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1966/90

THE GEOLOGY OF THE NORTHERN HALF OF THE MITCHELL 1:250,000 SHEET AREA, QUEENSLAND.

by

N.F.Exon, D.J.Casey* and M.C.Galloway
*(Geological Survey of Queensland)

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INTRODUCTION

Mapping of the northern half of the Mitchell Sheet area (between latitude 26°00'S and 26°30'S and longitudes 147°00'E and 148°30'E) was carried out jointly by the Bureau of Mineral Resources and the Geological Survey of Queensland in 1965. It was undertaken to resolve problems of correlation between the south-east Eromanga Basin and the Surat Basin sediments.

Field work took place in September and the first half of October; seven shallow drill holes were put down for stratigraphic information during October. The party consisted of N.F. Exon, party leader, M.C. Galloway, and E.H.J. Feeken (draftsman) of the Bureau of Mineral Resources and D.J. Casey of the Geological Survey of Queensland; R.W. Day of the Australian National University who had previously mapped the Roma-Wallumbilla district and reconnoitred the Mitchell Sheet area, introduced the party members to the area at the commencement of the field work. The division of work both in field mapping and text preparation was roughly as below:

Exon - Pre-Minmi Member stratigraphy west of the Maranoa River

Casey - Pre-Minmi Member stratigraphy east of the Maranoa River

Galloway - Minmi Member and Roma Formation

The field work and report writing was co-ordinated by N.F. Exon.

Only Mesozoic sediments crop out in the area mapped.

Following the field work, and completion of the geological map of the northern half of the Mitchell Sheet, J.C. Riverean (1966), produced a photogeological map of the southern half of the Sheet. The two are combined in Plate 3. Marine fossil collections were examined by Day (Appendix 2), and are stored in the Bureau of Mineral Resources Museum, Canberra. Collections are prefixed "GAB", but localities are shown on the map with the prefix "G".

The only sealed road is the Warrego Highway which links Roma, Mitchell, Morven, and Charleville with Brisbane. During the survey parts of the highway between Mitchell and Morven were unsealed, but these were to be sealed by the end of 1965. Most unsealed roads are impassable after heavy rain but major roads have been constructed with high crowns to facilitate drainage. Regular air services are provided from Brisbane to Roma, ten miles east of the area mapped, and, twice a week, from Brisbane to Mitchell. The Brisbane-Charleville railway passes through the southern part of the area.

The area, which consists largely of sandy country in the north, and black soil downs in the south (see Fig. 1), is devoted to the pastoral industry. The vegetation is closely related to the underlying rock types, which give rise to various soil types. Average annual rainfall is about 20 inches. The sandy soils of the north support either open eucalypt forest and some grass, or scrub. The black soil downs, which are generally well-grassed and treeless, are cultivated in places.

Aerial photographs taken by Adastra Airways at a scale of 1:85,000 in 1962, are available for the entire area. In addition, planimetric maps at a scale of 4 miles to 1 inch produced by the Royal Australian Survey Corps are available. A planimetric map at a scale of 1:250,000 is currently being produced by the Department of National Development, Canberra, A.C.T., and an early print of this was used as a base for the map. Other planimetric maps at a scale of 4 miles to 1 inch are available from the Department of Public Lands, Brisbane.

Water supplies (mostly subartesian) are obtained by bores from the aquifers of the Great Artesian Basin. Small supplies are also obtained from spear pumps in the sandy beds of the major water courses.

Details of the seven shallow scout holes drilled, including their grid references, are recorded in Appendix 4. Graphic logs are shown in figures 3, 4 and 5, and Plate 2. The cores and cuttings are stored at the Bureau of Mineral Resources, Core and Cuttings laboratory, Fyshwick, A.C.T.

Percentages of minerals in thin sections referred to in the text are estimates only. Localities given in brackets, thus (5600, 7600), refer to the 10,000 yard military grid covering the area (see Plate 3).

Palynology

Evans' palynological divisions of the Mesozoic (Evans, 1966) are referred to in the text.

Nomenclature

Crook's (1960) classification of arenites is followed. "Arenite" is used as the generalized non-genetic term for sand-sized clastic material. The generally accepted arbitary figure of 75% matrix is taken as the division between arenite and mudstone. All the arenites described fall into his genetic subdivision of 'sandstone' - traction current deposits. The term 'quartzose' is applied to those sandstones with quartz forming more than 90% of the clasts; if quartz forms 75 to 90% of the clasts the term 'sublabile' is applied; and if less than 75% of the clasts, the term 'labile' is applied. If the feldspar:lithics ratio is greater than 3:1, or less than 1:3, respectively, the qualifying terms 'feldspathic' or 'lithic' can be used with 'sublabile sandstone'; and 'labile sandstone' can be 'feldspathic sandstone' or 'lithic sandstone'.

"Siltstone is used as a grainsize term (1/16mm. to 1/256 mm.) The term "mudstone" is used as a general term for non-fissile sediments of the lutite class, and "shale" is defined as a fissile mudstone. "Claystone" is used for sediment consisting dominantly of clay minerals.

Grain size terminology follows the Wentworth Scale (Pettijohn 1957). Bedding terminology used is that proposed by McKee and Weir (1953).

Measured sections

There are four of these and their locations are shown below:

Section M1 :	Between (609,744) and (700,743)
Section M2 :	In position marked SII (622, 755)
Section M3 :	(646, 746)
Section M4 :	(647, 755)

PHYSIOGRAPHY

Drainage in the area is to the Warrego, Maranoa, Ballone and Dawson Rivers. The first three of these rivers are tributaries of the Darling River. The Dawson River joins the Fitzroy and flows to the Pacific Ocean. Part of the Great Dividing Range separates the Ballone and Dawson catchments.

All water courses are dry throughout most of the year; they flow only after heavy rain. Water can be obtained at shallow depth from sand deposits beneath the major water courses.

The area has been divided into physiographic regions (see Fig. 1). These are discussed below:

(1) Undulating country with scattered rounded hills and ridges. This is the most widespread region. It has both sandy soil (Us), and clayey soil (Uc), and is used throughout for cattle grazing. The areas of clayey soil are more fertile and are also used for grazing sheep.

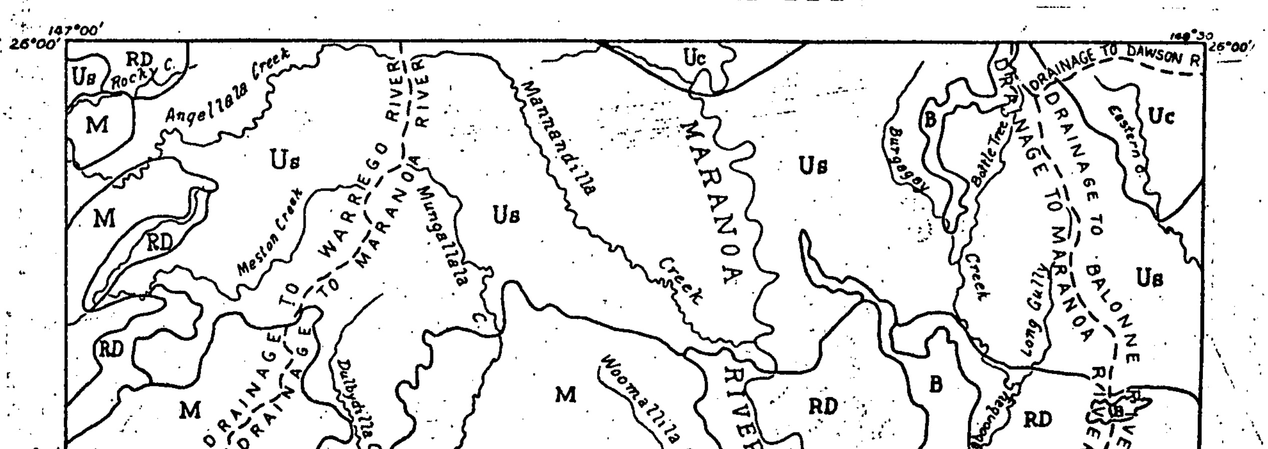
(2) Dissected mesa country. This region is thought to represent remnants of an extensive tableland which is now deeply and extensively dissected. The tableland had a resistant duricrust cap overlain by an extensive thin sand cover. The country is used for cattle and sheep grazing.

(3) Rolling Downs. This country is gently undulating and is typified by khaki clay soils. It is very fertile and is used for sheep grazing and farming. Small areas are irrigated.

(4) Basalt Plateaux. Basalt plateaux occur as a discontinuous submeridional line of hills near the eastern edge of the area. They produce very fertile soils. In the south, where the region is up to a mile wide, it is used for close farming. Where the belt is narrow it is used for grazing in the same way as the surrounding regions.

PHYSIOGRAPHY

Fig 1



To accompany Record 1966/89

REFERENCE

Us Undulating Sandy country with scattered rounded hills and ridges.

Uc Undulating Clayey (AS ABOVE)

M Dissected Mesa country

RD Rolling Downs

B Basalt Plateaux

Scale 1:1,000,000

G55/A11/3

PREVIOUS INVESTIGATIONS

Geological

Passing reference to the geology of the Mitchell Sheet area was made by Jensen (1921, 1926a) and Ball (1926). Whitehouse (1954) made the first regional survey of the whole Great Artesian Basin, including this area. The map accompanying this report shows some Tertiary basalt and, from north to south, Walloon Coal Measures, Blythesdale Group, Roma Formation and post Mesozoic sedimentary formations. Hill and Denmead (1960) review the geology of the region. Comprehensive bibliographies of the geological literature of the Mitchell area accompany these two publications.

Geophysical

Parts of the northern half of the Mitchell Sheet area have been covered by aeromagnetic and gravity surveys by oil exploration companies (Magellan Petroleum Corp., 1965), and by an aeromagnetic survey by the Bureau of Mineral Resources (BMR, 1964b, 1965).

A reconnaissance seismic traverse between Mitchell and Mungallala (Petty, 1963), indicates a flat-lying reflecting horizon within the pre-Permian Timbury Hills Formation. Thus it seems that folding in the Mesozoic sequence, in this area, is not related to irregularities in the basement surface. Several discontinuous reconnaissance lines along the northern end of the Forest Vale/Mitchell road (Petty, 1963), show a gentle southerly dip on the Timbury Hills reflector, which accords with surface information.

Exploratory drilling for oil and gas

Only two wells have been drilled in this area in the search for oil and gas. These were drilled by American Overseas Petroleum Ltd. (Amoseas) in 1965. Both were subsidised. Details are shown in Table I below. No significant shows were seen in these wells.

Oil Drilling — Table I

Name of well	Total Depth (feet)	Hydrocarbon shows	Status
Donnybrook No.1	1939	Trace fluorescence top Hutton Sandstone, Boxvale Sandstone, and Precipice Sandstone. Water saturated.	Abandoned
Dulbydilla No.1	2020	No shows	Abandoned

Other wells, namely Amoseas Strathmore No. 1, AAO Glenroy No. 1, AAO Lorne No. 1, and AAO Arbroath No. 1 have been drilled in the southern half of the Mitchell Sheet area.

DESCRIPTION OF ROCK UNITS

Rocks of Middle Jurassic to Cainozoic age crop out in this area. A summary of each unit appears in Table 2.

The present survey, in conjunction with those covering the Eddystone Sheet (Mollan, Forbes, Jensen, Exon and Gregory, in prep.), and the Tambo and Augathella Sheets (Exon, Galloway, Casey and

TABLE 2. SUMMARY OF ROCK UNITS

ERA	PERIOD	ROCK UNIT AND MAP SYMBOL	LITHOLOGY	THICKNESS (feet)	PALAEONTOLOGY	RELATIONSHIPS	ENVIRONMENT OF DEPOSITION	SYNONYMOUS NAMES
CAINOZOIC	QUATERNARY	Qa	Alluvium	less than 100			Fluviatile	
		Qs	Soil; gravel; sand; 'billy' boulder gravels.	probably mainly less than 100				
	UNDIFFEREN-TIATED	Cz	Poorly bedded clayey sandstone	Less than 20		Weathered and consolidated in situ, on sandy units.		
		Czd	Duricrust (laterite)	Less than 50		Alteration product, largely of Roma Fm.		
	TERTIARY	T	Well bedded clayey, quartz-rich to labile pebbly sandstone; conglomerate	Less than 100		Unconformably overlies pre-Tertiary sediments.	Fluviatile	
		Tb	Basalt flows	Less than 50		Unconformably overlies pre-Tertiary sediments, Interbedded with T in some places.	Terrestrial	
MESOZOIC	LOWER CRETACEOUS	Roma Fm. Klr	Grey siltstone;shale; sublabile sandstone. Some calcareous beds.	200 +	Abundant marine fauna (e.g.Day,1964) spores, acritarchs.	Conformable on Klb, J-Kh	Shallow water, marine.	
		Blythesdale Fm. Klb	White to buff, cross-bedded, quartzose sandstone; grey carbonaceous micaceous siltstone,mudstone, white claystone.	600 ±	Wood, plants, porous marine fossils in Minmi Member.	Apparently conformable on Juo	Fluviatile, minor lacustrine, minor marine.	Blythesdale Braystone (Jack 1895a,b). (see Day,1964).
		Minmi Mbr. Kli	Greenish glauconitic sublabile sandstone; minor siltstone, mudstone.	140 -	Aptian marine macrofossils (see Day,1964), wood, spores, dinoflagellates.	Conformably within Klb	Littoral marine	
		Nullawurt Sandstone Member Kln	White to buff quartzose sandstone; minor sublabile sandstone, siltstone.	100 ±	Plants, wood	Conformably within Klb	Fluviatile	
		Kingull Member Klk	Grey labile and sublabile sandstone; minor siltstone, mudstone.	0 - 100		Conformably within Klb	Lacustrine, fluviatile	
		Mooga Sandstone Member. Klk	White, crossbedded quartzose and sublabile sandstone; siltstone, claystone.	300 ±	Wood. Abundant Blythesdale flora on Roma Sheet (Day,1964).	Conformably within Klb	Fluviatile	
	JURASSIC CRETACEOUS	"Hooray Sandstone" J - Kh	White, crossbedded quartzose to labile sandstone, some pebbly,some siltstone, claystone.	300 - 400	Wood, plants.	Apparently conformable on facies equivalent of Klb, Juo and Jug	Fluviatile	

TABLE 2. Page 2. (Mitchell)

ERA	PERIOD	ROCK UNIT AND MAP SYMBOL	LITHOLOGY	THICKNESS (feet)	PALAEONTOLOGY	RELATIONSHIPS	ENVIRONMENT OF DEPOSITION	SYNONYMOUS NAMES
MESOZOIC	UPPER JURASSIC	Orallo Formation Juo	Grey siltstone, mudstone, quartzose to labile sandstone, calcareous sandstone.	350 - 400 (thicknes to S in subsurface)	Poor plant remains. Identifiable plants (Day, 1964) and spores in adjacent areas.	Conformable on Jug; facies equivalent of middle J - Kh	Lacustrine, fluvial	See Day, (1964.)
		Gubberamunda Sandstone Jug	White to brown quartzose to sublabile sandstone; minor siltstone.	200 - 250 (thins to S in subsurface)	Plant impressions, fossil wood.	Apparently conformable on Juo. Facies equivalent of lower J - Kh.	Fluviatile	See Day (1964)
		Westbourne Formation Juw	Siltstone, calcareous siltstone, mudstone very fine grained crossbedded quartz-rich sandstone.	350 -450 (thicker in Merivale Syncline)	Plants, spores, acritarchs.	Apparently conformable on Jmb	Lacustrine, deltaic.	"Upper Intermediate Series" (Woolley, 1941). "Injune Creek Beds" (Jensen, 1921a). Upper part.
	MIDDLE JURASSIC	Springbok Sandstone Lens Js	Crossbedded labile sandstone, some siltstone.	0 - 40		Conformable within uppermost Jmb	Fluviatile	
		Birkhead Formation Jmb	Calcareous labile and sublabile sandstone, carbonaceous siltstone and shale, cosl.	500 - 600 (thinner to W in subsurface)	Plants, spores, acritarchs.	Conformable on Hutton Sandstone.	Paludal, minor fluviatile.	"Injune Creek Beds" (Jensen, 1921a). lower part.

Table 3

NOMENCLATURE AND CORRELATES IN JURASSIC SEQUENCE,

EROMANGA AND SURAT BASINS

New Nomenclature and correlation		Recent usage
Eromanga Basin (Tambo area)	Surat Basin (Roma area)	Surat Basin e.g. AAO Blyth Creek No.1 (Minad, 1964a)
"Hooray Sandstone"	Blythesdale Formation++	Transition Member Mooga Member
	Orallo Formation ++	Fossil Wood Member
	Gubberamunda Sandstone	Gubberamunda Member
Westbourne Formation+	Westbourne Formation	Injune Creek Beds
Adori Sandstone	Springbok Sst. Lens	
Birkhead Formation	Birkhead Formation	
Hutton Sandstone	Hutton Sandstone	Hutton Sandstone

++ After Day (1964)

\+ After Gerrard (1964b)

The various members of the Blythesdale Formation (Day, 1964), defined in the Roma area, are present on the eastern edge of the Mitchell Sheet. These are the Mooga Sandstone Member, the silty Kingull Member, the Nullawurt Sandstone Member and the marine Minmi Member.

The Kingull Member is not mappable west of Nade Homestead, some 15 miles west of the Sheet boundary. Beyond here the overlying and underlying quartzose sandstone members cannot be distinguished from one another, and the Mooga and Nullawurt Sandstones are together mapped as undifferentiated Blythesdale Formation.

The Minmi Member, which consists dominantly of glauconitic sandstone, is recognisable as far west as Dunedin Homestead, 7 miles west of the Maranoa River. Beyond here it is lithologically, and in time, probably represented by glauconitic sandstone lenses within the typical mudstone of the Roma Formation (see Fig. 2). It is believed that the Minmi Member is a littoral facies developed in lowermost Roma times. Once it becomes discontinuous, it is mapped within the Roma Formation.

During Cainozoic times there was deposition of fluviatile sandstone in the west, and outpouring of basalt in the east, and duricrust developed on the Roma Formation.

JURASSIC INJUNE CREEK GROUP

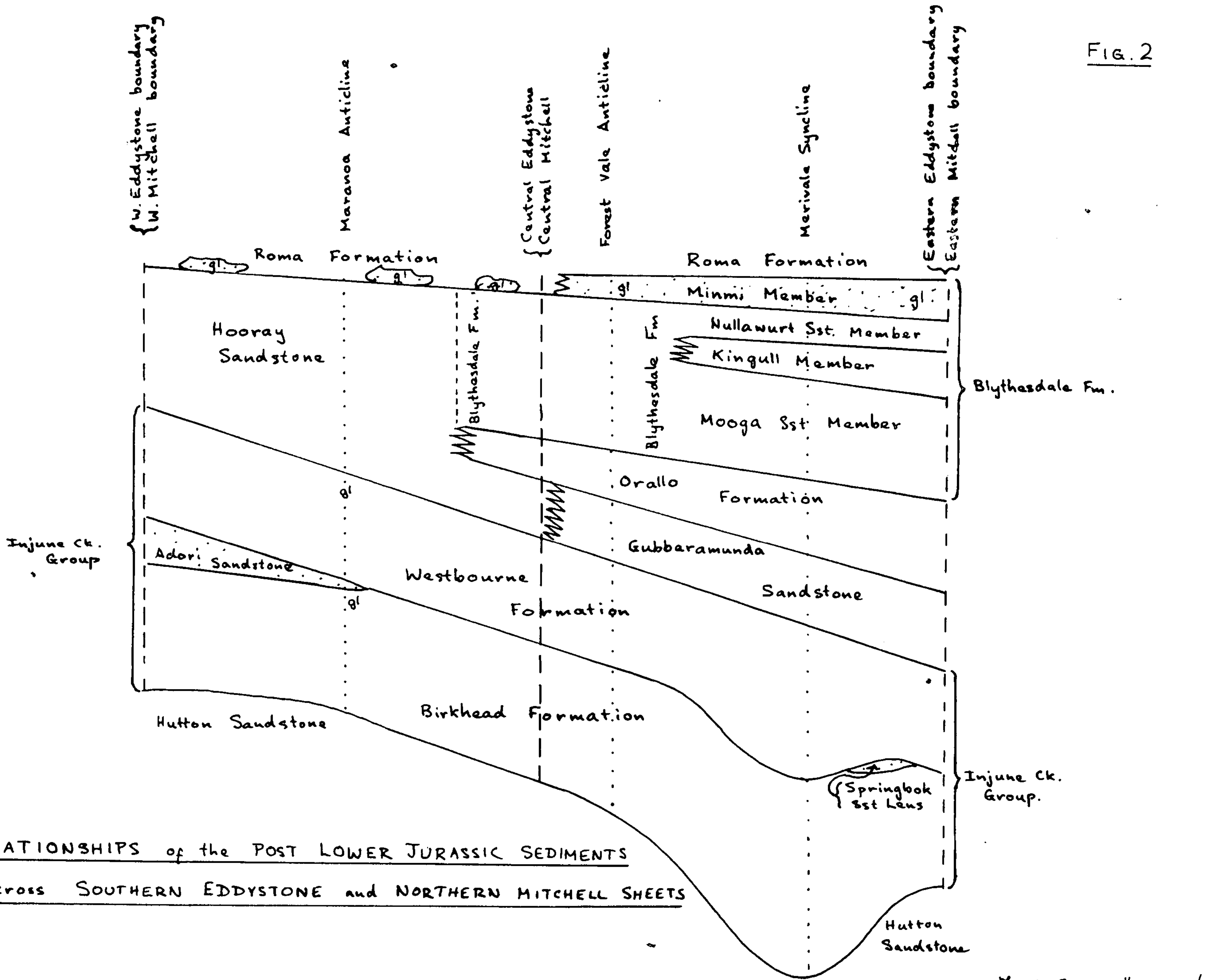
In this area the Injune Creek Group includes the Birkhead Formation, the Springbok Sandstone Lens, and the Westbourne Formation.

The term "Injune Creek Coal Beds" was first used by H.I. Jensen (1921, p. 92) for sediments of Jurassic age in the Roma-Injune area. The unit was included in the "Lower Walloon", Walloon apparently having been used by Jensen for all the Jurassic sediments in Queensland. In later publications, Jensen did not use "Injune Creek Coal Beds" but instead subdivided the Walloon Coal Measures into "Upper", "Middle", "Lower" and "Basal" Walloon Formations. Reeves (1947) used "Lower Walloon Series" for the Walloon Formation. Laing (in Hill and Denmead, 1960) suggested that, for the Roma-Injune area, it would be preferable to revive the term "Injune Creek Beds", and this is the name now generally used. Jensen et al. (1964) applied the name to the Jurassic sequence between the Hutton Sandstone and the Gubberamunda Sandstone, in the Injune-Roma area.

Woolley (1941) mapped an area around Tambo and divided the Jurassic sequence as in the table below. Surface mapping of the Tambo and Augathella Sheet areas (Exon; Galloway, Casey and Kirkegaard, 1966) and the Mitchell Sheet area, supported by palynological studies (Evans, 1966) has given the following correlation (see also Table 3):-

Woolley (1941)	Day (1964)	This report (after Exon, 1966)
	Blythesdale Formation	
Hooray Sandstone	Orallo Formation	"Hooray Sandstone"
	Gubberamunda Sandstone	
Upper Intermediate Series		Westbourne Formation
Adori Sandstone	Injune Creek Beds	Springbok Sandstone Lens
Lower Intermediate Series		Birkhead Formation

In the completion report of Amoseas Boree No. 1, Gerrard (1964) defined a new unit, the Westbourne Formation, and correlated it with the Upper Intermediate Series. Surface mapping and subsurface correlation has substantiated this interpretation (Exon, 1966). The Adori Sandstone pinches out in the south-west of the Eddystone Sheet area and cannot be traced into the Mitchell Sheet area. However, a sandstone lens, which crops out in the eastern part of the Mitchell Sheet area between the Westbourne Formation and the Birkhead Formation, is probably equivalent to the Adori Sandstone. Exon (1966) proposed the name Birkhead Formation for the Lower Intermediate Series, and the sandstone lens was defined as the Springbok Sandstone Lens. He also renamed the "Injune Creek Beds" the Injune Creek Group. The Injune Creek Group was deposited in freshwater, lacustrine and fluviatile conditions.



RELATIONSHIPS of the POST LOWER JURASSIC SEDIMENTS across SOUTHERN EDDYSTONE and NORTHERN MITCHELL SHEETS

Vert. Scale 1" = 500'

gl = glauconitic.

To accompany Record 1966/90

G55/A11/4

BIRKHEAD FORMATION

This formation was defined by Exon (1966) as a sequence of brown and grey, fine grained, generally calcareous, labile sandstone and siltstone. The unit is the equivalent of the Lower Intermediate Series of Woolley (1941), and of the lower part of Jensen's Injune Creek Beds (1921). Birkhead Creek, between Lat. 24° 23'S, Long. 146° 22'E, and Lat. 24° 33'S, Long. 146° 22'E, on the Tambo Sheet area, is the type area. Because of the paucity of outcrop in this area, the interval 1880-2244 feet in Amoseas Westbourne No. 1 is taken as the type section.

The Birkhead Formation crops out in the Tambo, Augathella, Springsure and Eddystone Sheet areas, and widely in the Surat Basin. It is very widespread in the subsurface. The unit crops out across the north-east of the Mitchell Sheet in a belt of undulating plains up to 8 miles wide. It naturally supports thick stands of brigalow scrub, but has been extensively cleared for pastoral development. Small rubbly outcrops with occasional large calcareous concretions are typical of the unit. Exposures up to 20 feet thick occur in Bungeworgorai Creek.

No representative sections could be measured in the Mitchell area because of the poor outcrop. Calcareous, brown and grey, medium to fine grained, labile, quartz-poor sandstone is the dominant outcropping rock type. Siltstone and mudstone comprise an important part of the unit but they weather readily and are rarely exposed. Thin coal seams have been noted (e.g. in BMR Mitchell No. 3, see Fig. 3). Two miles west of Hendon Park Homestead, the Springbok Sandstone Lens of medium to fine grained crossbedded sublabile to lithic sandstone occurs at the top of the Birkhead Formation. This lens is 40 feet thick in BMR Mitchell No. 3 and can be traced only for about 8 miles.

Two shallow drill holes penetrate the upper part of the unit in this area. BMR Mitchell No. 3 (Fig. 3), in the east of the area, penetrates 110 feet of the unit below the Springbok Sandstone. The sequence consists largely of light grey calcareous siltstone, with lesser labile sandstone (calcareous in part), mudstone and coal. The sandstone contains quartz, feldspar, lithic grains, mica and carbonaceous fragments in a clay matrix.

BMR Mitchell No. 6 (Fig. 4), near the Maranoa Anticline, in the west of the area, penetrates 185 feet of section below the Adori Sandstone, which pinches out nearby. The Birkhead Formation in this hole consists largely of carbonaceous siltstone, grading to mudstone, and very fine to medium grained labile sandstone. There is also a little coal. A thin section of a lithic sandstone shows it to consist of 50 percent lithic fragments (? volcanic), 20 percent quartz, 10 percent plagioclase, 10 percent chlorite and glauconite grains, and 10 percent chlorite matrix. [illegible] laminated [illegible] and fissile [illegible]

The Birkhead Formation conformably overlies the quartzose Hutton Sandstone north of this area (Mollan, Forbes, Jensen, Exon and Gregory, in prep.).

The calcium carbonate content of the Birkhead Formation indicates deposition in an area of restricted drainage. Conditions of deposition were largely lacustrine, with deltaic and fluviatile interludes. The coal seams indicate paludal conditions for some of the time. The large amount of volcanic detritus (rock fragments and plagioclase), suggests some contemporaneous volcanism. The presence of glauconite in BMR Mitchell No. 6 suggests periods of marine influence.

In the Mitchell area the full thickness of the Birkhead Formation is not exposed. However, in the adjacent Eddystone Sheet area, the Birkhead Formation is generally about 500 feet thick; in the Merivale Syncline it is up to 1000 feet thick (Mollan et al., op. cit.). Approximate subsurface thicknesses from west to east are:-

350 feet in Amoseas Alba No. 1, just west of the Mitchell Sheet area, 250 feet in Amoseas Dulbydilla No. 1, (on the Maranoa Anticline), 500 feet in Amoseas Donnybrook No. 1 (on the Forest Vale Anticline), 400 feet in Amoseas Strathmore No. 1 (on a photo-interpreted anticline), and 500 feet in AAO Arbroath No. 1 (in the Arbroath Trough, a probable southerly extension of the Merivale Syncline). In these wells the Birkhead Formation is medium to fine grained sandstone with a clayey matrix and, at some levels calcareous cement, grey sandy siltstone and grey shale.

Fragmentary plant remains are common in the formation, but no plants were identified on this survey. The palaeobotanical determinations listed by Whitehouse (1954) indicate a probable Jurassic age for the formation. Evans has found spores of division J5 in the top of the unit in BMR Mitchell No. 3 (Appendix 3). Elsewhere he has found J4 spores in most of the unit, with division J5 confined to the upper part (Evans, 1966). On this evidence he believes the unit to be of Middle Jurassic age ((Evans, in prep.). De Jersey and Paten (1964), also on palynological grounds, assign a Middle Jurassic age to the Walloon Formation, which they correlate with the Injune Creek Beds. They also found a similar assemblage in the Maranoa Colliery at Injune, which is within the Birkhead Formation.

Springbok Sandstone Lens

This lens, named from the Parish of Springbok (Lat. 26°S, Long. 148° 24'E), was defined in Exon (1966). The unit is poorly exposed so the type section (see Fig. 3), was taken from the interval 125 feet to 165 feet in shallow drill hole BMR Mitchell No. 3 (Lat. 26° 4'S, Long. 148° 22'E). A core was taken from 125 feet to 129 feet (recovery 3 feet 6 inches). The hole is near a dam on the north branch of Alcurah Creek in the north-east of the Mitchell 1:250,000 Sheet area. The cuttings and core are available for examination at the Bureau of Mineral Resources.

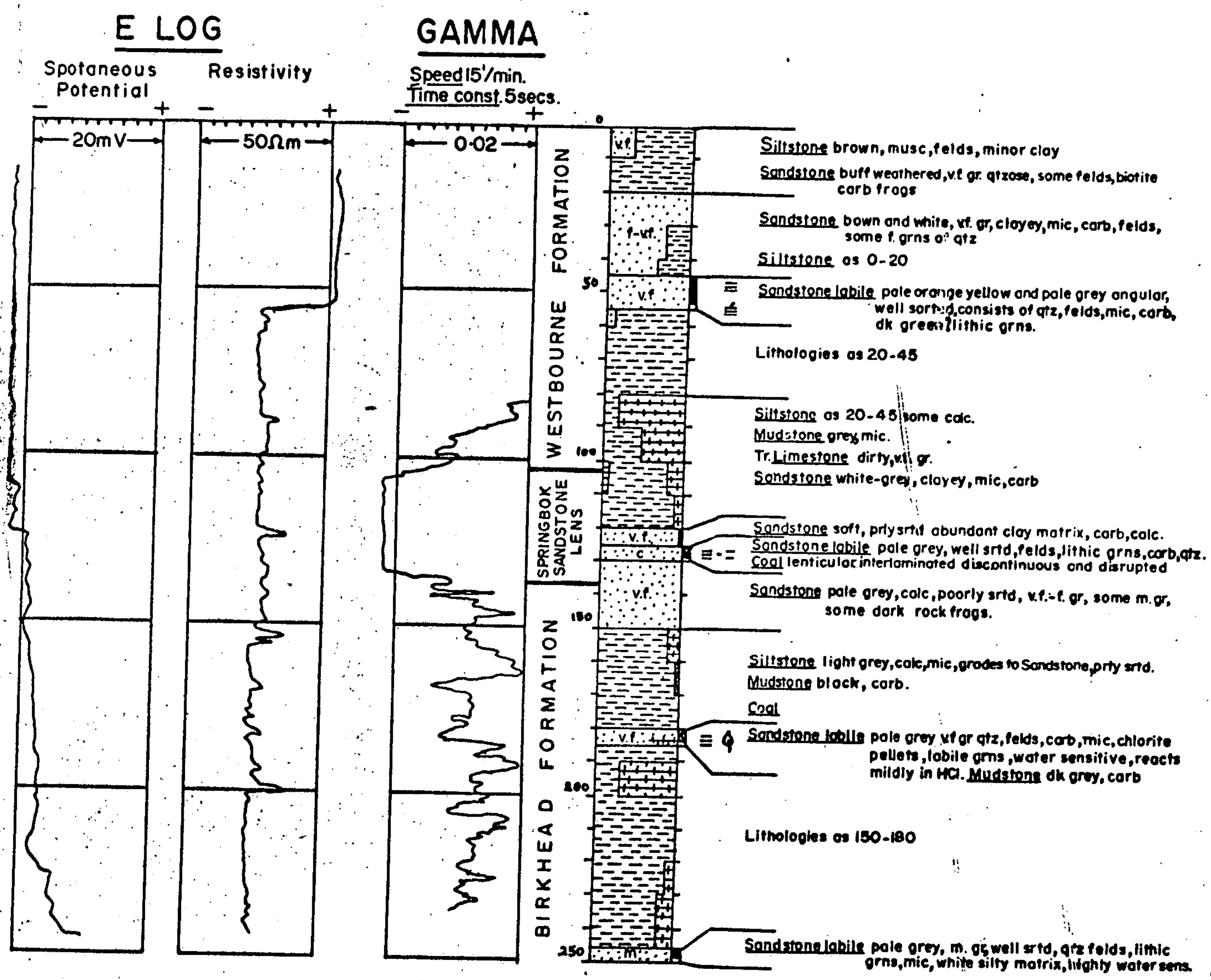
The lens crops out in the south-east of the Eddystone Sheet area and the north-east of the Mitchell Sheet area. It extends from about 1 mile east of the type section, north-west towards Mt. Hutton, over a distance of about 9 miles. It is also intersected in registered water bore 10880, one mile south of BMR Mitchell No. 3.

The unit is dominantly very fine to coarse grained, fairly well sorted, often calcareous, sublabile to lithic sandstone. Carbonaceous fragments are common in the sandstone, and other minor constituents are muscovite and an unidentified soft green mineral. A minor constituent is very fine grained feldspathic sandstone. In outcrop, the sandstone is generally brown and extensively weathered, but in the subsurface it is white to pale green, tight and clayey. The sandstone is medium bedded, and sometimes planar crossbedded. The lowermost 15 feet in the subsurface also contains abundant calcareous grey clayey siltstone, with carbonaceous fragments and mica flakes.

This lens is within the uppermost Birkhead Formation and is overlain by the Westbourne Formation. The gamma ray and lithological logs of the type section show the sharp change into silty sediments above and below the lens. This small sandstone body is approximately equivalent to the Adori Sandstone of the Eromanga Basin.

SHALLOW DRILL HOLE LOG

B. M. R. MITCHELL No. 3



BIRKHEAD FORMATION, SPRINGBOK SANDSTONE LENS, WESTBOURNE FORMATION

FIG 3

G55/A11/5

To accompany Record 1966/90

The presence of abundant intermediate volcanic fragments and fresh plagioclase, suggests a fairly close source area. The lens was deposited in a high-energy fluviatile environment.

It is 40 feet thick in the type section, which is probably a maximum. It is unfossiliferous, but on stratigraphic grounds its age is probably Middle Jurassic.

WESTBOURNE FORMATION

Gerrard (1964) proposed this name for the sequence from 1279 feet to 1651 feet in Amoseas Westbourne No. 1 well in the Augathella Sheet area, but he did not publish it. He also identified it in several nearby oil wells. Further mapping on the Tambo Sheet (Exon, Galloway, Casey and Kirkegaard, 1966) confirmed that this was the "Upper Intermediate Series" of Woolley (1941), as suggested by Gerrard. Exon (1966), with the agreement of Amoseas, formally published and defined the Westbourne Formation. The type section in Amoseas Westbourne No. 1, contains identical lithologies (very fine grained sandstone, siltstone and shale) to those in the Mitchell Sheet area.

The unit crops out on the Tambo and Augathella Sheets, the western and southern parts of the Eddystone Sheet, and on the northern part of the Mitchell Sheet. It forms a narrow, sinuous, east-west trending belt along the Eddystone/Mitchell Sheet boundary. The southerly dipping formation swings south down anticlinal axes, and north up synclinal axes, in and out of the Mitchell Sheet area. It is very widespread in the subsurface, and has a distinctive high density gamma ray log.

This unresistant unit generally forms a slope below the hills of the overlying sandstone units. In places more resistant beds form low cuestas. The unit, where it is not cleared, is covered with fairly open brigalow scrub.

This poorly exposed formation consists of two different rock assemblages, hereafter known as the "carbonaceous sequence" and the "crossbedded sequence". The first consists of dark grey to greenish grey, carbonaceous, micaceous well bedded <u>siltstone</u> and <u>mudstone</u>; the second consists of buff, weathering to brown, friable crossbedded quartz-rich <u>siltstone</u> and very fine grained <u>sandstone</u>.

The two classes appear to occur in roughly subequal proportions in this area. Each rock type generally occurs in a fairly homogeneous sequence, a few feet or more thick; this sequence is itself more thinly bedded.

The carbonaceous sediments contain muscovite and biotite, and there are abundant fragmentary plant remains in some beds. These siltstones and mudstones are laminated to thinly bedded, and fissile when weathered.

The sandstone of the "crossbedded sequence", in outcrop generally varies from quartzose to sublabile, with fewer labile beds. It contains feldspar, black rock fragments, muscovite and biotite. Mostly, it is very fine to fine grained but, in places, it is medium grained and may contain a few coarse grains. Minor coarse sandstone beds contain granules and small pebbles of quartz, quartzite and chert, and siltstone and mudstone clasts. The sandstone grades to similar siltstone, and both may contain plant remains. These sediments are thinly to medium bedded, and are often poorly bedded. Numerous small scale scour, and low-angle planar, crossbeds vary greatly in azimuth direction. Siltstone and mudstone clasts are abundant in some beds. Although these sediments are generally clean and friable in outcrop, they are clayey, and often labile in the subsurface; the clay matrix and clayey rock fragments have been weathered out near the surface.

Thin calcareous beds, and concretions, occur in the "crossbedded sequence" in places. Calcareous siltstone is generally in thin beds or tabular concretions; sandstone forms thicker, more rounded concretions. The calcareous beds are largely of secondary origin, forming after leaching of the original clay matrix. They have, in places, themselves been altered during weathering, giving tabular ironstone beds which do not occur in shallow drill holes.

Three thin sections of very fine grained sandstone, from outcrops in the adjacent Eddystone Sheet area (Mollan, Forbes, Jensen, Exon and Gregory, in prep.), contain abundant angular quartz, minor feldspar and muscovite, and generally some shale and quartzite fragments. Accessory green biotite, iron ore, tourmaline and zircon also occur.

Four shallow drill holes, BMR Mitchell No. 2 and No. 3 (Figs. 5 and 3), and No. 5 and No. 6 (Fig. 4), penetrate the unit in this area. Information from these holes, from oil wells, and from drill holes on the Eddystone Sheet, in conjunction with outcrop information from this area, suggest that the proportions of "crossbedded sequence" to "carbonaceous sequence" vary considerably, but that there is no obvious pattern of variation.

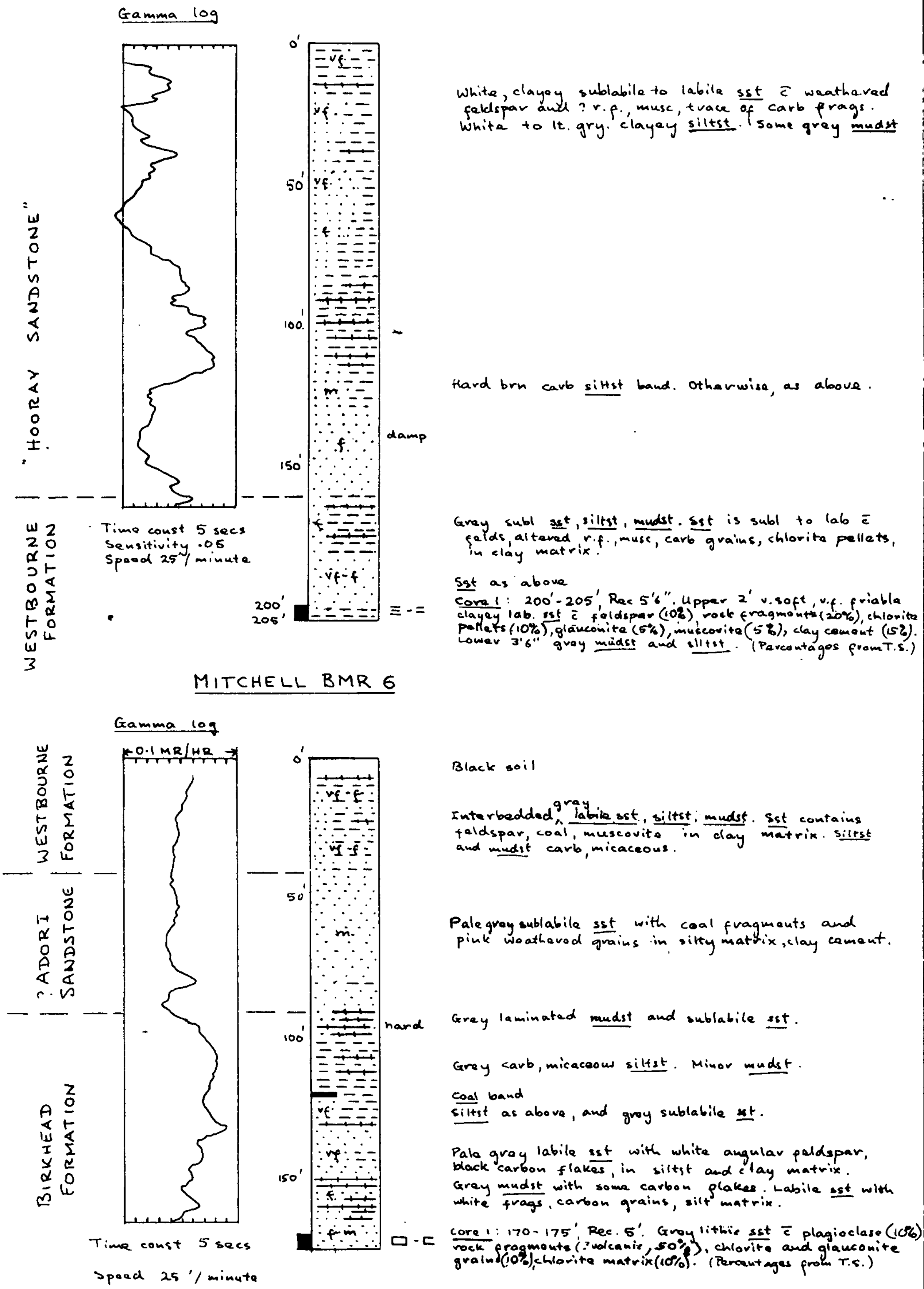
Drill holes No. 2 and No. 3 are in the eastern flank of the Merivale Syncline, in the east. Mitchell No. 2 contains 160 feet of the upper part of the sequence, and consists largely of carbonaceous siltstone, with lesser quantities of quartz-rich siltstone and clayey labile sandstone. The gamma log of this hole shows the typical high density of the formation. Mitchell No. 3 which contains 100 feet of the lower part of the formation, consists essentially of non-carbonaceous siltstone and labile sandstone (the "crossbedded sequence").

Drill holes No. 5 and No. 6 are in the eastern limb of the Maranoa Anticline, in the north-west. Mitchell No. 5 contains 50 feet of the uppermost Westbourne Formation, which belongs to the "crossbedded sequence" and is largely fine grained sublabile to labile sandstone. A thin section of a labile sandstone, from a core, consists of 35 percent quartz, 20 percent rock fragments, 10 percent feldspar, 10 percent chlorite pellets and 5 percent glauconite, 5 percent muscovite and 15 percent clay cement. Mitchell No. 6 contains 40 feet of the lowermost part of the formation, which consists of the "crossbedded sequence" and the "carbonaceous sequence" in roughly equal proportions.

Some 35 miles to the north-west of these two holes, shallow drill holes Eddystone BMR Nos. 49 and 50 (see Mollan et al., op. cit.), penetrated virtually the whole 400 feet of the unit. They consist dominantly of carbonaceous, micaceous siltstone and mudstone with lesser sandstone (see Plate 1). A little ?glauconite was seen in a core 80 feet below the top of the formation in BMR. No. 50.

The unit is conformable with the underlying Adori Sandstone north of this area. There may possibly be a disconformity in this area, where the Adori Sandstone is not present, but there is no evidence of this. The boundary with the Birkhead Formation is taken, in outcrop, immediately above the highest medium grained calcareous lithic sandstone bed, or immediately below the lowest very fine grained,

FIG. 4.



SHALLOW DRILL HOLE LOGS MITCHELL 5 & 6

"HOORAY SANDSTONE", WESTBOURNE FORMATION, ADORI SANDSTONE, BIRKHEAD FORMATION

To accompany Record 1966/90

G55/A11/6

buff, friable sublabile sandstone bed. In the subsurface, it is at the top of the highest coal seam, and generally above the highest medium grained lithic sandstone. In general, the Westbourne Formation may be distinguished in outcrop by the presence of buff, friable, very fine grained quartz-rich sandstone, and the Birkhead Formation by the presence of brown, coarser grained calcareous lithic sandstone.

The well bedded, laminated, to thinly bedded, carbonaceous siltstone and mudstone was deposited in quiet lacustrine conditions. The poorly bedded, crossbedded, clayey sandstone and siltstone, was probably largely deposited in deltaic conditions, varying to low-energy fluviatile conditions. The water level fluctuated continuously and, in different areas, thin deltaic, lacustrine and fluviatile sediments were deposited at the same time. The depositional area was a low lying one, with little relief, in which deltas advanced across lakes. When streams changed their courses, deltas built up elsewhere, and lacustrine conditions returned to previously deltaic areas. A low hinterland provided fine sand, silt and mud, and abundant carbonaceous material, for the sluggish rivers. The sand and the coarser silt were deposited in deltas and streams, but were not cleaned of all their clay fraction. Most of the mud, some of the silt, and nearly all the light carbonaceous material, was carried further, and deposited in the lakes. The presence of possible glauconite, and acritarchs, in Eddystone BMR No. 50, and glauconite in BMR Mitchell No. 5, suggests marine influence at some levels.

The thickness of the unit in outcrop in this area, is generally estimated to be between 350 and 450 feet, compared with 270 feet in the type section, and between 350 and 400 feet across the Eddystone Sheet area (Mollan et al., op. cit.). However, the formation may be up to 1000 feet thick in the Merivale Syncline to the north (Mollan et al., op. cit.), and is also thicker in the syncline in this area. Approximate subsurface thicknesses, from west to east, are:- 500 feet in Amoseas Alba No. 1 (just west of this area), 450 feet in Amoseas Dulbydilla No. 1 (on the Maranoa Anticline), 300 feet in Amoseas Strathmore No. 1 (on a photo-interpreted anticline) and 550 feet in AAO Arbroath No. 1 (in the Arbroath Trough, which is probably the southern extension of the Merivale Syncline).

No marine macrofossils have been found in this unit, and none of the poorly preserved plant remains found have been identified. Evans (Appendix 3) has found J5 and J6 spores in the unit, in cores from shallow drill holes in this area. These spore divisions are of Upper Jurassic age (Evans, in prep.), which agrees with general stratigraphic evidence.

JURASSIC-CRETACEOUS

Within this heading are discussed the "Hooray Sandstone" of the Eromanga Basin, and its Surat Basin correlates, the Gubberamunda Sandstone, Orallo Formation and Blythesdale Formation. The Blythesdale Formation is subdivided (after Day, 1964) into the Mooga Sandstone Member, Kingull Member, Nullawurt Sandstone Member and Minmi Member.

This conformable sequence consists essentially of freshwater sandstone, siltstone and mudstone. The only definitely marine material is the sandstone of the Minmi Member, at the top of the sequence.

"HOORAY SANDSTONE"

Woolley (1941) named this unit from Hooray Creek, and measured a section in Hooray and Mount Pleasant Creeks. The name was first published in Hill and Denmead (1960). The type section, in Hooray Creek 12 miles east-north-east of Tambo, is illustrated in Exon (1966). It consists of 250 feet of very fine to pebbly, white sublabile sandstone and conglomerate. The lower 150 feet is finer grained than the upper part. Exon stated, "Outcrop and subsurface information suggest that this unit contains an unconformity within it. Hence it is not a valid formation, and with further work, could probably be mapped as two units. The following information should be regarded as a discussion rather than a formal definition."

The "Hooray Sandstone" crops out in the Tambo, Augathella, Eddystone and Mitchell Sheet areas, and is widespread in the subsurface in the eastern part of the Eromanga Basin. It is confined to a broad belt in the western half of this area, where it consists of sand plains and flat-topped sandstone plateaux and mesas. The unit is almost flat-lying and gentle dips to the south, south-west or south-east are only discernible in places. Scrub and thin eucalypt forest grow on the sandy soil of the unit.

In this area the unit is dominantly white, very fine to medium grained <u>sandstone</u>, with considerable grey to white <u>siltstone</u>. There is also some white <u>claystone</u> and very minor conglomerate. The unit is a good aquifer.

Six thin sections, from similar sublabile to labile sandstones cropping out in the Eddystone Sheet area to the north (Mollan, Forbes, Jensen, Exon and Gregory, in prep.), are very uniform. They contain 40 to 60 percent quartz and quartzite, 5 to 10 percent feldspar, and up to 15 percent siltstone and mudstone fragments, set in a clay matrix. Accessories include iron oxide, mica, zircon and tourmaline.

In the Mitchell Sheet area the sandstone varies from clean and quartzose to clayey and labile. In the Mount Scott Syncline the basal part of the unit is very similar to the lower part of the "Hooray Sandstone" in the type area. It consists largely of very fine to fine grained clayey sublabile to labile sandstone, and some siltstone, and is generally thinly to medium bedded, with small scale cross-bedding. The sandstone generally contains quartz, feldspar, muscovite, dark rock fragments and a little biotite. Minor coarser beds contain pebbles of quartz, quartzite and sediments. Plant remains occur at a few localities. BMR Mitchell No. 5 (Fig. 4) penetrates 170 feet of this sequence - a monotonous succession of white to light grey, very fine grained clayey sandstone and siltstone, with a little mudstone.

Elsewhere, the sandstone is generally fine to medium grained, medium to thickly bedded, and planar and scour crossbedded. Gritty and pebbly beds, and conglomerates up to six inches thick, are fairly common. Pebbles are quartz, quartzite, chert and fine sediments. Siltstone and claystone clasts are abundant in some beds.

The upper part of the unit on the Maranoa Anticline, consists, essentially, of thinly to thickly bedded, rarely crossbedded, very fine to fine grained clayey sandstone, and laminated to thinly bedded white clayey siltstone. The siltstone often contains plant remains and micaceous partings.

In the middle of the unit there is a poorly exposed siltstone sequence, exposures of which are less than 70 feet thick. Good exposures occur three miles south of Mount Elliott Homestead, and at

Mount Hotspur. This sequence, which could possibly be an equivalent of the Kingull Member in the eastern part of the area, normally consists of white siltstone and fine grained clayey sandstone. At Mount Hotspur there is thinly bedded brown siltstone (with some possibly manganiferous ribbonstone), fine grained clayey sandstone, and some claystone.

On the Mount Elliott Homestead-Mungallala road, six miles south of the homestead (572,747) there is a scarp in which 35 feet of white, thinly bedded to massive claystone is exposed. Analysis of a random sample by A.M.D.L., showed it to contain kaolinite and illite, with kaolinite dominant. Similar claystone sequences occur to the south-west at Umberill and Bangor Homesteads.

Two shallow drill holes penetrate the upper part of the unit in this area (Plate 2). In BMR Mitchell No. 4, just east of the Maranoa Anticline, there is 210 feet of pale grey, clayey, fine to medium grained sublabile to labile sandstone, and grey siltstone and mudstone. In thin section the sandstone contains quartz, feldspar and some silty grains, with traces of glauconite and coaly fragments in some beds. In BMR Mitchell No. 7, further west, there is a similar sequence 130 feet thick.

The "Hooray Sandstone" conformably overlies the Westbourne Formation. The white sandstone and siltstone of the "Hooray Sandstone" contrast with the grey sandstone, siltstone and mudstone of the Westbourne Formation (e.g. BMR Mitchell No. 5), but there is no discernible scouring at the contact, where it has been seen. The "Hooray Sandstone" is a lateral equivalent of the interval Gubberamunda Sandstone/Orallo Formation/Blythesdale Formation. Between the Maranoa and Forest Vale Anticlines, the Gubberamunda Sandstone gives way to the lower part of the "Hooray Sandstone". A little further west the Orallo Formation becomes unrecognisable, and the Blythesdale Formation is not lithologically distinguishable from the upper part of the "Hooray Sandstone". An arbitrary straight line boundary, from the pinch-out of the Orallo Formation, separates the Blythesdale Formation from the upper part of the "Hooray Sandstone". (For more detail of lateral relationships see sections dealing with individual formations.)

The "Hooray Sandstone" was deposited in alternating fluviatile, deltaic, and lacustrine conditions. Crossbedding azimuths indicate streams flowing, on the average, from the north-west. In the Eddystone Sheet area, from which the streams came, the unit is coarser grained and largely conglomeratic. Probably the terrain was flatter southwards in that area, and as the streams lost their velocity, they dumped the heavy detritus. The finer grained fraction was deposited, in this area, from slowly moving streams, and in lakes and deltas. These clayey sediments were derived from pre-existing sediments, probably largely from the Jurassic sequence in the north. However, abundant reworked Permian spores in the sequence (Appendix 3), indicates some derivation from earlier sediments. Periods of marine influence are suggested by the presence of acritarchs (see Appendix 3), and glauconite, in BMR Mitchell No. 4.

The thickness of the "Hooray Sandstone" is generally about 400 feet in this area, but it thins slightly across the Maranoa Anticline. In Amoseas Alba No. 1, just west of the area it is about 400 feet thick, but in Amoseas Dulbydilla No. 1 (see Plate 2), on the Maranoa Anticline, it is only about 300 feet thick. This compares with a thickness of 250 feet in the type section near Tambo, and about 400 feet in the adjacent Eddystone Sheet area (Mollan et al., in prep.).

No identifiable plants, and no marine macrofossils, have been found in this unit. Evans (Appendix 3) has found spores of division J5, and some of Jurassic to Cretaceous age, in BMR Mitchell No. 4 Division J5 is of Upper Jurassic age (Evans, in prep.). On stratigraphic grounds the age of the unit extends from Upper Jurassic to Lower Cretaceous.

GUBBERAMUNDA SANDSTONE

The Gubberamunda Sandstone was named by Reeves (1947) but he did not nominate a type area. Day (1964) designated the main Injune-Roma road, between twenty and twenty-four miles north of Roma, the type area. He described the formation here as a medium to coarse-grained, virtually uncemented, quartz sandstone.

The formation crops out in the north Roma, north-east Mitchell and south-east Eddystone Sheet areas. In the area covered by this report, it extends in a belt about two miles wide from five miles east of Cornwall Homestead to about eight miles west of Amoseas Donnybrook No. 1. As the formation is very friable, it weathers readily to produce low, sand covered rises which support a thick scrub and cypress pine cover. Good exposures of the Gubberamunda Sandstone occur in cliffs with a protective cap of more resistant younger sediments or of basalt. However, small rubbly outcrops are more typical.

The Gubberamunda Sandstone is dominantly a brown, medium to very fine-grained quartzose to feldspathic sublabile sandstone; it is friable, soft and massive to thick bedded. Thin bands of poorly sorted pebbly and gritty sandstone and siltstone are also common. Section M1 (Plate 1) is typical of the unit. In this section some pebbly bands contain mud clasts indicative of an erosional break in sedimentation. These mud clasts characteristically weather concentrically. This section shows increasing amounts of siltstone and mudstone upwards. Large planar cross-beds are characteristic of the unit; current directions are highly variable but generally have a north or north-east average.

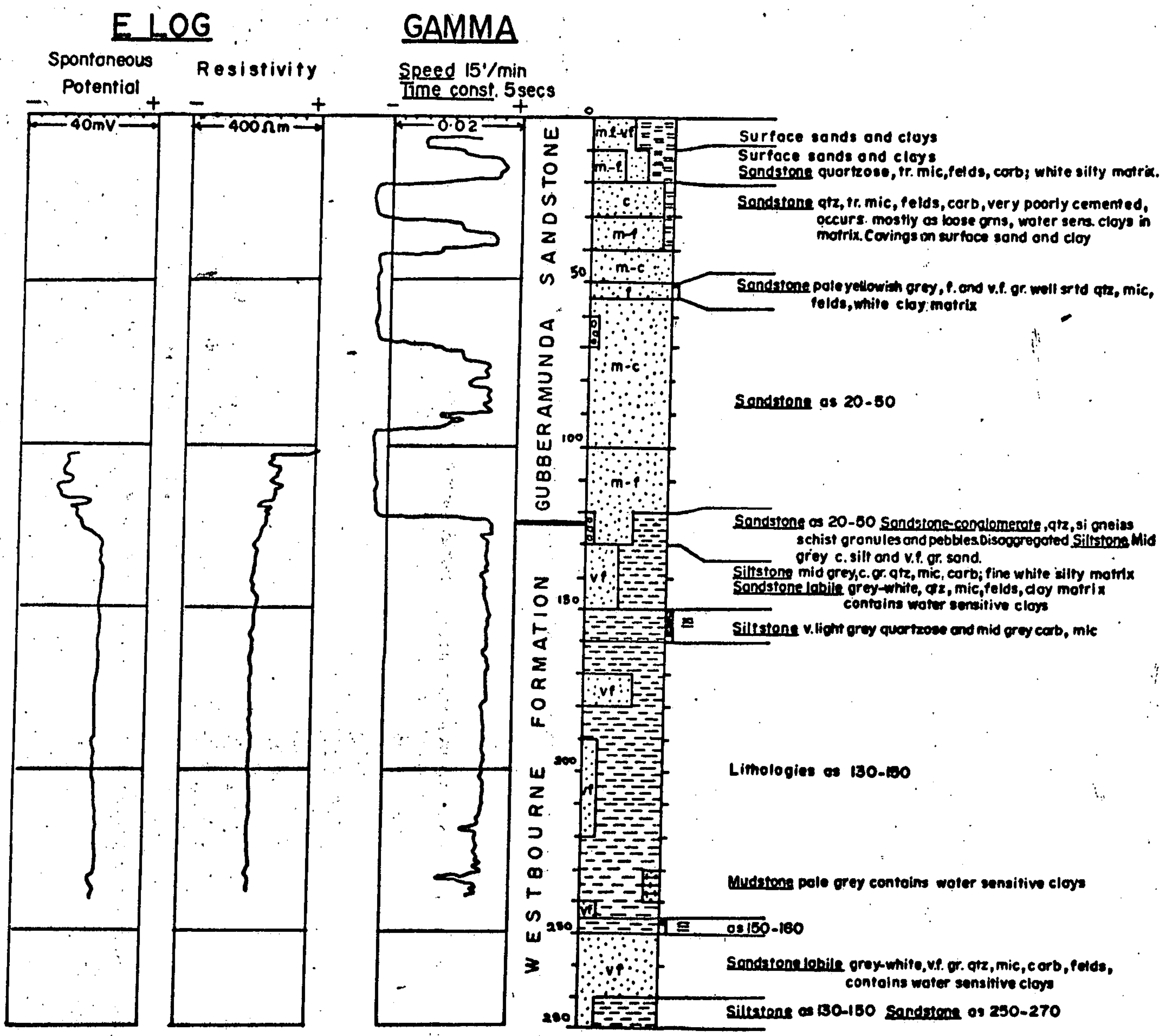
Beds of greenish-brown carbonaceous, micaceous, siltstone and mudstone, around 3 feet thick, are common, and similar clasts are found within the sandstone beds. Pebble bands consist largely of quartz, quartzite, chert, silicified sandstone, siltstone and mudstone, with lesser porphyritic acid volcanics and rhyolite. Asymmetrical ripple marks, worm casts, plant remains and impressions and fossil wood are found in some beds.

Shallow drill hole BMR Mitchell No. 2 (Fig. 5) in the eastern flank of the Merivale Syncline shows the lower 120 feet of the unit to be almost entirely fine to coarse grained quartzose sandstone with a little mica, feldspar, and clay matrix. The unit becomes more labile westwards.

The Gubberamunda Sandstone rests conformably on the Westbourne Formation and is overlain, also conformably, by the Orallo Formation. The contact between the Gubberamunda Sandstone and the Westbourne Formation is transitional. Typical Westbourne siltstones intertongue with medium grained quartz-rich sandstone beds, over a vertical interval of 20 feet, at an outcrop in the Maranoa River (609,744). Eight miles west of the Maranoa River, the unit grades laterally into the "Hooray Sandstone". Although outcrop is poor in the transitional area the brown, soft, generally non-pebbly Gubberamunda Sandstone is quite distinct from the white, hard, often pebbly and clayey "Hooray Sandstone". In addition, the Gubbermunda Sandstone is planar cross-bedded with current directions usually to the north-west in the transitional area, while the current directions in the "Hooray Sandstone" are mainly to the south-east. This facies change takes place between the Maranoa Anticline and the Forest Vale Anticline. The Gubberamunda Sandstone was deposited under fluviatile conditions with some lacustrine phases near the top of the sequence.

SHALLOW DRILL HOLE LOG

B. M. R. MITCHELL No. 2



WESTBOURNE FORMATION, GUBBERAMUNDA SANDSTONE

FIG. 5

G55/A11/7

To accompany Record 1966/90

It was deposited by streams which meandered greatly, but probably flowed north overall.

In the east of the area the formation is 200 to 250 feet thick compared with 200 feet thick in the type area; 120 feet of the unit was drilled in BMR Mitchell No. 2. In the subsurface further south, in AAO Arbroath No. 1, AAO Glenroy No. 1, and Amoseas Strathmore No. 1, it is about 100 feet thick.

No diagnostic macrofossils have been found in the Gubberamunda Sandstone; a few plant impressions, mainly stems, were found in the present survey, but none were identified. On microfossil evidence Evans (1966) places the unit in his J6 zone which is Upper Jurassic in age (Evans, in prep.).

ORALLO FORMATION

Day (1964) discussed the various names of this unit and formalized the name Orallo Formation to replace the Orallo Coal Measures of Jensen (1960), because the unit has no known workable coal. The unit is equivalent to the "Fossil Wood Stage" or "Series" of Reeves (1947). Day designated the type area as the vicinity of the Roma to Injune road via Orallo, between Nareeten and Hunterton. The formation name is derived from the village of Orallo which is within the type area. Typical rock types around Orallo are fine-grained, thin bedded siltstone and friable, medium to coarse grained, calcareous, labile sandstone; fossil wood is abundant. No type section was measured because the formation is poorly exposed.

The Orallo Formation crops out on the north Roma, south-east Eddystone and north-east Mitchell Sheet areas. Its surface expression is mostly a gently undulating plain with an open forest cover. Outcrops on the plains are sparse, but there are good exposures in ridges north of Walhallow Homestead.

The Orallo Formation is composed mainly of very fine grained, thin bedded, locally calcareous, sublabile to labile sandstone and siltstone. Medium-grained, grey and green, pebbly labile and sublabile sandstone with quartz fragments is also quite abundant. The coarser labile sandstone is usually medium to thick bedded and contains feldspar and dark rock fragments; this rock type is well exposed in the Maranoa River, two miles south of Vernview Homestead. Calcareous and ferruginous concretions in the sandstone are characteristic of the unit. Both the fine and medium-grained sandstones are planar and scour crossbedded; there is a dominant northerly current direction. Sections M2 (Plate 1) and M4 (Fig. 6), are representative of the Orallo Formation.

In general the upper part of the formation is dominantly siltstone, mudstone, and very fine grained sublabile sandstone (e.g. Section M2). Just below the top of the unit in the area about seven miles south-west of Currawarra Homestead there is a distinctive resistant bed of hard grey calcareous sandstone with quartz granules; this bed can be traced for some miles.

The lower part contains considerable fine to medium-grained, greenish sublabile to labile sandstone. Section E6 in the Eddystone Sheet area (Plate 1), shows the full sequence. Five thin sections of sandstone from this measured section illustrate the change from the lower to the upper part. In all five thin sections the shaly fragments (10 percent) and feldspar (5 percent) content remains constant. The quartz content increases from 30 to 75 percent, and the clay content decreases from 50 to 5 percent, upwards.

The Orallo Formation conformably overlies the Gubberamunda Sandstone and in turn appears to be overlain with regional conformity by the Blythesdale Formation. The change from the quartzose to sublabile Gubberamunda Sandstone, to the partially calcareous labile sandstone, siltstone and mudstone of the overlying Orallo Formation, is obvious in bulk, but somewhat transitional. The contact is taken at the top of the uppermost quartz-rich sandstone bed.

The unit thins west of the Maranoa River and ten miles west of Currawarra Homestead a tongue of white, clayey sandstone and minor conglomerate of the "Hooray Sandstone" separates the upper, fine grained part of the formation, from the lower sandy part. The contact with the lower part (585, 758) is scoured, and there is a basal conglomerate in the "Hooray Sandstone". The contact between the Blythesdale Formation and the upper part was not seen in this area. 14 miles west of Currawarra Homestead both parts of the Orallo Formation become unrecognisable, and give way to the "Hooray Sandstone". Some silty lithologies are still present in the "Hooray Sandstone" farther west, but they are not mappable.

Most of the sediments were probably deposited under conditions ranging from lacustrine to deltaic. Coarse-grained, immature sediments of the formation (especially abundant in the lower part of the unit) were deposited in a higher energy environment under fluviatile conditions.

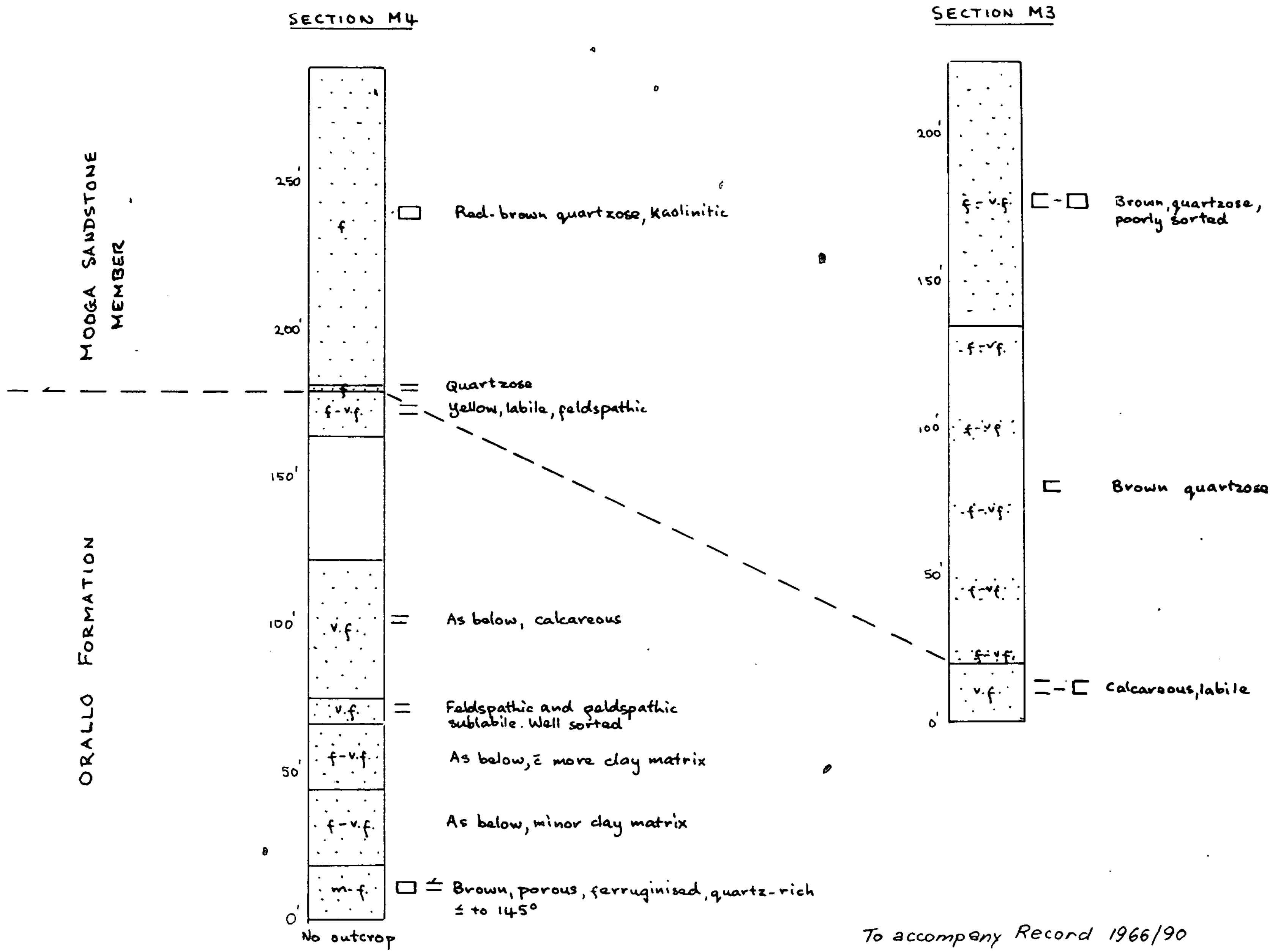
No plants were identified during this survey. Day (1964) listed numerous plants previously indentified from the formation, as well as ones which he collected. However, although the flora is extensive, he stated it "is too imperfectly known at present to be of much use for correlation and age determination". Microfossil evidence (Evans 1966) indicates that the unit belongs to Evan's spore division J6?, of Upper Jurassic age (Evans, in prep.).

BLYTHESDALE FORMATION

Day (1964) redefined the term "Blythesdale Formation" to resolve the confusion which has existed since Jack (1895) used "Blythesdale Braystone" for a "series of soft, grey, very friable sandstones, grits, and conglomerates" at the base of the Lower Cretaceous. The complicated history of the nomenclature of this formation is well explained by Day (op. cit.) and in this report his interpretation is followed. In the eastern part of the Mitchell 1:250,000 Sheet area, the Blythesdale Formation has been subdivided into four members:- Mooga Sandstone, Kingull, Nullawurt Sandstone and Minmi Members. The uppermost unit, the Minmi Member, is marine, while the remainder are freshwater. Day designated the type area of the Blythesdale Formation as near the intersection of Blyth Creek and Twelve Mile Creek in the Roma Sheet area.

The Kingull Member is unrecognisable west of Nade Homestead and it becomes impossible to separate the freshwater members. They are mapped together as undifferentiated Blythesdale Formation, with only the Minmi Member mapped separately. An arbitary straight-line boundary has been drawn at the approximate position of the facies change.

West of Nade Homestead the Blythesdale Formation consists mainly of white and buff, thinly to thickly bedded, fine and very fine-grained quartzose sandstone. There is also some feldspathic sublabile sandstone. Medium-grained, poorly sorted quartzose sandstone and siltstone beds are abundant in the upper part of the unit. Planar crossbedding iswell developed with the main current directions from the north and east.



MEASURED SECTIONS M3 & M4

ORALLO FORMATION, MOOGA SANDSTONE MEMBER

Measured by D.J. Casey.

SECTION M3 measured up hill 4 miles NE of Katanga Homestead (Mitchell, Run 1, Photo 5038, Point 197)

SECTION M4 measured up hill 7 miles NE of Katanga Homestead (Mitchell, Run 1, Photo 5038, Point 196)

FIG. 6

To accompany Record 1966/90

G55/A11/8

The four members of the Blythesdale Formation in the eastern part of the Mitchell Sheet area and the undifferentiated Blythesdale Formation farther west, are described below.

Mooga Sandstone Member

Day nominated the type area of this unit as near the junction of Bungil and Mooga Creeks on the Roma Sheet area where mainly white to light buff, fine-grained quartz sandstone with minor siltstone interbeds crop out.

The Mooga Sandstone extends in a belt of varying width across the north-east of the Mitchell Sheet area; it is only mapped out in the north-east corner of the Sheet. It is well exposed in numerous scarps, with the best sections in basalt-capped cliffs near Kilmorey Homestead. Sections M2 (Plate 1) and M3 and M4 (Fig. 6) are typical of the Mooga Sandstone in the area. Brown and white, medium bedded, fine and very fine-grained, well sorted, quartzose to lithic sublabile sandstone makes up most of this fluviatile sequence. Beds of slightly coarser quartzose sandstone and also of siltstone are quite common. Strongly developed planar bedding is a feature of the unit; current directions indicate derivation from the north and east. Lower Jurassic sandstones which crop out on the north of the Eddystone and Taroom Sheet areas could be the source rocks for the Mooga Sandstone.

An accurate determination of the thickness of the member cannot be made because gentle folding has produced dips which vary considerably across the area of outcrop. However the Mooga Sandstone is appreciably thicker than in the type area where Day (op. cit.) estimated the thickness at 200 feet; south of Stewart's Creek Homestead the unit could be up to 400 feet thick. The thickness of the Mooga Sandstone in the subsurface from east to west is about:-
150 feet in AAO No. 1 (Roma), 300 feet in AAO Arbroath No. 1 and 350 feet in Amoseas Strathmore No. 1.

Kingull Member.

The type area for this member is in the vicinity of Kingull Siding, on the Roma-Injune railway (Day, op. cit.). This unit approximately corresponds to the "Minka Beds" of Jensen (1960) but Minka Siding is south of its area of outcrop. In the type area, calcareous, micaceous siltstone, carbonaceous shale and medium -grained, calcareous labile sandstone are exposed.

The Kingull Member is a poorly outcropping unit which extends in a narrow belt across the eastern part of the Mitchell Sheet area. It forms an area of low relief with occasional rubbly outcrops.

Calcareous, very fine-grained, grey, labile sandstone is the main outcropping rock type, while fine-grained sublabile sandstone is also common. Calcareous sandstone concretions occur in places. The Kingull Member becomes gradually sandier and less calcareous to the west until it cannot be distinguished from the other freshwater members of the Blythesdale Formation east of Nade Homestead.

In the type area the Kingull Member is about 200 feet thick (Day, op. cit.) but in the area of this survey it probably does not exceed 100 feet. An accurate measurement of thickness is not possible because of the paucity of outcrop.

Nullawurt Sandstone Member

Day (op. cit.) designated the type area of this member as near Nullawurt Siding on the Roma-Injune railway line. Typically, the unit is composed of yellowish-brown, fine to very fine-grained quartzose sandstone and a few, thin grey shale beds. In the area covered by this report, the Nullawurt Sandstone Member consists mainly of thin to thick bedded, fine and very fine-grained, slightly lithic, well sorted quartzose sandstone. Sublabile sandstone and thin beds of siltstone are subsidiary. In places, ripple marks and planar cross-bedding are developed, but the current bedding does not show any consistent orientation.

The Nullawurt Sandstone Member is approximately 100 feet thick in the Mitchell Sheet area, compared with 50 feet in the type area. It is well exposed in low ridges over most of the area of outcrop.

Minmi Member

Day (1964) named this unit after Minmi Crossing, the type area, which is four miles north of Roma. In the Mitchell Sheet area, the exposed sediments are dominantly fine and medium-grained calcareous glauconitic quartz-rich sandstone and calcareous sublabile sandstone; they commonly form large ovate exposures up to ten feet across. Similar sandstone without a calcareous cement is very common in the stratigraphic column but it rarely crops out. Scattered clayey siltstone fragments, and coarse-grained sandstone lenses and laminae also occur. Minor amounts of siltstone and mudstone are present.

The member is generally poorly exposed in rubbly outcrops and its topographic expression is rolling downs. It can be traced in almost continuous outcrops as far west as Dunedin Homestead, about six miles west of the Maranoa River. Farther west, sand cover commonly obscures the member. Fine and medium grained sandstone similar to sandstone of the Minmi Member between Mitchell and Roma, occurs in the Roma Formation north-west of Dulbydilla Homestead (5450, 7290), north-east of Mount Maria (5445, 7370 and 5420, 7909) and below the diricrust profile south of Amoseas Dulbydilla No. 1 (5440, 7163). If outcrops were better, some or all of these localities may have been mapped as Minmi Member and not Roma Formation.

BMR Mitchell No. 1 and Amoseas Dulbydilla No. 1 contain, dominantly, sandstone typical of the Minmi Member in the type area (see Plate 2). Thus the apparently dominant "mudstone" east of Dunedin Homestead must largely be soft friable non-outcropping sandstone.

BMR Mitchell No. 7 (Plate 2), west of the Maranoa Anticline near Orkadilla Homestead, drilled directly from the Roma Formation into the "Hooray Sandstone"; the Minmi Member was absent. Quartz granules occur in the mudstone of the Roma Formation 60 feet above its base. The granule-bearing beds and the sandstone seen in outcrop are thought to occur within the basal 100 feet of the Roma Formation, which may be stratigraphically equivalent to the Minmi Member between Roma and Mitchell.

The presence of animal trails, worm tubes, thin intraformational mudstone-pebble conglomerates and the abundance of burrowing bivalves and fossil wood, indicate a very shallow-water near-shore environment.

It appears that the Minmi Member was deposited between the Nebine Ridge and Roma and, if deposited west of the Nebine Ridge, was eroded prior to deposition of the Roma Formation. This is evident from the unconformity at the top of the "Hooray Sandstone" in BMR Mitchell No. 7.

In the type area the member is 70 feet thick. North of Mitchell in BMR Mitchell No. 1 it is 140 feet thick; 28 miles farther west BMR Mitchell No. 4 intersected 110 feet; while still farther west in Amoseas Dulbydilla No. 1 a few miles east of the crest of the Maranoa Anticline, the member is 110 feet thick. West of the Maranoa Anticline, in BMR Mitchell No. 7, the member was absent.

In places marine fossils indicating an Aptian age (see Appendix 2), and wood fragments are abundant. In the Mitchell Sheet area, the bivalve Maccoyella barklyi is 2¼ to 4 inches long in the Minmi Member, but the same species is much smaller in the Roma Formation. This relationship is not apparent in the type area near Roma. Spores and dinoflagellates of Evan's division (1966), Klb have been identified in drill holes in the member (see Appendix 3).

Undifferentiated Blythesdale Formation

West from Nade Homestead, to where the Orallo Formation pinches out west of the Maranoa River, only the green, glauconitic Minmi Member can be readily distinguished from the rest of the Blythesdale Formation. This is because the silty Kingull Member has pinched out, leaving the Nullawurt Sandstone overlying the similar Mooga Sandstone. The interval Mooga Sandstone/Nullawurt Sandstone was mapped, and is discussed below, as undifferentiated Blythesdale Formation.

The sequence can, in places, be subdivided into a lower sandstone sequence, and an upper sandstone, siltstone and mudstone sequence. The lower sandstone sequence corresponds to the Mooga Sandstone, and the upper sequence to the Kingull Member plus the Nullawurt Sandstone. Unfortunately, extensive sand cover, and generally poor outcrop, makes it impossible to subdivide the unit in many areas. A two-fold division into Mooga Sandstone, and upper silty part plus Minmi Member is evident in the subsurface in wells to the south. Each division is about 300 feet thick, with the Mooga Sandstone thickening slightly westwards.

Lower sandstone sequence (Mooga Sandstone)

This sequence is well illustrated in Section M2 (Plate 1), where it consists largely of very fine to medium grained, white to buff, quartzose sandstone grading to siltstone. This material varies from thinly to thickly bedded, and is often well bedded. High-angle crossbedding is often developed and, although very variable, azimuth readings generally suggest deposition by streams flowing to the east. The sandstone generally contains a little feldspar and rock fragments and, in places, muscovite. Plant remains and clay clasts are quite common. A considerable thickness of white claystone, about 150 feet above the base of this section, may well be a correlate of the claystone south of Mount Elliott Homestead, within the "Hooray Sandstone". Elsewhere, within this sequence the quartzose sandstone grades to similar feldspathic sublabile sandstone. Ripple marks occur in places. The contact with the underlying Orallo Formation is transitional in places, and scoured in others.

The distinctive fine grained well-bedded sandstone of the lower part of the sequence can be traced from some distance into the "Hooray Sandstone", west of the arbitrary boundary between the Blythesdale Formation and that unit.

Upper silty sequence

This sequence, which is about 200 feet thick, is well exposed along Mannandilla Creek, west of the Maranoa River. It consists of interbedded quartzose sandstone identical to that of the lower sequence, siltstone and mudstone. The sandstone is white to buff, very fine to fine grained and is generally thinly to medium bedded and crossbedded. In places it contains ripple marks, worm casts, and plant remains. Isolated crossbedding azimuth readings suggest deposition from streams flowing to the east. The siltstone and mudstone is brownish-grey, carbonaceous and often micaceous. It forms thick, laminated to thinly bedded sequences.

Relationships, deposition, age of the Blythesdale Formation

The Blythesdale Formation is apparently regionally conformable on the Orallo Formation. However, there was probably a break in sedimentation before deposition of the Blythesdale Formation, as the uppermost Orallo Formation is ferruginised in places (e.g. Section E5, Plate 1). In the west of the Mitchell Sheet area, the Orallo Formation intertongues with the "Hooray Sandstone" and it is not possible to separate the Blythesdale Formation from the lithologically similar "Hooray Sandstone". Hence the Blythesdale Formation is included in the "Hooray Sandstone" from 4 miles east of Mt. Elliott, with an arbitrarily placed straight-line boundary between the two formations.

Reworked Permian and Triassic spores (Appendix 3) in the Blythesdale Formation suggest that the margins of the basin had been uplifted, prior to Blythesdale times, and the pre-existing sediments were being eroded and redeposited in the basin, during Blythesdale sedimentation. In the basin these sediments were conformable with the earlier sequence.

The Mooga and Nullawurt Sandstone Members were both probably deposited under fluviatile conditions; conditions of sedimentation were fairly uniform throughout the area as there is little lateral variation in either member. Finer sediments and an abundance of calcareous material in the Kingull Member suggest deposition in a restricted lacustrine environment. The Minmi Member represents a transition from freshwater to marine conditions. From evidence on the Roma Sheet area, Day (op. cit.) suggests that part of the Minmi Member could be a near-shore facies equivalent of sediments in the lower part of the Roma Formation.

Marine fossils from the Minmi Member indicate that it is of Aptian age but as yet it cannot be distinguished from the Roma Formation on palaeontological evidence. Microfloral evidence (AAO, 1961) suggests an Upper Jurassic age for the base of the Formation but the exact position of the Jurassic-Cretaceous boundary cannot be fixed.

CRETACEOUS

ROMA FORMATION

Whitehouse (1926) first named this unit the "Roma Series" after Roma town. In 1954 he renamed it the Roma Formation, and designated the type area as "The banks of Bungeworgorai Creek just north and south of the railway line". Day (1964 and pers. comm.) considers that a section about fifty feet thick in the uppermost part of the unit is exposed in the type area, and that the total thickness of the unit in the type area ia about 200 feet.

The unit crops out over much of the Surat Basin, and in the south-east part of the Eromanga Basin. It crops out in a latitudinal belt in the south of this area and generally forms rubbly outcrops in areas of typical rolling downs topography. Good exposures are to be seen north of Mitchell in the banks of the Maranoa River, and in Amby Creek and its tributaries north of Amby.

The formation is dominantly dark blue-grey mudstone, commonly gypsiferous, in places calcareous, and locally fossiliferous. The mudstone is massive, laminated, or thinly laminated. Fine and coarse grained sublabile glauconitic siltstone occurs as very thin beds and laminae. These were seen only in the best exposures, and have not been observed in the rubbly outcrops of the rolling downs. The lower 100 feet of the formation, includes mudstone and minor fine grained glauconitic sandstone; the mudstone contains angular quartz granules. The stratigraphic significance of these sediments is discussed with the underlying Minmi Member.

The formation conformably overlies the Minmi Member of the Blythesdale Formation at Roma, and probably as far west as the Maranoa Anticline. West of there, the unit is nowhere seen in contact with an underlying unit in outcrop, but in BMR Mitchell No. 7 (Plate 2), the Roma Formation directly overlies yellow-brown, apparently weathered, "Hooray Sandstone". The Minmi Member is missing. This may be evidence of an unconformity. The formation is unconformably overlain by Tertiary Quartzose sandstone, silty claystone and unconsolidated Cainozoic alluvium.

The presence of marine fossils, the fine grain size of the sediments and the rhythmic fine bedding indicate deposition in quiet shallow marine conditions. Some bottom disturbance by burrowing organisms and bottom current action is indicated by the intermingling of siltstone and mudstone laminae and fragments.

The total thickness of the unit in this area is not known, because nowhere has the top of the unit been identified. However several hundred feet are present.

A rich marine molluscan fauna of Aptian age is found at a few widely spaced localities (Appendix 2). Abundant fossil logs, to 6 feet in length, are commonly associated with the marine fossils.

CAINOZOIC

The Cainozoic rocks are represented by Tertiary basalt, well bedded coarse terrestrial clastic sediments, and poorly bedded clayey sandstone.

For convenience in the field, and on the map, the well bedded sediments have been referred to as Tertiary, whereas the poorly bedded clayey sandstone, which probably post-dates the well bedded sediments, has been called "undifferentiated Cainozoic". It is believed that the "Hooray Sandstone", throughout Cainozoic times, has been continually weathered. The derived sand has been eroded, carried south by streams from the high sandstone area, and deposited as Tertiary sandstone and conglomerate on the plains of the Roma Formation. In more recent times, some weathered sands, on sandy Jurassic/Cretaceous units, have been consolidated in situ - these are referred to as "undifferentiated Cainozoic".

Tertiary basalt

Erosion residuals of finely prophyritic and glassy basalt occur, as plateau cappings, occupying about 20 square miles in the eastern half of the area. These erosion residuals are probably remnants of a single sheet of basalt which occupied a topographic depression corresponding to the axial region of the Merivale Syncline, and which was thicker nearer the axis. The basalt remnants are probably not more than 50 feet thick.

One specimen of basalt, examined in thin section, contains about 30% augite phenocrysts and 45% anhedral andesine in a glassy groundmass. A Tertiary age has been assumed for this basalt because it unconformably overlies the Aptian Roma Formation and because the topographic reversal and extensive erosion is considered to preclude a younger age. Similar basalts farther north (Mollan, 1965) are of Tertiary age. There is a little soil developed on the basalt and the plateaux are well-grassed.

Tertiary Sediments

Well-bedded cemented fluviatile deposits of quartz-rich to labile sandstone and pebble conglomerate which unconformably overlie the Roma Formation and, to a lesser extent, older rocks, have been designated "Tertiary". They occupy a large part of the western half of the area and a much lesser area in the east.

The sandstone is similar to sandstone of the "Hooray Sandstone" and has been derived largely from this formation. In places, the outcrop surface of these sediments is characterized by small mounds of ferruginous sandstone, 2 to 3 feet high; these were colloquially called "niggerheads" in the field. They were not seen on the surface of outcrop of older sandstone.

Undifferentiated Cainozoic sediments

Included in this category is poorly bedded to massive clayey sandstone consolidated, in situ, on Jurassic-Cretaceous sandy units. These sediments occur as small outliers. They are particularly common in the north-western part of the area. Also, included in the Cainozoic sediments is duricrust (lateritic), developed on the Roma Formation.

QUATERNARY

Unconsolidated sands, gravels and clays deposited in the beds, flood plains and outwash fans of present-day rivers, are considered to be Quaternary (Qa). General sand and soil cover which is also regarded as Quaternary, is mapped as Qs.

STRUCTURE

The Mitchell Sheet area is crossed by a number of sub-meridionally trending folds which have been indicated by field mapping and can be related to structures revealed by gravity (BMR. 1964) and magnetic surveys (Magellan Petroleum Corp., 1965). All the major structures are gentle warps, often related to basement trends. The Maranoa Anticline and Merivale Syncline, were high and low areas respectively, throughout Jurassic and Cretaceous times. The structures are discussed in order, from west to east.

Maranoa Anticline

The Maranoa Anticline extends from the Eddystone Sheet area, through 147° 24'E, at the northern edge of the Mitchell Sheet area, and thence southwards across the map. A plunge to the south of 10-20 feet per mile is evident from comparison of the relative positions of the top and bottom of the "Hooray Sandstone" along the crest of the structure.

The anticline overlies the Nebine Ridge, a basement ridge which crops out near the centre of the Eddystone Sheet area. Gentle movement along this buried ridge has warped the Jurassic/Cretaceous sediments into the Maranoa Anticline. The Bouguer anomaly map (BMR., 1965) shows a pronounced maximum coinciding with the anticline. The magnetic intensity map (BMR, 1964b) shows a number of pronounced elongated maxima, separated by broad saddles, along the axis of the structure.

The amount by which the basement rises on the ridge at approximately 26° 30'S is indicated by the depths to basement in the Mitchell town bore (2485 feet), the Morven town bore (2980 feet), and Amoseas Dulbydilla No. 1 (2008 feet) which was drilled near the crest of the Maranoa Anticline. The "Hooray Sandstone" thins from 400 feet a few miles west of the anticline, to 300 feet on its crest.

Mount Scott Syncline

This gentle south-plunging structure is parallel to and east of the Maranoa Anticline. The structure coincides with a depression in magnetic basement and an easterly decrease in gravity values.

Forest Vale Anticline

The Maranoa River flows along the axis of this structure in this area. It occurs on the eastern side of a magnetic basement depression. A gravity depression corresponds with the anticlinal axis at the northern boundary of the Mitchell Sheet area, but farther south, along the axis, no systematic relationship with gravity data can be detected.

Merivale Syncline

This large structure extends southwards across the map from 148° 15'E on the northern boundary of the Sheet area. It coincides with a broad "high" on the Bouguer anomaly map. The presence of Tertiary basalt along the axis of the syncline is thought to be the reason for the presence of pronounced magnetic basement highs along the synclinal axis north of 26° 15'S. South of this latitude the syncline follows an ill-defined depression in the magnetic basement. The Merivale Anticline appears to have been a low area during deposition of the Birkhead and Westbourne Formations which are much thicker in the syncline than elsewhere (Exon, 1966).

Dear Sir,

Alicker Anticline

Receipt is acknowledged of your letter dated

This is a broad gentle structure in the extreme east of the area complementary to the Merivale Syncline. It is not discernible on the geophysical maps, and is probably of post-Jurassic age.

Yours faithfully,

Katanga Anticline, Nade Syncline, Taboonbay Anticline

These three small strucutres occur immediately east of the axis of the Merivale Syncline. They lie on the trend of the Merivale Fault (Mollan, Forbes, Jensen, Exon and Gregory, in prep.). This fault, in the Eddystone Sheet area, is downthrown to the west, and the anomalously steep western limb of the Katanga Anticline is believed to be the surface expression of the fault.

(J.M. Rayner)
Director

ECONOMIC GEOLOGY

Water

Underground Water

Sub-artesian aquifers are an important source of water in the Mitchell area, although flowing bores are a rarity. In the east the best supplies, both for quality and quantity, come from the Gubberamunda Sandstone; higher in the sequence good supplies of potable water come from the Mooga Sandstone Member and from sands in the Orallo Formation. In the west, the "Hooray Sandstone" provides good supplies of potable water. Numerous bores have been drilled into the Injune Creek Group but only small, brackish supplies were obtained. It would be better for owners of properties on this formation to drill to the Hutton Sandstone, an extremely good aquifer. Although this would require drilling to about 1,200 feet it would be more economical than drilling three or four 500 foot bores in the Injune Creek Group. Chemical analyses of water from many registered water bores are available in the files of the Queensland Irrigation and Water Supply Commission, Brisbane.

Surface Water

There are numerous earth tanks and dams, in and near creeks, gullies and depressions, especially in areas of clayey soil These tanks and dams are particularly common on the black and brown soil of the Roma Formation and the Injune Creek Group.

Oil and Gas

Only two wells have been drilled in the search for oil and gas in this area, and a general summary of them is given in Table 1.

The reason for the general lack of interest in this area, despite intensive drilling in the nearby Roma area, is the shallowness of prospective basement. The two wells drilled reached basement at about 2,000 feet. Also practically the whole sequence is of freshwater origin.

There has been more interest in the south-eastern part of the Sheet area, where basement is considerably deeper, and this is the most likely area for future drilling. Four dry wells have been drilled so far in that area - Amoseas Strathmore No. 1, AAO Glenroy No. 1, AAO Lorne No. 1, and AAO Arbroath No. 1. The first two reached basement between 3,000 and 4,000 feet. The other two were drilled in the Arbroath Trough (a southern extension of the Merivale Syncline), and are considerably deeper (8366 feet in Arbroath No. 1). The Arbroath Trough, with its thick sequence, is probably the most prospective area.

The discovery of traces of oil in sandstone cores in the Minmi Member of the Blythesdale Formation, in two shallow holes drilled during this survey (see Appendix 1; and Galloway and Duff, 1966), is of interest. If the Minmi Member is found to be present in future wells, a drill stem test in it would be justified. Other targets in holes to the south are the Triassic Precipice and Boxvale Sandstones, and sands in the Permian sequence.

Construction Materials

Shipway (1962) inspected a basalt quarry near Amby township, just south of the area mapped. Up until 1962 this quarry had produced 70,000 yards of aggregate. Very large reserves of good quality rock exist both north and south of the quarry; the northern reserves extend on to the area mapped. Other basalt flows in the area mapped are also suitable for use as road metal if required.

Coal

The only important coal-bearing sequence in the area is in the Birkhead Formation. The major coal seams, one of which was worked in the Maranoa Colliery at Injune, about 15 miles to the north-east, are several hundred feet below the exposed sequence in this area. The Maranoa Colliery has closed, and at present there is no demand for such coal.

Clay

Within the "Hooray Sandstone" there is at least one thick claystone sequence. This is best exposed in a scarp 20 miles north of Mungallala (572, 747), on the Mungallala/Mount Elliott Homestead road. There is 35 feet of white, thinly bedded to massive claystone in this exposure. Analysis of a random sample, by A.M.D.L., showed it to contain kaolinite and illite, with kaolinite dominant.

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APPENDIX 1

CORE ANALYSIS RESULTS FROM SHALLOW DRILL HOLES IN THE MITCHELL SHEET AREA

by

P.G. Duff

Following tentative microscopic identification of oil in several cores in the Minmi Member of the Blythesdale Formation by Galloway, Duff carried out core analysis on all cores from shallow drill holes BMR Mitchell Nos. 1, 4 and 7. Traces of oil were extracted from cores 1 and 2 in Mitchell No. 1, and from core 1 in Mitchell No. 4. All these cores were in the Minmi Member. The results of all analyses are tabulated hereafter.

This oil discovery was reported in Galloway and Duff (1966).

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CORE ANALYSIS RESULTS

Note: (i) Unless otherwise stated, the porosities and permeabilities were determined on two small plugs (V&H) cut at right angles from the core. Ruska porosimeter and permeameter were used with, air at 30 p.s.i.g. and dry nitrogen, respectively, as the saturating and flowing media. (ii) Residual oil and water saturations were determined using soxhlet type apparatus. (iii) Acetone test precipitates are recorded as nil, trace, fair, strong or very strong.

Well name and No. B.M.R. Mitchell S.H. No. 4 — Date of test 29th March 1966

Core No.	Depth From: To:	Lithology	Average Effective Porosity from 2 plugs (% Bulk Vol.)	Absolute Permeability (Millidarcy) V	H	Average Density (gm/cc.) Dry Bulk	Apparent Grain	Fluid Saturation (% of pore space) Water	Oil	Acetone Test	Core Water Salinity (P.P.M. NaCl)	Solubility in 15% HCl (% Bulk Vol.)	Fluroescence of freshly broken core
1	88' 0" 88' 6"	Shale & sandstone	Fine cracks formed on drying, results unreliable.					23 +	Less than 1 +	Fair	N.D.	N.D.	Dull yellow
2	200' 8" 201' 4"	Sandstone	36	2,040	3,070	1.67	2.61	1	Nil	Nil	"	"	Nil
2	202' 0" 202' 8"	"	36	1,720	1,850	1.69	2.65	N.D.	N.D.	N.D.	"	"	N.D.
3	266' 1" 266' 9"	"	28	3	28	1.94	2.69	Nil	Nil	Nil	"	"	Nil
4	305' 10" 306' 5"	"	31	20	23	1.88	2.74	Nil	Nil	Nil	"	"	Nil
5	395' 10" 396' 5"	"	37	2,930	4,000	1.69	2.67	N.D.	N.D.	N.D.	"	"	N.D.
5	397' 7" 398' 0"	"	35	2,200	4,500	1.72	2.67	2	Nil	Nil	"	"	Nil

\+ Assuming 20% porosity

Remarks: Some oil from core 1

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CORE ANALYSIS RESULTS

Note:- (1) Unless otherwise stated, the porosities and permeabilities were determined on two small plugs (V&H) cut at right angles from the core. Ruska Porosimeter and permeameter were used with, air at 30 p.s.i.g. and dry nitrogen, respectively, as the saturating and flowing media. (ii) Residual oil and water saturations were determined using soxhlet type apparatus. (iii) Acetone test precipitates are recorded as nil, trace, fair, strong or very strong.

Well name and No. B.M.R. Mitchell S.H. No. 1

Date of test 29th March 1966

Core No.	Depth from: to:	Lithology	Average effective Porosity from two plugs (% Bulk Vol.)	Absolute Permeability (Millidarcy)		Average Density (gm/cc.)		Fluid Saturation (% of pore space		Acetone test	Core Water Salinity (P.P.M. NaCl)	Solubility in 15% HCl (% Bulk Vol.)	Fluorescence of freshly broken core
				V	H	Dry Bulk	Apparent Grain	Water	Oil				
1	53' 6"	Sandstone & siltstone	Fine cracks formed when drying. results not reliable					64 +	Less than 1 +	strong	N.D.	N.D.	Greyish glow
2	127'11" 128' 6"	"	as above					60 +	" +	"	"	"	"
2	130' 4" 130'11"	Sandstone	36	N.D.	N.D.	1.71	2.67	16	"	Nil	"	"	Dull yellowish
2	133' 9" 134' 6"	"	35	78	960	1.76	2.71	3	Nil	"	"	"	"
3	276' 9" 277' 2"	"	30	1	1	1.96	2.80	11	"	"	"	"	Nil
3	278' 6" 279' 0"	"	30	3	5	1.93	2.75	8	"	"	"	"	"
3	279' 4" 279'10"	"	30	2	3	1.93	2.76	8	"	"	"	"	"
3	283' 0" 283' 8"	"	28	1	2	1.96	2.75	10	"	"	"	"	"
4	346' 5" 346'11"	"	26	Nil	40	1.96	2.69	6	"	"	"	"	"
4	349' 1" 349' 8"	"	25	"	15	2.04	2.73	4	"	faint trace	"	"	"

In interbedded sandstone & shale sections, the dull fluorescence was observed only in the sandstone. Acetone tests were carried on separated shale and sandstone pieces, positive results were obtained from both.

+ Assuming 20% porosity, oil extracted from the first three samples was whitish yellow and waxy, fluorescence greenish yellow.

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CORE ANALYSIS RESULTS

Note: (i) Unless otherwise stated, the porosities and permeabilities were determined on two small plugs (V&H) cut at right angles from the core. Ruska porosimeter and permeameter were used with, air at 30 p.s.i.g. and dry nitrogen, respectively, as the saturating and flowing media. (ii) Residual oil and water saturations were determined using soxhlet type apparatus. (iii) Acetone test precipitates are recorded as nil, trace, fair, strong or very strong.

Well name and No. B.M.R. Mitchell S.H. No. 7 Date of Test 29th March 1966.

Core No.	Depth From: to:	Lithology	Average effective Porosity from 2 plugs (% BUlk Vol.)	Absolute Permeability (Millidarcy)		Average Density (gm/cc.)		Fluid Saturation (% of pore space)		Acetone Test	Core Water Salinity (P.P.M. NaCl)	Solubility in 15% HCl (% Bulk vol.)	Fluorescence of freshly broken core
				V	H	Dry Bulk	Apparent grain	Water	Oil				
1	80' 7" 81' 0"	Sandstone ironstained	30	N.D.	+	1.95	2.79	26	Nil	Nil	N.D.	N.D.	Very dull yellow brown
1	84' 0" 84' 7"	Sandstone & Mudstone	30	N.D.	+	1.89	2.69	30	"	"	"	"	Dull yellow-white
2	87' 0" 87' 8"	"	31	N.D.	+	1.86	2.70	47	"	"	"	"	Dull whitish
2	87' 8" 88' 4"	"	29	N.D.	+	1.92	2.71	51	"	"	"	"	"
3	92' 0" 92' 7"	Siltstone & Shale	229	N.D.	+	1.92	2.65	N.D.	N.D.	N.D.	"	"	Nil
4	97' 2" 97' 9"	Siltstone, sand-stone, mudstone	32	N.D.	+	1.80	2.65	"	"	"	"	"	Nil
5	102' 0" 102'10"	Siltstone fine cracks developed on drying, Results unreliable											
6	107' 6" 108' 0"	Siltstone	33	N.D.		1.80	2.69	N.D.	N.D.	N.D.	N.D.	N.D.	Nil
7	125' 9" 126' 3"	"	Fine cracks developed on drying Results unreliable					26 ¢	Nil	Nil	"	"	Dull yellowish
8	141' 3" 141'10"	Sandstone	30	256	139	1.97	2.81	12	"	"	"	"	Whitish glow
9	157' 5" 157'11"	Calcareous Sandstone, carbilaminal	38	71	N.D.	1.70	2.75	53	Trace only @	Fair	"	"	Nil
10	180'11" 181' 6"	Sandstone	Fine cracks developed on drying results unreliable					N.D.	N.D.	N.D.	"	"	"
10	182' 6" 183' 0"	siltstone & claystone	31	N.D.	Nil	2.22	3.12	26	Nil	Nil	"	"	"
11	218' 7" 219' 1"	Sandstone	33	28	34	1.86	2.76	8	Nil	Nil	"	"	"
12	260' 0" 260' 7"	Sandstone	34	31	34	1.78	2.70	N.D.	N.D.	N.D.	N.D.	N.D.	Nil
12	264' 0" 264' 6"	"	35	2,579	2.661	1.73	2.65	Nil	Nil	Nil	"	"	Nil

\+ Because of the friable nature of the formation regular plugs could not be cut therefore permeabilities could not be determined.
¢ Assuming 30% porosity
@ Probably derived from carbonaceous material.

APPENDIX 2

APTIAN MACROFOSSILS FROM THE NORTHERN HALF OF THE MITCHELL 1:250,000 SHEET AREA

by

R.W. Day

Of 14 collections reported here, 3 (GAB 1942, 1950 and 2168) are from the Minmi Member of the Blythesdale Formation, the remainder are from the Roma Formation. The collections from the Roma Formation are reported in their approximate stratigraphic order.

MINMI MEMBER

Locality:	GAB 1942: Tributary of Pegleg Creek, just E. of Mitchell - "Forestvale" road (m.r. 618725)
Collectors:	D.J. Casey, R.W. Day, M.C. Galloway
Lithology:	Fine grained, glauconitic, calcareous sandstone
Determinations:	Maccoyella barklyi (Moore) Fissilunula clarkei (Moore) "Gari" cf. elliptica Whitehouse Nuculana sp. ind. ? Nucula sp. ind. Indet. trigonid Indet. belemnite fossil wood
Age :	Aptian
Locality:	GAB 1950: Burgagay Creek, about ½ mile SE of where the Amby - "Walhallow" road crosses (m.r. 645720)
Collector:	D.J. Casey
Lithology:	fine grained, calcareous sandstone
Determinations:	Fissilunula clarkei (Moore) Tatella maranoana (Etheridge Jnr.) Lingula cf. subovalis Davidson
Age:	Aptian
Locality:	GAB 2168: Tributary of Amby Creek from E. about 2½ miles WSW of "Echo" (m.r. 652717)
Collector:	M.C. Galloway
Lithology:	fine grained, glauconitic, calcareous sandstone
Determination:	Maccoyella barklyi (Moore) fossil wood
Age:	Aptian

APPENDIX 2 (cont)

ROMA FORMATION

Locality: GAB 2162: E. bank of Maranoa River about 6 miles NNW of Mitchell (m.r. 611720)

Collector: M.C. Galloway

Lithology: Calcareous mudstone, silty limestone concretions and glauconitic siltstone

Determinations: Pseudavicula anomala (Moore)
Camptonectes socialis (Moore)
Cyrenopsis cf. meeki (Etheridge Jnr.)
Nuculana randsi Etheridge Jnr.
"Nucula" sp. ind.
Tatella? sp. 1
Laevidentalium sp.

Age: Aptian

Locality: GAB 2163: 75 feet NE of GAB 2162

Collector: M.C. Galloway

Lithology: Calcareous mudstone and glauconitic siltstone

Determinations: Tropaeum cf. leptum (Etheridge Jnr.)
Maccoyella barklyi (Moore)
Pseudavicula anomala? (Moore)
Camptonectes socialis (Moore)
Nuculana randsi Etheridge Jnr.
? Cyrenopsis sp. ind.
Euspira reflecta? (Moore)
Laevidentalium sp.
crinoid pinnules
fossil wood

Age: Aptian (Probably Upper Aptian)

Locality: GAB 2166: near roadside about 2½ miles ENE of "Gap plains" (m.r. 636727)

Collector: M.C. Galloway

Lithology: limestone concretions and glauconitic siltstone

Determinations: Maccoyella barklyi (Moore)
Pseudavicula anomala (Moore)
Panopea maccoyi (Moore)
Onestia cf. etheridgei (Etheridge Jnr.)
Pholadomya sp.
Nuculana sp. ind.
? Cucullaea sp.
Peratobelus sp. ind.
Purisiphonia clarkei (Bowerbank)
Lingula cf. subovalis Davidson
Isocrinius sp. ind.
Indet. rhynchonelloid brachiopod
worm burrows

Age: Aptian

Locality: GAB 2169: small creek about 3 miles S of "Echo" (m.r. 656713)

Collector: M.C. Galloway

Lithology: silty limestone concretions

APPENDIX 2 (cont)

Determinations: Maccoyella barklyi (Moore)
Pseudavicula anomala (Moore)
Lingula cf. subovalis Davidson
Indet. belemnite
crinoid brachials

Age: Aptian

Locality: GAB 2167: Tributary of Five Mile Creek, about 3 miles ENE of "The Peaks" (m.r. 629717)

Collector: M.C. Galloway

Lithology: silty limestone concretions

Determinations: Tropaeum or Australiceras sp. ind.
Pseudavicula anomala (Moore)
Maccoyella corbiensis (Moore)
Cyrenopsis sp. ind.
Laevidentalium sp.
Lingula cf. subovalis Davidson
Indet. natiooid gastropod
worm burrows

Age: Aptian

Locality: GAB 2156: About 5 miles ¼ of "Bangor" (m.r. 575734)

Collector: M.C. Galloway

Lithology: silty limestone concretions

Determinations: Maccoyella barklyi (Moore)
Pseudavicula anomala (Moore)
Panopea rugosa (Moore)
Indet. mytilid
Lingula cf. subovalis Davidson
Calcareous tubes (? annelid)

Age: Aptian

Locality: GAB 2155: About 2 Miles N. of "Mt. Lonsdale" (m.r. 574732)

Collector: M.C. Galloway

Lithology: Calcareous glauconitic mudstone, siltstone with mud pebbles.

Determinations: Maccoyella barklyi (Moore)
Pseudavicula anomala (Moore)
Cyrenopsis sp. ind.
? ganoid fish scale

Age: Aptian

Locality: GAB 1887: back Creek about 3 miles SSW of "Bangor" (m.r. 567729)

Collector: N. Exon

Lithology: in siltstone with mud pebbles

Determinations: Maccoyella barklyi (Moore)
Camptonectes socialis (Moore)
Panopea rugosa Moore
Calcareous tubes (? annelid)

Age: Aptian

APPENDIX 2 (cont)

Locality: GAB 2159: Near earth tank about 5½ miles NE of "Dulbydilla" (m.r. 555731)
Collector: M.C. Galloway

Lithology: Limestone concretions

Determinations: Maccoyella sp. ind.
"Nucula" sp. 1
fossil wood
Age: Aptian

Locality: GA GAB 2098: S. bank of Maranoa River, where the river curves from a, SE course to the ENE one, about 2½ miles west of Mitchell. (m.r. 611711)
Collectors: D.J. Casey, R.W. Day, M.C. Galloway

Lithology: Calcareous concretions and silty mudstone

Determinations: Tropaeum or Australiceras sp. ind.
Purisiphonia clarkei Bowerbank
Maccoyella barklyi (Moore)
Maccoyella corbiensis (Moore)
Pseudavicula anomala (Moore)
"Mytilus" rugosostatus (Moore)
"Myacites" planus (Moore)
Panopea Maccoyi (Moore)
Tatella Maranoana (Etheridge Jnr.)
Inoperna ensiformis (Etheridge Jnr.)
Cyrenopsis cf. meeki (Etheridge Jnr.)
Onestia aff. etheridgei (Etheridge Jnr)
?"Nucula" sp. ind.
Euspira reflecta (Moore)
Laevidentalium sp.
crinoid pinnules
fossil wood
Age: Aptian

Locality: GAB 2152: Earth tank about 3 miles ENE of "Brunel Downs" (m.r. 516739)
Collector: M.C. Galloway

Lithology: limestone concretions

Determinations: Pseudavicula anomala (Moore)
Panopea rugosa (Moore)
Lima randsi (Etheridge Jnr.)
Cyrenopsis cf. meeki Etheridge Jnr.
"Gari" elliptica Whitehouse
"Modiolus linguloides Hudleston
Nuculana cf. randsi Etheridge Jnr.
Actaeon hochstetteri? (Moore)
Laevidentalium sp.
Lingula cf. subovalis Davidson
crinoid brachials
Age: Aptian

Remarks

Fossils from the 3 localities in the Minmi Member (GAB 1942, 1950 and 2168) are similar to those recently reported from sandstones at the base of the Roma Formation in the Tambo area. Similarities with faunas of the over-lying Roma Formation in the Mitchell area, and the Minmi Member and Roma Formation of the Roma area, are also apparent. The pelecypods Maccoyella barklyi, Fissilunula clarkei and Tatella maranoana are common to all units. More species were listed by Day (1964, table 3) from the Minmi Member of the Roma area, than are reported here. However, the Roma area has been more intensely collected.

Appendix 2 (cont)

"Gari" cf. elliptica and single indeterminate trigonid reported from GAB 1942 have not been observed in collections from the Minmi Member of the Roma Area. "Gari" cf elliptica is represented at GAB 1942 by numerous specimens with closed valves. The form has a deep pallial sinus, but it is proportionately higher than the holotype of this species figured by Etheridge Jnr., (1901, pl. 2, fig. 8) (1902, pl. 2, fig. 25) from the Lake Eyre basin of South Australia.

The occurrence of a large specimen identified as Tropaeum cf. leptum at GAB 2163, close to the base of the Roma Formation, indicates a probable Upper Aptian age for this horizon. The specimen exceeds 450 mm in diameter and lacks only the initial proconch whorl and a short portion behind the last septum. The ornament is non-tuberculate and the ribbing is relatively uniform throughout. Although the specimen has been compressed to a certain extent, the whorl section is elevated like that of the type figured by Etheridge Jnr. (1909 pl. 30, figs. 1-3) from "Lind River" (Blackdown Formation, Carpentarian Basin). The present specimen is larger and much more complete than the type.

Tropaeum or Australiceras sp. ind. from GAB 2098 and 2167 are septate fragments which have quadrate whorl sections like those of T. australe and T. articum.

Ammonites are comparatively rare in the Surat Basin. Tropaeum australe (Moore), (1870, p. 115, fig. 3) from the "Upper Maranoa" and T. articum Stolley from "Roma" figured by Etheridge Junior (1909, pl. 32, fig. 2; pl. 34, fig. 1) (as Crioceras jackii) are, so far as I am aware, the only ammonites figured from this area. According to Casey, (1960, p. 41) the latter is very like the English species T. subarticum, a characteristic ammonite of the Upper Aptian nutfieldensis zone.

The fauna in all collections from the Roma formation in the Mitchell area corresponds closely with that of the Purisiphonia horizon reported from the lower part of the Roma Formation of the Roma area by Day (1964, p. 17). The species in common are Purisiphonia clarkei, Maccoyella barklyi, M. corbiensis, Pseudavicula anomala, Fissilunula clarkei, Tatella maranoana, "Gari" elliptica, "Myacites" planus, Camptonectes socialis, Inoperna angusta, "Modiolus" linguloides, Onestia aff. etheridgei, Cyrenopsis cf. meeki Tatella? sp. 1 and Nuculana randsi.

The brachiopod Lingula cf. subovalis occurs quite frequently in these collections, and is here reported from GAB 1950, 2152, 2156, 2166, 2167 and 2169. Curiously in the Roma area, it was noted at only one locality (R.D. 78).

Pholadomya sp. is represented by a small specimen with closed valves. Radial ribbing is very prominent on the anterior parts of the shell. The Maryborough species Lima randsi Etheridge Jnr. (1892, pl. 21, fig. 13) has not been previously reported from the Surat or Eromanga Basins. Five left valves from GAB 2152 closely approach the shape and ribbing of the holotype.

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APPENDIX 3.

PALYNOLOGY OF SHALLOW HOLES IN THE MITCHELL 1:250,000 SHEET AREA, QUEENSLAND, PROVISIONAL REPORT

by

P.R. Evans

Samples of cores from shallow holes, which were drilled by the Bureau of Mineral Resources during 1965 in the Mitchell 1:250,000 Sheet area, have been examined for their content of spores, pollen grains and microplankton. The samples selected and the stratigraphic units to which they are ascribed are summarized in the following table.

Bore	Core	Depth	Sample No.	Age	Formation	Unit
1	1	530' 6"	MFP3966	Cretaceous	Minmi Member	Klb +
	2	126' 6"	3967)			"
	3	278' 0"	3968)		Blythesdale	K und, ¢
	3	284' 6"	3969)			Kla @
	4	347' 5"	3970)			Kla @
2	cut	140-50"	MFP3972)			J5/6
	1	157' 4"	3974)	Jurassic	Westbourne	"
	2	248' 7"	3975)			"
	cut	270-80'	3973)			J5
3	1	52' 9"	MFP3978	Jurassic	Westbourne	J5
	3	182' 5"	3979	"	Birkhead	J5
4	1	88' 6"	MFP3971	Cretaceous	Minmi Member	Klb +
	2	198' 7"	3988)			J/K und¢
	3	265' 5"	3976)	Jurassic/ Cretaceous	Hooray Sst.	" ¢
	4	306'10"	3989)			" ¢
	5	398' 2"	3977)			
5	cut	110-20'	MFP3981	Jurassic	Hooray	J6
	1	203' 8"	3980	"	Westbourne	J6

¢ Has high content of recycled late Permian and Triassic fossils.
\+ Also in the dinoflagellate Zone of Dingodinium cerviculum.
@ Contains a high proportion of "Gen. et sp. nov A" Eisenack & Cookson.

The Cretaceous, unit Klb/ Dingodinium cerviculum Zone age of the Minmi Member of the Blythesdale Formation is established. The presence of unit Kla in the underlying undifferentiated Blythesdale Formation is established by the association of Cicatricosisporites australiensis and Murospora florida. The presence of "Gen. et sp. nov. A" Eis. & Cooks. at the same horison is completely in accord with its occurrence in unit Kla in the Otway and Gippsland Basins in Victoria (Evans, 1966b). A few other acritarchs (Micrhystridium spp.) were detected in the oldest sample of Kla, in BMR1 (Mitchell), core 4. "Gen. et sp.nov. A" swarms in illitic mudstone at certain horizons in Kla in the Otway Basin. Its relative abundance in BMR1 (Mitchell) in the Great Artesian Basin coincides with the presence of glauconite (M.C. Galloway, pers. comm.),

APPENDIX 3 (cont)

and provides yet another pointer to the existence of at least ephemeral brackish or marine conditions of sedimentation during deposition of the Blythesdale Formation below the Minmi Member.

The presence of unit Kla age microfossils in the Blythesdale Formation below the Minmi Member, i.e., somewhere in the interval Mooga Sandstone Member - Nullawurt Sandstone Member, provides a useful link across the Surat Basin, as the same zone has been detected in the interval sampled between 1581 feet and 1848 feet in UKA Cabawin No. 1 Well.

The relative stratigraphic positions of BMR 2 and 3 (Mitchell) are in accord with the ages of the horizons sampled. The unit J5 age for the sample from within the top of the Birkhead Formation is confirmation of the relationship determined from the Eddystone Sheet area (Evans, 1966a) that unit J5 commences within, but near the top of the Birkhead Formation.

There is still little evidence of the length of the period of deposition of the Hooray Sandstone. Cuttings at 110-120 feet in BMR5 (Mitchell) yielded a typical unit J6 assemblage. However, cores from presumably higher up the section, in BMR4 (Mitchell) failed to yield anything but a few spores and pollen grains of species which are not diagnostic of any particular zone within the Jurassic or Cretaceous, in association with a high proportion of recycled late Permian and Triassic fossils.

Reworked late Permian microfloras, presumably derived by stripping of a landscape of Permian sediments during late Jurassic time, seems to be widely distributed in Upper Jurassic sediments on both sides of the Nebine Ridge. They were recognized within the Augathella Sheet area, to the northwest of the Mitchell Sheet, in Amoseas Westbourne No. 1, where the Hooray Sandstone, sampled by core 2, 1035-49 feet, yielded only Permian spores and pollen (Evans, in Gerrard, 1964).

REFERENCES.

Evans, P.R., 1966a - Palynological studies in the Longreach, Jericho, Galilee, Tambo, Eddystone & Taroom 1:250,000 Sheet areas, Queensland. Bur.Min.Resour.Aust. Rec., 1966/61 (unpubl.)

Evans, P.R., 1966b - Mesozoic stratigraphic palynology of the Otway Basin. Ibid., 1966/69 (unpubl.)

Gerrard, M.J., 1964- American Overseas Petroleum Limited Westbourne No. 1 Well completion report (unpubl.)

APPENDIX 4

SHALLOW STRATIGRAPHIC DRILLING, MITCHELL SHEET AREA, 1965.

by

N.F. Exon.

General

The Great Artesian Basin Party supervised the drilling of seven holes (1745 feet of drilling, and 179 feet of coring) for stratigraphic information, in the northern half of the Mitchell Sheet area, from the 1st to the 11th October. The contractors, Geophysical Associates International, used a truck-mounted Mayhew 1000 rig with an air compressor. 400 feet of drill pipe, a five foot core barrel, and equipment for drilling with mud, were available. Where possible the holes were electric and gamma ray logged with a Widco portalogger.

Drilling

The holes were drilled and cored to:-

(1) Obtain lithological information of poorly exposed and weathered formations.

(2) Intersect formation boundaries

(3) Obtain palynological material.

The holes were all moderately successful in obtaining one or more of these aims. Cuttings were collected from 10 foot intervals. The results are summarised below:

Shallow Drill hole No.	Grid.ref.	Total depth in ft.	Drilling in ft.	Coring in ft.	Core Recovery Actual	%	Drilled with	Logging
BMR Mit.1	618,724	350	316	34	21½	63	mud	Electric
" " 2	660,744	275	250	25	9½	38	mud	Electric & gamma
" " 3	657,758	249	227	22	17½	80	mud	Electric & gamma
" " 4	569,732	405	377	28	16½	59	mud	Gamma
" " 5	564,760	205	200	5	5½	110	air	Gamma
" " 6	561,769	175	170	5	5	100	air	Gamma
" " 7	528,748	265	205	60	47	78	mud	Nil
Total		1924	1745	179	122½	68		

The drilling rate (7 holes in 10 days drilling) was slow compared with the comparable holes drilled in the Bowen Basin in 1964 with a similar rig (25 holes in 13 days - see Mollan, Exon and Forbes, 1965b). The slower rate was entirely due to the less effective coring equipment. Firstly, a five foot core barrel necessarily takes twice the turn-around time to drill a ten foot core, compared with the 10 foot barrel used in the earlier programme. Secondly, the teeth of the bits used had far too small clearance, and the water holes were also too small. In the soft sediments met with, this meant that:-

Appendix 4 (cont)

(a) the holes invariably clogged up if coring with air was attempted, and sometimes even with mud coring. It was generally impossible to employ any more weight than that of the string.

(b) the low teeth were extremely slow-cutting, and the time spent rotating for a five foot core was roughly 2 hours (twice the time taken for a 10 foot core with the earlier drilling).

Unfortunate side effects of theabove were:-

(a) the bits wore out very fast, as they rotated four times as often for each foot of core, compared with the earlier drilling.

(b) all drilling had to be with mud once the first core was taken, resulting in virtually worthless cuttings.

Attempts to obtain more suitable bits during the programme proved unsuccessful. Overall, the value of the drilling was greatly diminished by the need to drill with mud. Two holes were drilled entirely with air to overcome the cuttings problem, but this allowed coring, with mud, only at the bottom of the hole.

It has been found that the two ways of getting maximum geological results with such drilling are:-

(a) Air drilling with cores every 50 feet, or as the well site geologist decides. The dry cuttings give a good idea of bulk lithology, and the cores of structure.

(b) Continuous coring. This gives very detailed information, and cannot be bettered for palynological purposes.

The mud drilling reduced the effectiveness of method (a) above, and the extremely slow coring rate militated against method (b).

The author believes that in any future contract let, definite specifications for core bits, and a 10 foot core barrel, should be compulsory.

Logging.

Logging with the Widco portalogger was supervised by A. Radeski, in company with a geologist. This portable machine which is very simply worked, is capable of taking spontaneous potential and resistivity logs as well as a gamma ray log. It can log a typical shallow drill hole in less than half an hour.

Unfortunately, there had not been time to service the logger before despatching it to the field. This resulted in various breakdowns and delays, and the logging of six holes took five days. In various holes either electric log or gamma log was not working (see table). A large cavern developed in black soil made it unsafe to attempt to log Mitchell No. 7.

Examination

The cores and cuttings were logged with a binocular microscope by Galloway and Exon. Galloway also examined samples from cores in thin section. The gamma and electric logs showed that results obtained from wet cuttings were generally very inaccurate. The results are presented in Figs. 3, 4 and 5, and Plate 2 in the body of the record.

APPENDIX 4 (cont)

The stratigraphic results of the drilling are discussed in the text, and the palynological results in Appendix 3. The cuttings and cores are stored at the BMR Core and Cuttings Laboratory, Fyskwick, Canberra, where they are available for reference.

During examination of cores from the Minmi Member of the Blythesdale Formation, Galloway suspected the presence of oil, and this was confirmed by core analysis by Duff (see Appendix 1). This discovery is discussed in Galloway and Duff (1966).

Discussion

The drilling was fairly successful overall. However, poor coring equipment led to mud drilling, very poor cuttings, and slow coring. The Widco logging of the holes allowed fairly accurate estimation of proportions of lithologies in the holes. These were often greatly at variance to the results obtained from the more resistant cuttings which remained after mud drilling. The logs were found to be of little use for correlation between these shallow holes.

REFERENCE.

Mollan, R.G., Exon, N.F. and Forbes, V.R., 1965: Shallow stratigraphic drilling, Bowen and Surat Basins, 1964. Bur. Min.Resour. Aust. Rec. 1965/119

5Φ5394

Plate 1

CORRELATION CHART OF MEASURED SECTIONS & SHALLOW DRILL HOLES

JURASSIC AND CRETACEOUS SEDIMENTS,

EDDYSTONE AND MITCHELL SHEET AREAS

Sections measured by N.F. Exon and V.R. Forbes using anaeroid barometer (M1 using Abney Level)
Lithological samples e.g. Ed 351B , examined in thin section

Bureau of Mineral Resources, Geology and Geophysics, April 1965

To accompany Record 1966/90

G55/A7/3

5d53.94

CORRELATION CHART OF JURASSIC AND CRETACEOUS SEDIMENTS PENETRATED IN DRILL HOLES MITCHELL 1,4 & 7 AND AMOSEAS DULBYDILLA No1

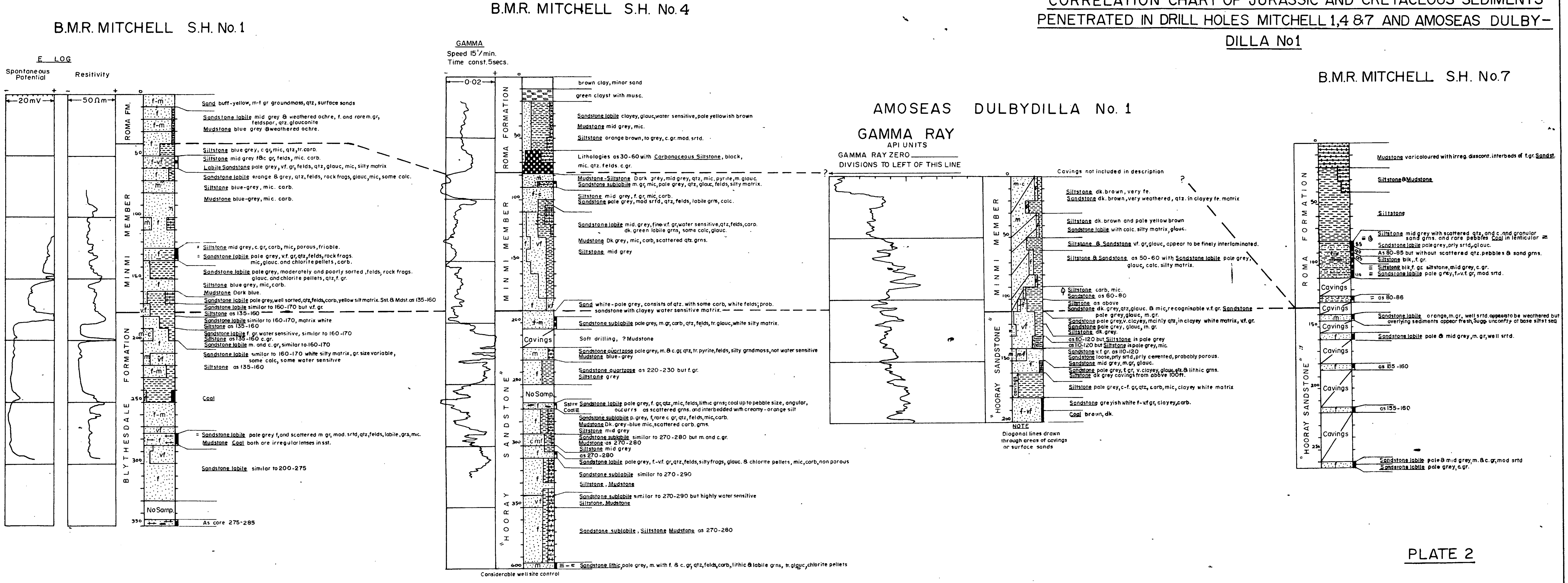


PLATE 2

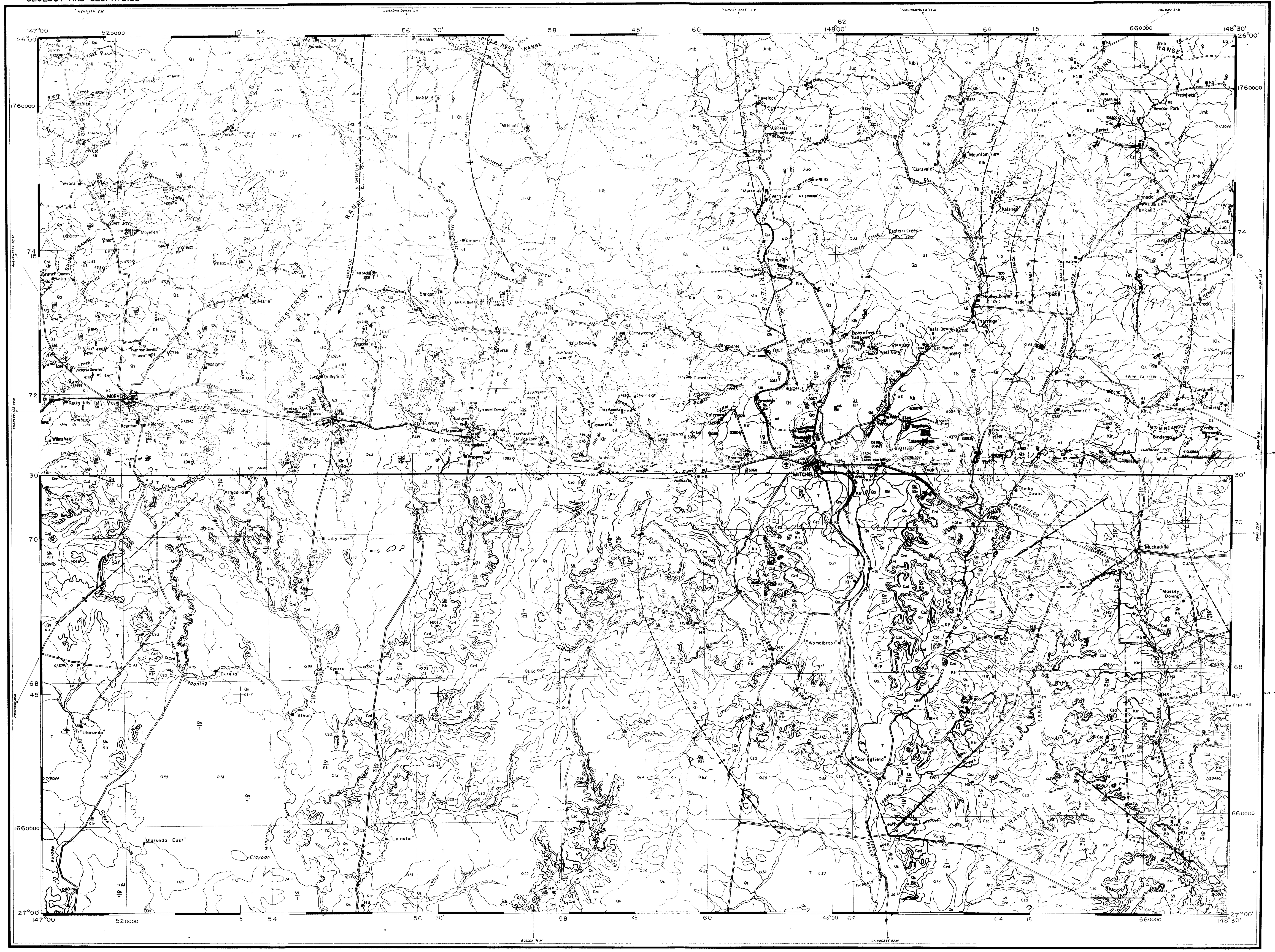
To accompany Record 1966/90

G55/A11/9

BUREAU OF MINERAL RESOURCES,
GEOLOGY AND GEOPHYSICS

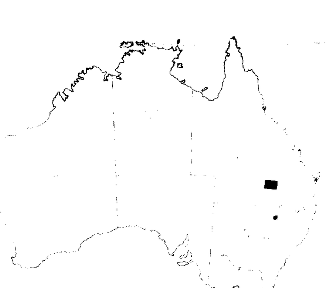
MITCHELL
QUEENSLAND

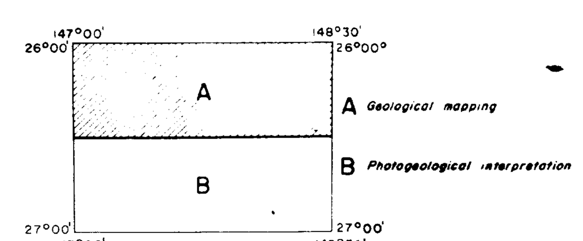
AUSTRALIA 1:250,000
PHOTOGEOLOGICAL SHEET SG 55-11



Compiled by the Bureau of Mineral Resources, Geology and Geophysics.
Detail adjusted to photoscale compilation prepared by the Division of National Mapping, Department of National Development.
Aerial photography by Adastra Airways Pty. Ltd.; complete vertical coverage at 1:85,000 scale. Transverse Mercator Projection.

Scale 1:250,000





INDEX TO ADJOINING SHEETS

AUGATHELLA	EDDYSTONE	TAROOM
CHARLEVILLE	MITCHELL	ROMA
WYANDRA	HOMEBOIN	SURAT

Photo-interpretation by the Photogeological Group,
Bureau of Mineral Resources, Geology and Geophysics 1966
interpreted by: J.C Rivereau, Institut Français du Pétrole.

G55/A11/2

REFERENCE

Photogeological Character		Possible Geological Equivalent		
	Qa	Alluvium	QUATERNARY	CAINOZOIC
	Qa1	Old alluvium	QUATERNARY	CAINOZOIC
	Qc	Colluvium	QUATERNARY	CAINOZOIC
	Qs	Sand, residual sand	QUATERNARY	CAINOZOIC
Dark-toned, flat, scarp forming	Czd	Duricrust	UNDIFFERENTIATED	CAINOZOIC
Medium grey-toned, fairly soft formation covered with timber, bedded, scarp forming, with white patches in places	T	Lateritised sandstone, sand, siltstone, conglomerate	TERTIARY	CAINOZOIC
Dark-toned, high relief, hard appearance	Tb	Basalt	TERTIARY	CAINOZOIC
Light grey-toned, with white spots, very soft	Klr	Siltstone, mudstone, claystone — Roma Formation	LOWER CRETACEOUS	MESOZOIC

Photogeological Symbols

- Lithological boundary
- Probable lithological boundary
- Anticlinal axis
- Synclinal axis
- Fault
- Probable fault or lineament
- Edge of bed
- Probable edge of bed
- Edge of bed expressed as scarp

Geological Reference

Geology and compilation 1965 by N.F. Exon, M.C. Galloway (B.M.R.) and D.J. Casey (G.S.Q.)

CAINOZOIC	QUATERNARY		Qa	*Alluvium*
CAINOZOIC	QUATERNARY		Qs	*Sand, gravel, soil*
CAINOZOIC	UNDIFFERENTIATED		Cz	*Poorly consolidated clayey sandstone*
CAINOZOIC	UNDIFFERENTIATED		Czd	*Duricrust (silcrete, laterite)*
CAINOZOIC	TERTIARY		T	*Well bedded clayey sandstone and conglomerate*
CAINOZOIC	TERTIARY		Tb	*Basalt flows*
MESOZOIC	LOWER CRETACEOUS	Roma Formation	Klr	*Mudstone, siltstone; glauconitic sublabile sandstone lenses*
MESOZOIC	LOWER CRETACEOUS	Blythesdale Formation	Klb	*Quartzose sandstone, siltstone*
MESOZOIC	LOWER CRETACEOUS	Minmi Member	Kli	*Glauconitic sublabile sandstone*
MESOZOIC	LOWER CRETACEOUS	Nullawurt Sandstone Member	Kln	*Fine grained quartzose sandstone, siltstone*
MESOZOIC	LOWER CRETACEOUS	Kingull Member	Klk	*Siltstone, shale, lithic sandstone, in part calcareous*
MESOZOIC	LOWER CRETACEOUS	Mooga Sandstone Member	Klx	*Crossbedded, fine to medium grained quartzose sandstone; siltstone, claystone. Minor pebbles*
MESOZOIC	JURASSIC-CRETACEOUS	Hooray Sandstone	J-Kh	*Crossbedded quartzose to feldspathic sandstone, minor pebbly; siltstone*
MESOZOIC	MIDDLE TO UPPER JURASSIC	Orallo Formation	Juo	*Sublabile to labile sandstone, in part calcareous; siltstone and mudstone, some carbonaceous*
MESOZOIC	MIDDLE TO UPPER JURASSIC	Gubberamunda Sandstone	Jug	*Crossbedded sublabile sandstone, minor pebbly; some siltstone and mudstone*
MESOZOIC	MIDDLE TO UPPER JURASSIC	Injune Creek Group: Westbourne Formation	Juw	*Siltstone, mudstone, very fine grained quartz-rich sandstone*
MESOZOIC	MIDDLE JURASSIC	Injune Creek Group: Springbok Sandstone Lens	Js	*Crossbedded labile sandstone, in part calcareous; some siltstone*
MESOZOIC	MIDDLE JURASSIC	Injune Creek Group: Birkhead Formation	Jmb	*Sublabile to labile sandstone, in part calcareous; carbonaceous siltstone and mudstone, some coal*

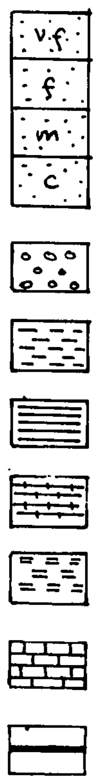
- *Geological boundary*
- *Anticline showing plunge*
- *Syncline showing plunge*

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 0–5°* (Air-photo interpretation)
- *Dip 5°–15°* (Air-photo interpretation)
- *Horizontal dip* (Air-photo interpretation)
- *Trend lines* (Air-photo interpretation)
- *Macrofossil locality*
- *B.M.R. scout holes*
- *Oil well, dry hole (abandoned)*
- S12 *Measured section*
- *Fossil wood*
- *Principal road*
- *Minor roads and tracks*
- station — *Railway line*
- "Durella" — *Homestead*
- *Building*
- Yd — *Yard*
- *Airfield, landing ground*
- *Spring*
- *Dam*
- E — *Earth tank*
- *Bore: artesian, sub-artesian*
- *Abandoned bore*
- *Photo-centre points*
- *Photo-centre points adjoining sheets*
- 1234 — *Bore with registered number*

PLATE 4

REFERENCE FOR COLUMNAR MEASURED SECTIONS AND SHALLOW DRILL HOLE LOGS



sandstone — grain size (mm)

very fine	0·06 - 0·12	
fine	0·12 - 0·25	
medium	0·25 - 1·0	
coarse	1·0 - 2·0	

quartzose sandstone > 90% clasts quartz
sublabile (feldspathic, lithic) 75-90% " "
labile (feldspathic, lithic) < 75% " "

conglomerate

siltstone

shale

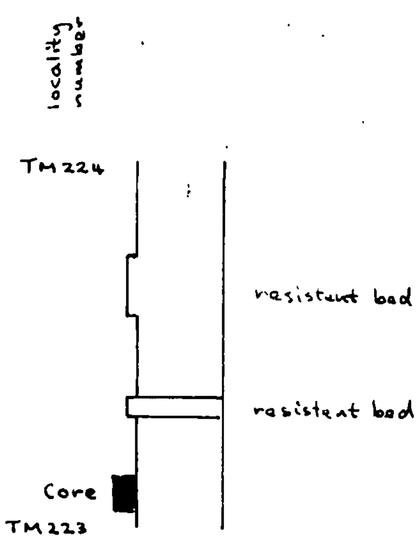
mudstone

claystone

limestone

coal band

gaps in sections are concealed areas



bedding structure

very thick	> 40"	
thick	12 - 40"	
medium	4 - 12"	
thin	0·4 - 4"	
laminate	< 0·4"	

brackets around symbol indicate poor development

cross bedded
slumped
ripple marks
trails

other symbols

calcareous concretion
plant fossil

abbreviations

si	siliceous
fe	ferruginous
mic	micaceous
calc	calcareous
feld	feldspathic
carb	carbonaceous
sst	sandstone
siltst	siltstone
mudst	mudstone
clayst	claystone
grnd	grained
r.f.	rock fragments
conc	concretionary