 - 4	black soil
4 - 31	yellow clay
31 - 70	hard yellow sandstone with very hard seams
70 - 126	fine sandstone
126 - 202	grey fine sandstone
202 - 222	coarse sandstone
222 - 242	fine sandstone
242 - 255	dark grey sandy shale
255 - 260	fine sandstone
260 - 300	coarse sandstone

Field No. 112

0 - 7	black soil
7 - 29	yellow sandstone
29 - 68	white coarse sandstone
68 - 83	puggy shale
83 - 91	grey shale
91 - 100	sandy shale
100 - 107	grey sandy shale
107 - 112	shale
112 - 120	white coarse sandstone
120 - 125	grey sandy shale
125 - 128	shale
128 - 133	grey sandy shale
133 - 163	grey shale
163 - 177	grey sandy shale
177 - 214	grey puggy shale
214 - 364	sandy shale
364 - 375	sandstone, (water)
375 - 418	light-grey sandy shale
418 - 440	grey shale
440 - 470	sandy shale
470 - 518	dark grey shale
518 - 528	light grey sandstone
528 - 540	coarse free drilling sandy shale
540 - 570	fine sandstone
570 - 582	coarse milky sandstone
582 - 588	coarse sandy shale
588 - 625	coarse sandstone

Field No. 126

0 - 3	sandstone
3 - 20	sandy clay
20 - 35	grey and brown shale
35 - 36	coal
36 - 87	brown, black and grey shale
87 - 105	grey sandstone
105 - 111	white rock with boulders
111 - 128	sandstone
128 - 169	black shale
169 - 170	sandstone
170 - 223	grey shale
223 - 239	hard and sandy grey shale
239 - 269	grey shale
269 - 350	sandy shale
350 - 440	sandstone, (water)
440 - 500	black and grey shale
500 - 512	sandy shale
512 - 535	sandstone
535 - 729	grey and black shale
729 - 735	hard slate
735 - 750	hard grey shale
750 - 850	grey shale
850 - 868	sandstone
868 - 915	grey and blue shale
915 - 956	grey shale with hard seams
956 - 982	black shale
982 - 999	sandy shale, (water)
999 -1034	grey sandy shale
1034 -1044	sandstone
1044 -1060	hard sandstone
1060 -1106	dry sandstone
1106 -1125	white coarse sandstone
1125 -1210	grey shale and hard slate
1210 -1220	water sand
1220 -1222	sandstone
1222 -1230	sandy shale
1230 -1269	sandstone
1269 -1286	hard sandy shale
1286 -1335	sandstone
1335 -1376	coarse and fine sandstone, (water)
1376 -1395	sandstone

Field No. 128

0 - 4	sandy loam
4 - 52	clay and decomposed rock
52 - 112	grey shale
112 - 171	sandstone, (water)
171 - 192	grey puggy shale
192 - 206	light muddy shale with coal seams
206 - 212	tight grey shale

Field No. 175

0 - 2	sandy soil
2 - 4	hard rock
4 - 18	yellow sandstone
18 - 55	yellow clay
55 - 80	yellow sandstone
80 - 94	shale
94 - 148	grey sandstone
148 - 161	shale
161 - 234	sandstone with shale seams
234 - 310	brown shale

Field No. 175 (Contd.)

310 - 318	very hard sandstone
318 - 348	fine dark sandstone
348 - 354	shale
354 - 372	fine dark sandstone and shale seams
372 - 425	fine sandstone, (water)
425 - 438	shale with small sandstone seams
438 - 443	hard fine sandstone
443 - 450	shale.

E(XII)

DRILLERS LOGS OF SIX BORES ON TAROOM SHEET AREA

Field No. W1

(feet)	
0 - 19	shale
19 - 53	sand
53 - 54	hard red rock
54 - 58	clay
58 - 105	sandstone
105 - 112	dark grey shale
112 - 228	sandstone
228 - 238	dark blue shale
238 - 255	sandy mud rock
255 - 269	blue shale
269 - 275	brown rock
275 - 285	conglomerate
285 - 295	brown rock
295 - 389	sandstone
389 - 403	water beds, sandstone.

Field No. W2

0 - 20	sandy soil
20 - 25	gravel
25 - 55	yellow sandstone
55 - 65	yellow clay, (with water)
65 - 85	dark shale
85 - 97	sandy shale
97 - 187	grey shale
187 - 300	sandy shale
300 - 307	hard sandstone
307 - 376	sandy shale
376 - 399	dark shale
399 - 410	sandstone
410 - 431	white sandstone, (with water)
431 - 449	shale.

Field No. W5

0 - 10	soil
10 - 70	basalt
70 - 111	yellow sandstone with clay seams
111 - 170	basalt
170 - 230	yellow "slippery back"
230 - 240	yellow sandy silt, (with water)
240 - 272	yellow "slippery back"
272 - 277	grey sandstone
277 - 337	grey sandy shale
337 - 340	hard grey sandstone
340 - 387	sandy shale
387 - 395	white sandstone with shale seams
395 - 461	dark shale
461 - 477	white shale
477 - 486	white sandstone
486 - 489	dark shale
489 - 546	white sandstone
546 - 619	dark shale
619 - 718	white soft sandstone with water
718 - 749	shale
749 - 758	very hard sandstone
758 - 770	dark shale.

Field No. W10
(feet)

0 - 4	soil
4 - 38	coarse sandstone
38 - 41	shale
41 - 60	white sandstone
60 - 123	sandy brown shale
123 - 128	white sandstone with water
128 - 151	white sandstone
151 - 192	shale
192 - 263	grey sandstone
263 - 270	coarse white sandstone
270 - 299	white sandstone
299 - 315	hard grey sandstone with coal seams
315 - 335	shale.

Field No. W11

0 - 12	soil
12 - 74	sandstone, (with water)
74 - 82	shale
82 - 102	sandstone, (with water)
102 - 204	shale
204 - 224	sandstone
224 - 268	shale
268 - 286	sandy shale
286 - 310	grey shale
310 - 345	sandy shale
345 - 372	sandy shale with sandstone seams
372 - 425	white sandstone
425 - 428	shale
428 - 579	white sandstone, (with water)

APPENDIX F.

RESULTS OF ANALYSES

Abbreviations:-

T. sheet = Taroom 1:250,000 sheet
M. sheet = Mundubbera 1:250,000 sheet
Jmi = 'Injune Creek Beds'
Jlh = Hutton Sandstone
Jlo = Oolite Member
Jlp = Precipice Sandstone
Pln = Camboon Andesite
Pur = Barfield Formation

AMDL = Australian Mineral Development Laboratories
BMR em.sp. = Bureau of Mineral Resources, emission spectrograph
QGA = Queensland Government Analyst

Sample Number	Location	Source and date	Lithology of sample	Formation	Results
T758	T. sheet 25°51'S, 149°54'E	AMDL 1964	yellow calcareous sandstone	Jmi	% Phosphorus = 0.44
T814b	T. sheet 26°00'S, 148°48'E	AMDL 1964	grey calcareous sandstone	Jmi	% Phosphorus = 0.041
T786	T. sheet 25°53'S, 148°32'E	AMDL 1964	yellow calcareous sandstone	Jmi	% Phosphorus = 0.037
T831	T. sheet 25°57'S, 148°44'E	AMDL 1964	weathered yellow calcareous sandstone	Jmi	% Phosphorus = 0.036
T708	M. sheet 25°55'S, 150°27'E	AMDL 1964	ironstone with yellow pellets (siderite?)	Jlo	% Phosphorus = 0.127
T784b	T. sheet 25°45'S, 148°41'E	AMDL 1964	heavy green labile sandstone	Jlo	% Phosphorus = 0.012
T686	M. sheet 25°37'S, 150°08'E	AMDL 1964	oolitic limonite	Jlo	% Phosphorus = 0.685; % iron = 45.3
T729	M. sheet 25°34'S, 150°04'E	AMDL 1964	ferruginous labile sandstone	Jlo	% Phosphorus = 0.415; % iron = 33.4

Sample Number	Location	Source and date	Lithology of sample	Formation	Results	
T766	M. sheet 25°36'S, 150°09'E	AMDL 1964	oolitic limonite	Jlo	% Phosphorus = 0.56;	% Iron = 37.2
T789	T. sheet 25°49'S, 148°53'E	AMDL	oolitic limonite	Jlo	% Phosphorus = 1.51;	% Iron = 41.1
T825	T. sheet 25°45'S., 148°43'E	BMR em.sp. 1964	pyrite nodules from quartzose sandstone	Jip	% Potassium = 0.1-1; % Sodium = 0.1-1; % Titanium = 0.1-1;	% Rubidium = 0.01-0.1 % Barium = 0.01-0.1 % Manganese = 0.01-0.1 % Magnesium = 0.01-0.1
T767	M. sheet 25°43'S, 150°17'E	BMR em.sp. 1964	heavy sandstone impregnated with pyrite	Jlp	% Arsenic = 0.1-1;	% Potassium = 0.01-0.1 % Sodium = 0.01.0.1 % Titanium = 0.01-0.1 % Magnesium = 0.01-0.1
T393a	M. sheet 25°19'S, 150°21'E	AMDL 1964	Pallid zone of laterite	Pln	% Aluminium = 9.45	
T393b	M. sheet 25°19'S, 150°21'E	AMDL 1964	Pallid zone of laterite	Pln	% Aluminium = 11.8	
T393c	M. sheet 25°19'S, 150°21'E	AMDL 1964	Scilicified part of pallid zone of laterite	Pln	% Aluminium = 6.85	

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Sample Number	Location	Source and date	Lithology of sample	Formation	Results
GS 41/55	T. sheet, Maranoa Colliery, south of Injune 25°52'30"S,148°33'E	QGA 1955	Representative coal analysis	Jmi	S.G. = 1.395 Moisture at 105°C = 5.3% Sulphur = 0.61 Volatile Matter = 38.4% Coking Index = Cw Fixed Carbon = 35.9% Ash = 20.4% Calorific value = 10720 B B.T.U.
GS 392/36	T. sheet, Maranoa Colliery, 25°52'30"S,148°33'E	QGA 1936	Coal	Jmi	Crude oil by destructive distillation = 20 gal/ton Ash = 39.5%
GS268/53	Taroom sheet, Injune Stock Route Bore No. 12788, one mile north-west of Injune 25°50'S, 148°34'E	QGA 1953	Sample of "grease" from interval 275'-279'	Probably Jlh	Mineral oil = 66% Siliceous matter = 7.5% Water = 26.5%
T639	Mundubbera Sheet 25°43'S, 150°19'E	AMDL1964	White crystalline salt deposit on Precipice Sandstone.	Jlp	Acid Insoluble Material 35.8% Acid Soluble oxide of iron and aluminium 2.7% Water 27.95% Total sulphur trioxide 23.1% Chlorine 0.05% Water Soluble Salts (present as sulphates) MgO 0.83% CaO 0.18% Na_2O 0.81% K_2O 0.02% Al_2O 8.35%

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Sample Number	Location	Source and date	Lithology of sample	Formation	Results
A1	M. sheet BMR bore 28, 100ft.	BMR 1963	Grey mudstone	Pur	0.4% P_2O_5
A2	M. Sheet BMR bore 28, 101ft.	"	" "	Pur	0.4% P_2O_5
A3	M. Sheet BMR bore 29, 65ft.	"	Black mudstone	Jle	0.6% P_2O_5
A4	M. Sheet BMR bore 30, 80-82ft.	"	Black mudstone - slightly calcareous	Pur	0.4% P_2O_5
A5	M. Sheet BMR bore 31, 80-85ft.	"	Black mudstone	Pur	0.3% P_2O_5
T166	M. Sheet 25°14'S, 150°14'E	"	Calcilutite	Pur	1.0% P_2O_5

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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

THE GEOLOGY OF THE TAROOM 1:250,000 SHEET AREA, AND THE WESTERN PART OF THE MUNDUBBERA 1:250,000 SHEET AREA, QUEENSLAND

BY

A. R. JENSEN and C. M. GREGORY (Bureau of Mineral Resources)
and V. R. FORBES (Geological Survey of Queensland)

RECORDS 1964/61

ENCLOSURES

1. Taroom 1:250,000 Geological Sheet.
2. Mundubbera (western part) 1:250,000 Geological Sheet
3. Correlation Chart of Oil Wells

AUSTRALIA 1:250,000

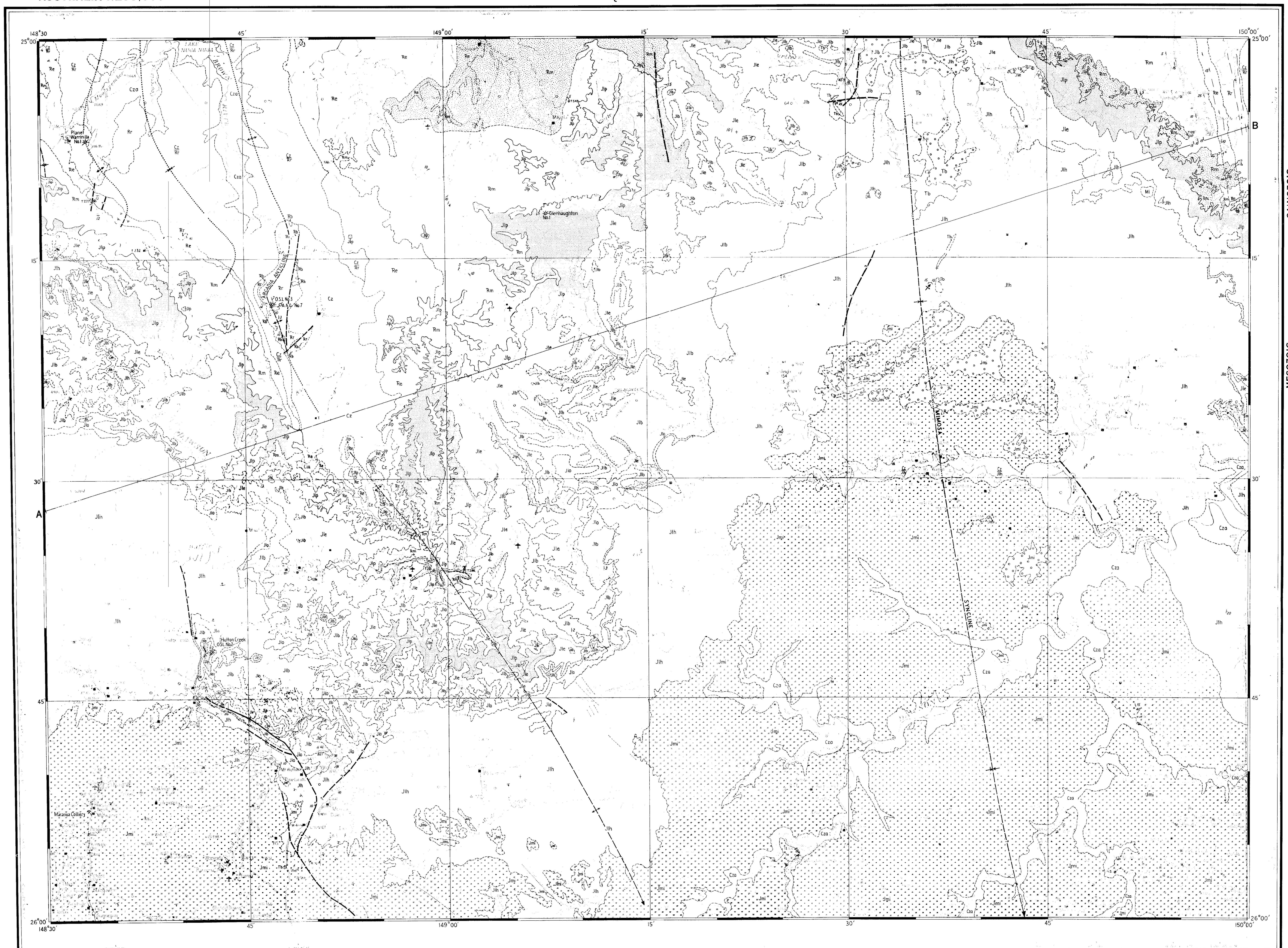
TAROOM

QUEENSLAND

1:250,000 GEOLOGICAL SERIES SHEET SG 55-8

PRELIMINARY EDITION, 1964

SUBJECT TO AMENDMENT



Reference

CAINOZOIC

		Cza	*Alluvium*
		Cz	*Soil, sand*
			Laterite, lateritic soil
TERTIARY		Tb	*Basalt, olivine basalt, vesicular basalt, minor quartzose sandstone*

MESOZOIC

		Mi	*Gabbro*
MIDDLE JURASSIC	Injune Creek Beds	Jmi	*Calcareous lithic sandstone, calcareous siltstone, shale, carbonaceous shale, coal*
LOWER TO MIDDLE JURASSIC	Hutton Sandstone	Jlh	*Argillaceous sublabile sandstone and quartzose sandstone, commonly containing mud pellets; minor pebble bands, siltstone and claystone*
LOWER JURASSIC	Evergreen Formation	Jle	*Labile and sublabile sandstone, mudstone, argillite, minor siltstone, shale, coal*
		Jlo	*Pelletal or oolitic chamositic rock with minor mudstone, sandstone and shale; cropping out as oolitic limonite and concretionary banded ironstone*
	Boxvale Sandstone Member	Jlb	*Quartzose sandstone commonly micaceous; minor siltstone*
	Precipice Sandstone	Jlp	*Cross-stratified quartzose sandstone, sublabile lithic sandstone, siltstone, argillite*
			Subaerially altered rocks of pre-Jurassic age
MIDDLE TO UPPER TRIASSIC	Moolayember Formation	Rm	*Mudstone, lithic sandstone, sublabile lithic sandstone, conglomerate, carbonaceous shale, fine tuff*
MIDDLE TRIASSIC	Clematis Sandstone	Re	*Cross-stratified sublabile lithic sandstone, siltstone, conglomerate*
LOWER TRIASSIC	Rewan Formation	Rr	*Brown mudstone, lithic sandstone, minor conglomerate*
	Brumby Sandstone Member	Rb	*Conglomeratic coarse lithic sandstone*

Geological boundary

Syncline, showing plunge

Anticline, showing plunge

Fault

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

Strike and dip of strata

Dip < 5°

Horizontal strata

Dip < 15°
Trend lines } *air-photo interpretation*
Joint pattern

Microfossil locality

T125 *Plant fossil locality*

Coal mine - not being worked

Abandoned oil well with show of gas

Dry hole (abandoned)

Flowing water bore
Non-flowing bore
Dry bore
Well
} 4963 *Queensland I.W.S. registered number*; W26 *B.M.R. Field reference number*

Windpump

Lake

Spring

Earth dam

Earth tank

Road

Vehicle track

Track

Railway with siding

Town

Settlement

Homestead

Building

Airport

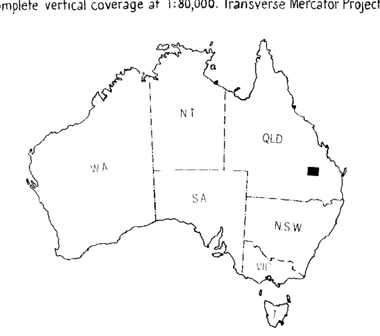
Landing ground

Yard

Height in feet, instrument levelled
Height in feet, barometric
} *datum: mean sea level*

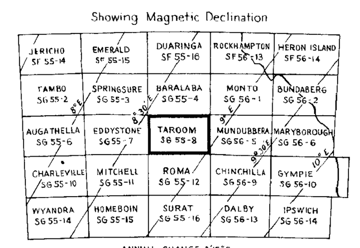
Photo-centre point - run/number

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photography by Adastra Airways Pty. Ltd.; complete vertical coverage at 1:80,000. Transverse Mercator Projection

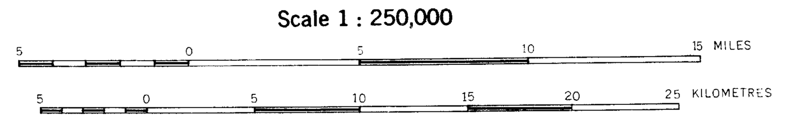


INDEX TO ADJOINING SHEETS

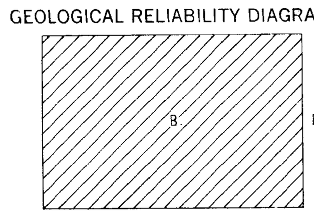
Showing Magnetic Declination



Scale 1 : 250,000

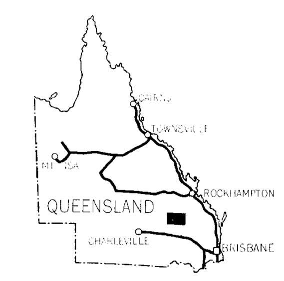


GEOLOGICAL RELIABILITY DIAGRAM



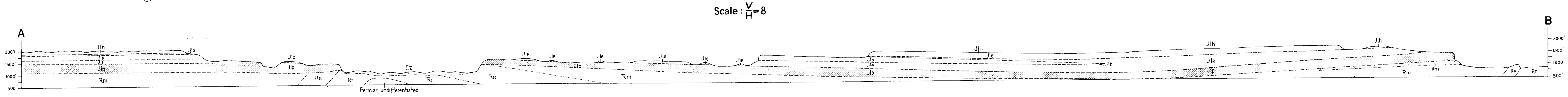
B Detailed reconnaissance - numerous traverses, air photo interpretation

Geology and compilation, 1963, by: A.R. Jensen and C.M. Gregory (B.M.R.); V.R. Forbes (G.S.Q.)
Geology of Arcadia area based on mapping by Shell (Queensland) Development Pty. Ltd., 1944
Drawn by: E.H.J. Feeken

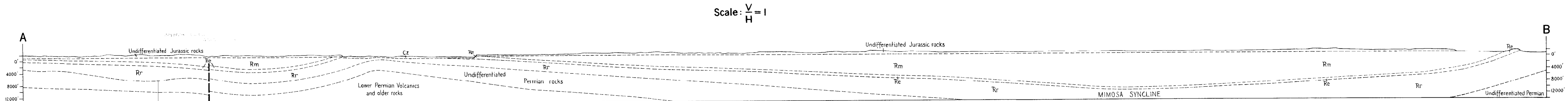


Section

Scale : $\frac{V}{H} = 8$



Scale : $\frac{V}{H} = 1$



TAROOM

SHEET SG 55-8

ENCLOSURE 1

MUNDUBBERA
WESTERN PART
QUEENSLAND

AUSTRALIA 1: 250,000 — 1:250,000 GEOLOGICAL SERIES SHEET SG 56-5

PRELIMINARY EDITION, 1964
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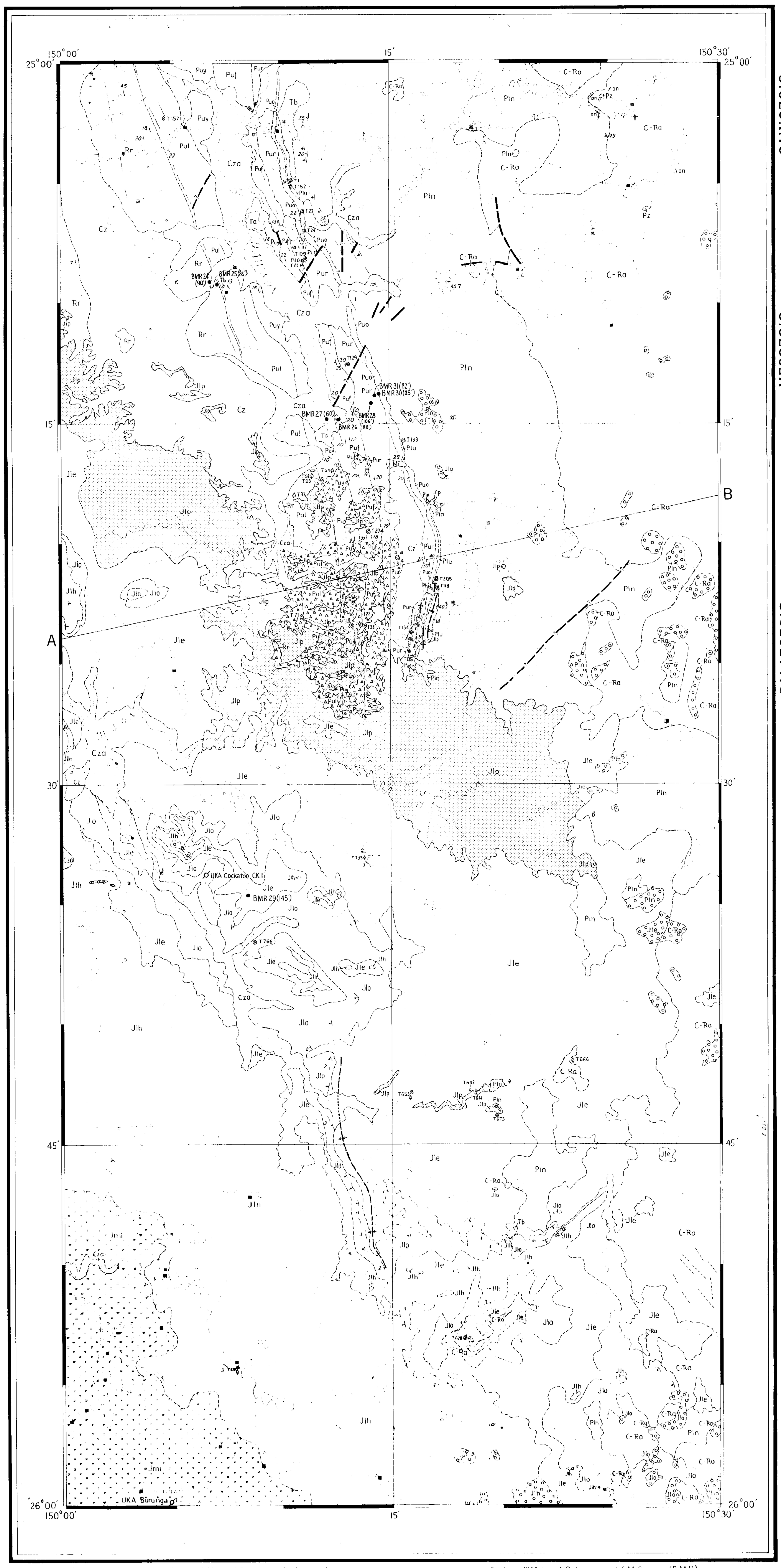


Reference

CAINOZOIC

		Cza	Alluvium
		Cz	Soil, sand
TERTIARY			Laterite
TERTIARY		Ta	Silicified gravel
TERTIARY		Tb	Basalt

MESOZOIC

		Mi	Gabbro
MIDDLE JURASSIC	Injune Creek Beds	Jmi	Calcareous lithic sandstone, carbonaceous shale, coal
LOWER TO MIDDLE JURASSIC	Hutton Sandstone	Jlh	Brown argillaceous quartzose sandstone, sublabile sandstone
LOWER JURASSIC	Evergreen Formation	Jle	Fine sandstone, argillite, mudstone, coal
LOWER JURASSIC		Jlo	Pelletal or oolitic chamositic rock with minor mudstone, sandstone and shale, cropping out as oolitic limonite and concretionary banded ironstone
LOWER JURASSIC	Precipice Sandstone	Jlp	Quartzose sandstone, siltstone, argillite
TRIASSIC			Silicified sedimentary rocks
TRIASSIC	Clematis Sandstone	Re	Argillaceous quartzose sandstone, sublabile sandstone (section only)
TRIASSIC	Rewan Formation	Rr	Brown mudstone, lithic sandstone, volcanic conglomerate

PALAEOZOIC

CARBONIFEROUS TO TRIASSIC	Auburn Complex	C-Ra	Granodiorite, dacite dykes
UPPER PERMIAN	Baralaba Coal Measures	Pul	Carbonaceous mudstone, lithic sandstone, coal, conglomerate
UPPER PERMIAN	Gyranda Formation	Puy	Lithic sandstone, siltstone, mudstone, minor conglomerate, tuff
UPPER PERMIAN	Flat Top Formation (Back Creek Group)	Puf	Blue and brown mudstone, buff argillite, sandy tuffaceous siltstone
UPPER PERMIAN	Barfield Formation (Back Creek Group)	Pur	Grey mudstone, lithic sandstone, concretionary limestone, greywacke, lapilli tuff, vesicular keratophyre
UPPER PERMIAN	Oxtrack Formation (Back Creek Group)	Puo	Calcarenite, coquinite, calcareous mudstone, silicified limestone
LOWER PERMIAN	(Back Creek Group)	Plu	Calcarenite, coquinite, calcareous mudstone, silicified limestone
LOWER PERMIAN	Camboon Andesite	Pln	Andesite, dacite, trachyandesite, tuff, agglomerate
		Pz	Granulite, meta-quartzite

Geological boundary
Syncline
Anticline
Monocline
Fault

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

Strike and dip of strata
Dip < 15°
Trend lines } air-photo interpretation
Joint pattern }
Platy flow, inclined
Macrofossil locality
Plant fossil locality
Fossil wood locality
T 642 Fossil collection number
Andesite dyke

Mine
Mine, not being worked
Open cut
Gold

Bore
Well
Artesian bore } 34/45 Field reference number / Depth
Dry bore
Windpump
Earth dam
Earth tank

BMR27(60) Shallow drill hole (number and depth)
Dry oil well

Road
Vehicle track
Track
Homestead
Building
Landing ground
Altitude in feet - instrument levelled } datum: mean sea level
Altitude in feet - barometric }
Photo-centre point - run/number

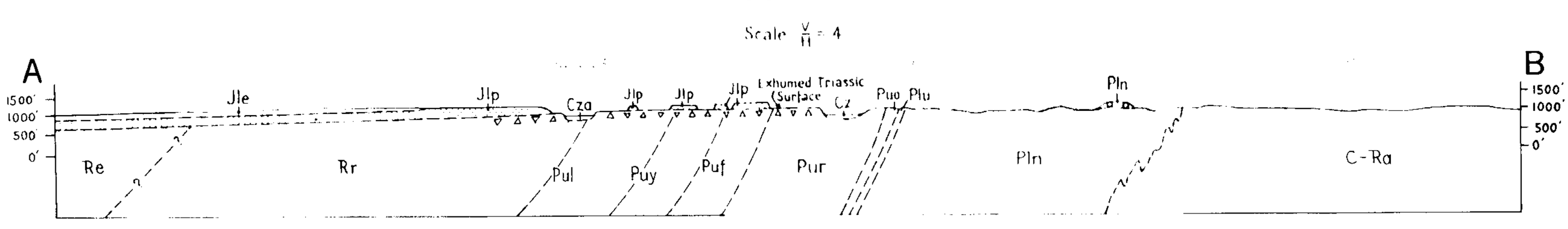
Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Topographic base compiled by the Division of National Mapping, Department of National Development. Aerial photographs by Adastra Airways Pty Ltd; complete vertical coverage at 1:80,000. Transverse Mercator Projection.

Geology, 1963, by A.R. Jensen and C.M. Gregory (B.M.R.), V.R. Forbes (G.S.Q.)
Compiled, 1963, by A.R. Jensen and C.M. Gregory (B.M.R.), V.R. Forbes (G.S.Q.)
Drawn by: F. Leeken

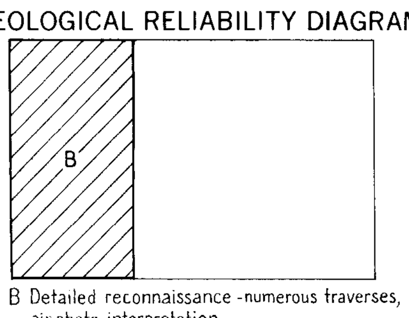
Scale 1 : 250,000

5 0 5 10 15 MILES
5 0 5 10 15 20 25 KILOMETRES

Section

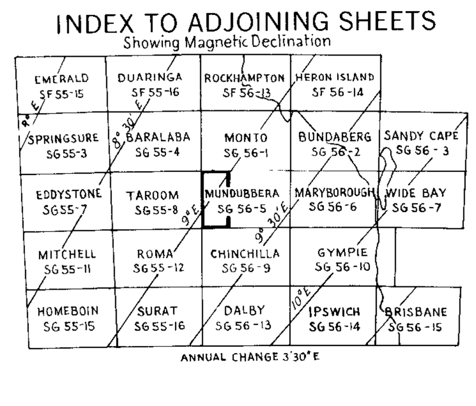


GEOLOGICAL RELIABILITY DIAGRAM



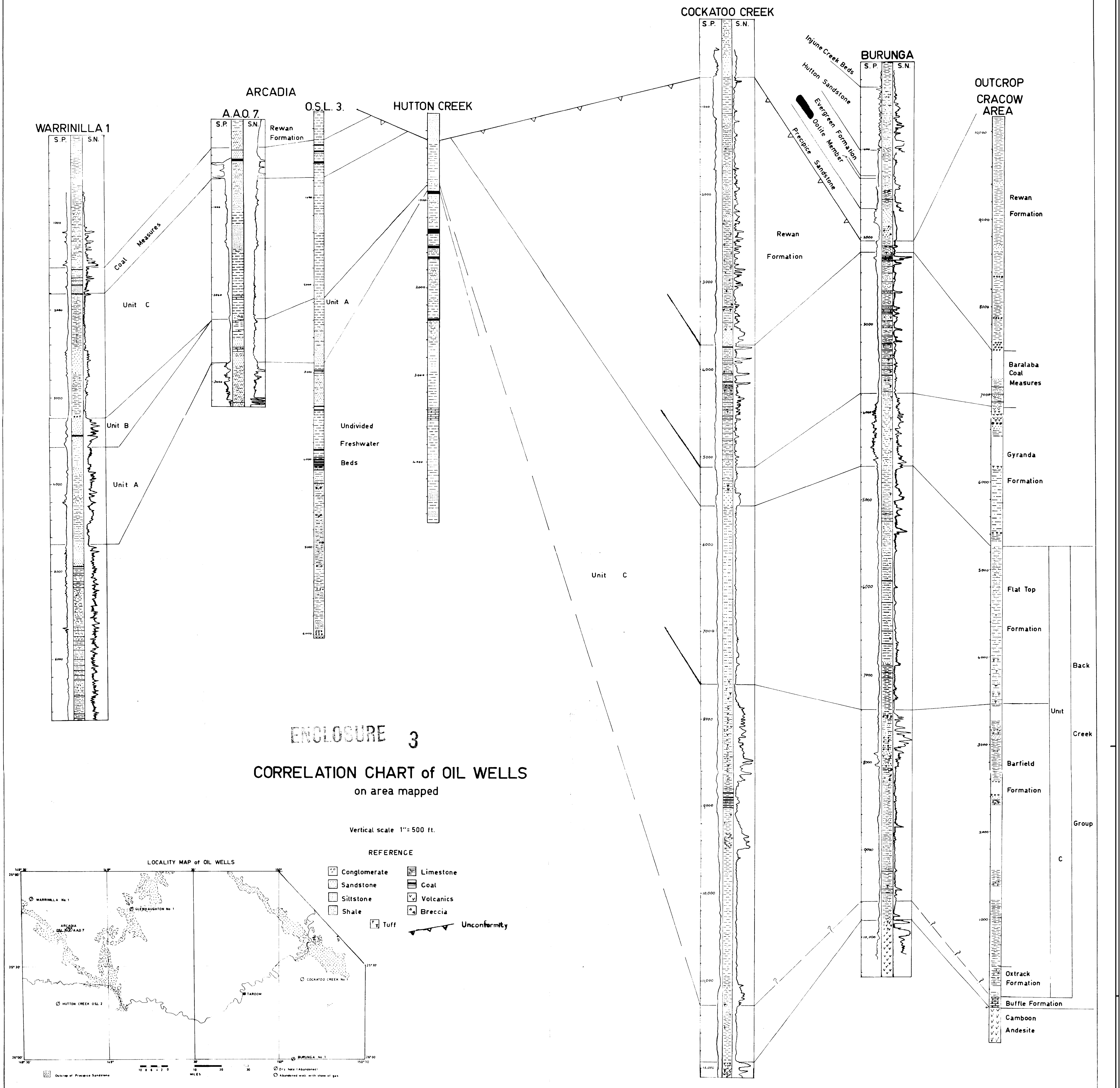
B Detailed reconnaissance - numerous traverses, air photo interpretation

INDEX TO ADJOINING SHEETS
Showing Magnetic Declination



MUNDUBBERA
SHEET SG 56-5

ENCLOSURE 2



ENCLOSURE 3

CORRELATION CHART of OIL WELLS

on area mapped

Vertical scale 1" = 500 ft.

To accompany Record No. 1964/61 Bureau of Mineral Resources, Geology and Geophysics. April, 1964.

G55/A8/9