COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES

GEOLOGY AND GEOPHYSICS

RECORDS:

RECORD No. 1967/63

THE GEOLOGY OF THE ROMA AND MITCHELL 1:250,000 SHEET AREAS,

QUEENSLAND

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N.F. EXON, E.N. MILLIGAN, D.J. CASEY and M.C. GALLOWAY

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(* Geological Survey of Queensland)

Records 1967/63

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SUMMARY

During 1965 and 1966 the Jurassic to Cainozoic sequence exposed at the surface in the Mitchell and Roma 1:250,000 Sheet areas was mapped, and a brief subsurface study followed. The area covers parts of three major basins. The Bowen Basin sequence is generally present in the subsurface in the eastern half. The Surat Basin sequence covers most of the area, but is replaced in the far west by the Eromanga Basin sequence. The entire sequence has a gentle regional dip south into the Great Artesian Basin; changes in sedimentary facies and thickness are more pronounced parallel to the east/west trending basin margin than normal to it. All the major structures are oriented longitudinally, and these are responsible for the facies and thickness changes. The basement rocks consist of Devonian metamorphics intruded by Lower Carboniferous granites, and smaller masses of andesitic volcanics of Carboniferous age.

The Bowen Basin sequence is best developed in the Mimosa Syncline in the east, where a maximum of 20,000 feet of Permian and Triassic shallow water sediments, and lesser volcanics, deposited under both freshwater and marine conditions, is preserved. 4000 feet of Lower Permian freshwater sediments are preserved in the faulted Merivale/Arbroath Trough in the centre of the area. The Roma Shelf, between these two areas, is covered by a variable veneer of Permian and Triassic sediments.

Sediments in the Surat and Eromanga Basin are quite similar, although they are more arenaceous west of the Nebine Ridge in the Eromanga Basin. The eroded surface of Triassic and older rocks is completely covered with Lower Jurassic sediments, and an essentially conformable 4000 feet thick sedimentary sequence continues well into the Lower Cretaceous. This sequence is entirely of shallow water origin; the only thick marine sediments are Lower Cretaceous in age.

Cappings of duricrust, Tertiary sandstone and basalt, and sand and soil cover, obscure much of the Cretaceous sequence.

Oil exploration companies have been very active in the area and nearly 200 wells have been drilled to date. Gas, but not oil as yet has been exploited commercially. A pipeline is now being built to transport

gas to Brisbane. Commercial gas flows and oil shows, are mostly from stratigraphic traps in the Lower Jurassic Precipice Sandstone, but some come from Triassic sandstones. The main source rocks are believed to be marine mudstones in the Lower Jurassic Evergreen Formation.

The main aquifers are Jurassic and Cretaceous sandstones; subartesian bores are very numerous, and there are some artesian bores in the south. Bentonite was discovered during this survey in the Upper Jurassic Orallo Formation, but testing has yet to prove any economic deposits. Blue metal deposits are readily accessible between Mitchell and Warooby.

INTRODUCTION

This report presents the results of a joint geological survey, over two years, by the Bureau of Mineral Resources and the Geological Survey of Queensland, in the Roma and Mitchell 1:250,000 Sheet areas, most of the area is within the Surat Basin. The survey continued the project of mapping the Queensland part of the Great Artesian Basin. J.C. Rivereau of the I.F.P. prepared photogeological maps of the Roma Sheet and the southern half of the Mitchell Sheet (Rivereau, 1966), before mapping commenced in those areas.

The northern half of the Mitchell Sheet was mapped in 1965 to resolve problems of correlation between the south-east Eromanga Basin and the Surat Basin. The report on this area (Exon, Casey and Galloway, 1966) is incorporated in this report.

During 1966, in the period June to November the remainder of the area was mapped, and the north-eastern quadrant of the Mitchell Sheet was remapped. The party consisted of N.F. Exon (party leader), E.N. Milligan and D. Williams (draftsman). D.J. Casey (G.S.Q.) was with the party for one month. Palynologist D. Burger visited the party for six weeks and did some mapping. J.C. Rivereau checked his photo-interpretation of these Sheets, and the adjacent Chinchilla, Surat and Dalby Sheets in three weeks field work. Marine fossil collections were examined by R.W. Day of the Australian National University, plant fossils by Mary E. White, and palynological examination was carried out by D. Burger.

The rough division of work was:-

Exon - 5 months field work on pre-Rolling Downs Group on northern Mitchell Sheet; several weeks on pre-Blythesdale Formation on north-western quadrant of Roma Sheet. Both mapping and text. Subsurface work.

Milligan - 3½ months field work on Blythesdale Formation and Rolling Downs Group on Roma Sheet; one month on Rolling Downs Group of Mitchell Sheet. Both mapping and text.

Casey - 2 months mapping of pre-Rolling Downs Group in northern parts of Mitchell and Roma Sheets.

Galloway - 6 weeks mapping of Rolling Downs Group and Minmi Member on northern Mitchell Sheet.

Burger - 3 weeks mapping of pre-Blythesdale Formation on north-east Roma Sheet.

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

The area is essentially one of "layer-cake" geology, with sediments of Middle Jurassic to Recent age cropping out, and a regional dip to the south. The only igneous rocks exposed are Tertiary basalts. Sandy and clayey soils occur in roughly equal proportions in the area. The better sandy soils support open eucalypt forest; poorer sandy soils support scrub consisting largely of wattle, lancewood and boodgeroo. The clayey soils naturally support brigalow-wilga-belah-bottle tree-sandalwood scrub, but are extensively cleared. Cleared areas are well grassed or grow crops.

There is a large pastoral industry with cattle favoured in the hilly, scrubby areas, and sheep on the open plains. Feed crops for local stock, and cash crops (largely wheat and oats) are being rapidly developed, especially in the east. Average annual rainfall is 20 inches.

The main cultural features are shown in Fig. 1. Towns and townships are concentrated along the Brisbane/Charleville railway line, which bisects the area. From east to west these centres are Drillham, Dulacca, Jackson, Yuleba, Wallumbilla, Blythdale, Roma, Muckadilla, Amby, Mitchell, Mungallalla and Morven. The only other township is Wandoan in the far north-east. A branch railway line runs north from Roma to Injune. The only fully sealed roads are the Warrego Highway, which parallels the main railway line, and Condamine Highway from Roma to the south-east. Main roads connect the Warrego Highway with Taroom and Injune to the north, Augathella to the north-west and Surat to the south. Miles on the Warrego Highway, and Condamine on the Condamine Highway, are immediately east of the area.

Access throughout the area is good, with numerous formed main roads, and formed homestead roads. Those in the clayey soil areas are impassable after heavy rain.

Aerial photographs taken by Adastra Airways in 1962, at an approximate scale of 1:83,000 are available for the entire area. Planimetric maps at a scale of 1:250,000 are currently being produced by the Department of National Development, Canberra, and early compilations of these were used as bases for the two geological maps. Planimetric maps at a scale of 4 miles to 1 inch are available from the Department of Public Lands, Brisbane.

Water supplies are obtained by bores from various aquifers. In general water is pumped from fairly shallow depths. In many areas earth tanks and dams are abundant.

Details of shallow scout holes drilled in 1966, including their grid references, are shown in Appendix 8. Graphic logs are shown in various figures and plates (see Contents). Cores and cuttings are stored at the Bureau of Mineral Resources, Core and Cuttings Laboratory, Fyshwick, A.C.T. Seven holes were drilled in the Mitchell Sheet area in 1965, and another four in 1966. Six holes were drilled in the Roma Sheet area in 1966.

The marine fossil collection localities of Day (1964) in the Roma area are prefixed "RD" on the map. Earlier collections held in the Geological Survey of Queensland are prefixed "L". Collections made during the present survey are stored at the Bureau of Mineral Resources Museum, Canberra. 1965 collections are prefixed "GAB" but are shown on the map with the prefix "G"; 1966 collections are prefixed "SB".

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.

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 sandsized 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 sub-division 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; 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 (1/16 mm. 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).

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 River which flows into the Pacific Ocean. Part of the Great Dividing Range separates the Ballone and Dawson catchments.

Water courses are usually dry, and only flow after heavy rain. Larger streams have some permanent and semi-permanent waterholes, and water can generally be obtained at shallow depth from sandy alluvium.

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

1. Sandstone cuestas forming escarpments; intervening rolling country.

   This unit is confined to the northern half of the area. It consists of shallowly south-dipping Jurassic and Cretaceous sandstone units which form scarps and dipslopes and softer intervening units which form lower areas of little outcrop.

2. Undulating country with clay soil.

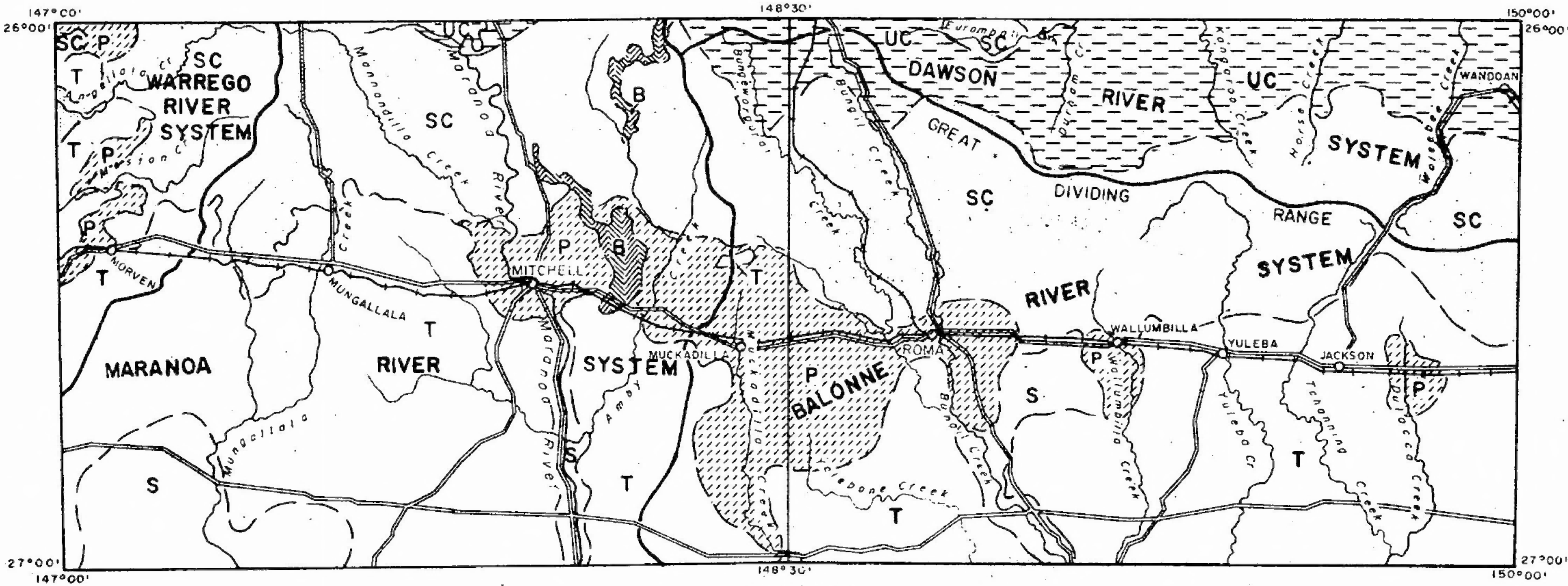
   This country is confined to the Jurassic Injune Creek Group in the north. More resistant beds form low buttes. This good pastoral country is extensively cleared.

3. Dissected elevated plains.

   This unit forms a large part of the southern half of the area. A south-sloping Tertiary plain consisting of duricrusted Cretaceous sediments, and Tertiary sediments, it has since been dissected. It now consists of areas of black soil and sand below mesas and buttes representing the old land surface.

PHYSIOGRAPHY

Fig. 1



REFERENCE

SC	Sandstone cuestas forming escarpments; intervening rolling country.
UC	Undulating country with clay soil.
T	Dissected elevated plains.
B	Basalt plateaux.
P	Prairie, with black soil.
S	Sand plains.

Divide

scale 0 — 30 miles

G55/A/24

To Accompany Record 1967/63

4. Basalt plateaux

Basalt forms elongated submeridional hills in the centre of the area. These are probably erosional residuals from more extensive flows which flowed down the depression of the Merivale Syncline in Tertiary times.

5. Prairie

The prairie ("rolling downs") forms belts in the west and south where the Tertiary cover and duricrust has been completely stripped from the Cretaceous Wallumbilla Formation. The rich black soils form excellent pastoral country.

6. Sand Plains

The main area of sand plains is in the south-west. There it has virtually no surface drainage and the sand is probably colluvial, extending down-slope from source areas to the north. Other areas are Tertiary and Recent alluvia along the Maranoa River and Bungeworgorai Creek.

PREVIOUS INVESTIGATIONS

Geological

Passing reference to the geology of the 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 his 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 (eds, 1960) reviewed the geology of the region. Comprehensive bibliographies of the geological literature of the Mitchell area accompany these two publications.

Day (1964) mapped the Roma-Wallumbilla area during the period 1959-1961 and was the first person to undertake a comprehensive study of the area and to resolve the confused stratigraphic nomenclature that was current at that time. Numerous company reports are available on the area, but these are principally interpretive results of wire-line logging of deep wells in the area.

Geophysical

Geophysical surveys by companies and the Bureau of Mineral Resources are tabulated in Table 1. Regional gravity work by the Bureau of Mineral Resources (BMR, 1965a, 1965b) covers the whole area. This delineates, in particular, the Maranoa Anticline, the Mount Scott Syncline, the Roma Shelf and the Eurombah Dome (Plate 9).

Aeromagnetic work (U.O.D., 1960; Aero Service Corp., 1963; M.P.C., 1963; BMR 1964a, 1964b) covers most of the area, with the exception of the area between, and north of, Mitchell and Roma (Plate 10). Interpretations of magnetic basement indicate, in particular, the Maranoa Anticline, the Mimosa Syncline and the north-north-west trending faulting south of Eurombah Dome.

A patchy coverage is provided by reconnaissance and detailed seismic work which was largely done for the Associated Group (see Table 1). This has been extensively used to define drilling targets, mostly anticlines which are not reflected at the surface.

TABLE 1 - GEOPHYSICAL SURVEYS

Survey	Organisation	Reference
Gravity and magnetic reconnaissance Roma district	Bureau of Mineral Resources	Dooley, 1950.
Regional gravity*	Bureau of Mineral Resources	BMR, 1965a
Regional gravity, Mitchell Sheet	Bureau of Mineral Resources	BMR, 1965b
Aeromagnetic; regional	Union Oil Development Corp.	U.O.D., 1960
Aeromagnetic; regional	" " "	Aero Service Ltd., 1963
Aeromagnetic, Mitchell Sheet	Magellan Petroleum Corp.	M.P.C., 1963
Aeromagnetic	Bureau of Mineral Resources	BMR, 1964a

TABLE 1 - GEOPHYSICAL SURVEYS (Continued)

Survey	Organisation	Reference
Aeromagnetic, Mitchell Sheet	Bureau of Mineral Resources	BMR, 1964b
Detailed seismic	" "	Dooley, 1954
Detailed seismic	" "	Williams, 1955
Regional and semi-detailed seismic	Associated Australian Oilfields N.L.	A.A.O., 1961
Detailed seismic	" "	A.A.O., 1962a
Reconnaissance and detailed seismic	" "	A.A.O., 1962b
Regional and detailed seismic	Mines Administration Pty. Ltd.	G.S.I., 1962a
Semi-detailed seismic	" " "	G.S.I., 1962b
Reconnaissance seismic	Union Oil Development Corp.	Kahanoff, 1962
Reconnaissance seismic, Mitchell Sheet	American Overseas Petroleum Ltd.	Petty, 1963
Semi-reconnaissance and detailed seismic	Phillips Petroleum Co.	Fjelstul and Beck, 1963
Regional and detailed seismic	Associated Australian Oilfields N.L.	A.G.P. and Minad, 1963a
Reconnaissance seismic	" "	A.G.P. and Minad, 1963b
Detailed seismic	" "	A.G.P. and Minad, 1963c
Semi-detailed and detailed seismic	" "	A.G.P. and Minad, 1964
Semi-detailed seismic, Mitchell and Roma Sheets	" "	A.G.P. and Minad, 1965
Detailed seismic with tie lines, Mitchell Sheet	American Overseas Petroleum Ltd.	G.A.I., 1965

* Area covered involves Roma Sheet unless otherwise specified.

Exploratory Drilling for Oil and Gas

The Roma area has been the centre of interest for oil and petroliferous gas exploration since 1900 when petroliferous gas was encountered in a Roma Town water bore. The smallness of the supply of gas, flooding by water and technical troubles hindered early operations and discouraged intensive exploration. Less than 40 bores were drilled before 1953 when the discovery of oil in Rough Range, Western Australia stimulated increased exploration throughout Australia. The well histories and details of this early exploration are documented by the Geological Survey of Queensland (1960). Details of drilling up to the end of 1964 are outlined in supplements to this Publication (G.S.Q., 1961-1966) and a full list of exploration wells is given in Table 1 of this Record.

Australian Associated Oil Fields, N.L. (A.A.O.) holds the authority to prospect in the Roma area (119P) and an accelerated programme of drilling was carried out, both in the region of the earlier exploration and on targets in new areas delineated by geophysical work. By 1965, A.A.O. entered a period of intensive appraisal and development of a number of proven gas (and minor oil) fields and continuing exploration was directed towards locating stratigraphic traps. A summary of the Bony Creek Gas Field has been prepared by Power (1966) after Traves (in press). The various gas fields of the Roma area are to be connected by pipeline to a new nitrogenous fertilizer plant in Brisbane. Gas has been used at the Roma powerhouse for some years.

In 1962, Union-Kern-A.O.G. started drilling operations in a neighbouring lease to the east. One hole drilled on the "Wandoan Anticlinal Trend" (Conloi No. 1) struck an appreciable quantity of oil and has been capped as a potential producer.

In 1965, American Overseas Petroleum Ltd. (Amoseas) began a series of stratigraphic and hydrocarbon reservoir test holes in the west of the Mitchell Sheet area (and in the neighbouring Charleville Sheet area) to establish a western continuation of reservoir beds in the Roma area.

SUBSURFACE UNITS

The majority of the subsurface units in this area crop out further north in the Eddystone, Springsure and Taroom Sheet areas.

Differences in their lithologies from outcrop to the subsurface are generally quite limited, and the detailed descriptions of surface lithologies given in the Records by Mollan, Exon and Kirkegaard (1964), Mollan, Exon and Forbes (1965a) and Jensen, Gregory and Forbes (1964), and the Reports by Mollan, Dickins, Exon and Kirkegaard (in press) and Mollan, Forbes, Jensen, Exon and Gregory (in prep.), need not be repeated here. Further detail on the subsurface units is given by Tissot (1963a, 1963b), Fehr (1965), Bastian(1965a, c, d), and in well completion reports. Tissot's units in this area, and outcrop and company nomenclature is shown below.

Tissot	This Record	Common differing company nomenclature
Units L, M, N.	Reids Dome Beds	Unit 8 (Minad)*
Unit Q2	Peawaddy Formation	Back Creek Formation (U.K.A.)**
Unit R	Blackwater Group	Kianga Formation (U.K.A.)
Unit S	Rewan Formation	Cabawin Formation (U.K.A.)
Unit T1 (lower part)	Clematis Sandstone	Showgrounds Sandstone (Minad) Wandoan Formation (U.K.A.)
Unit T (remainder)	Moolayember Formation	Wandoan Formation (U.K.A.)
Unit A	Precipice Sandstone	
Unit B	Evergreen Formation	

* Minad: Mines Administration Pty. Ltd.

** U.K.A.: Union-Kern-A.O.G.

Tissot (1963a) also shows isopach maps for the various units. The area can be divided into a structural units as shown in Fig. 11. The general distribution of subsurface units can be seen in the map cross-sections and Plates 5, 6. The basement distribution in the Roma area is shown in Fig. 2. In the Mimosa Syncline it is not known and information is sketchy on the Mitchell Sheet.

The Triassic and Jurassic sequences are both essentially conformable. There are significant regional unconformities at the base of the Upper Permian, the base of the Triassic, and the base of Jurassic.

Pre-Jurassic rocks are virtually confined to the Merivale-Arbroath Trough and the Mimosa Syncline, although veneers of Upper Permian and Triassic rocks occur in places on the Roma Shelf. In the Arbroath Trough, only the Lower Permian Reids Dome Beds occur and these are directly overlain by the Lower Jurassic Precipice Sandstone. In the Mimosa Syncline the very thick Permian and Triassic sequence is comparable to that outcropping to the north. The main difference from the outcrop area is the abundance of tuff in the Upper Permian.

The Jurassic sequence is generally fairly complete throughout the area. However, Lower Jurassic sediments may thin or pinch out over anticlinal structures (e.g. Amoseas Scalby No. 1).

The correlations shown in Plates and the map cross-sections are based largely on a comparison of the electric and lithological logs of the various wells, and outcrop knowledge. The divisions of the Blythesdale Formation are carried from electric logged shallow drill hole BMR Mitchell No. 11 (Plate 7).

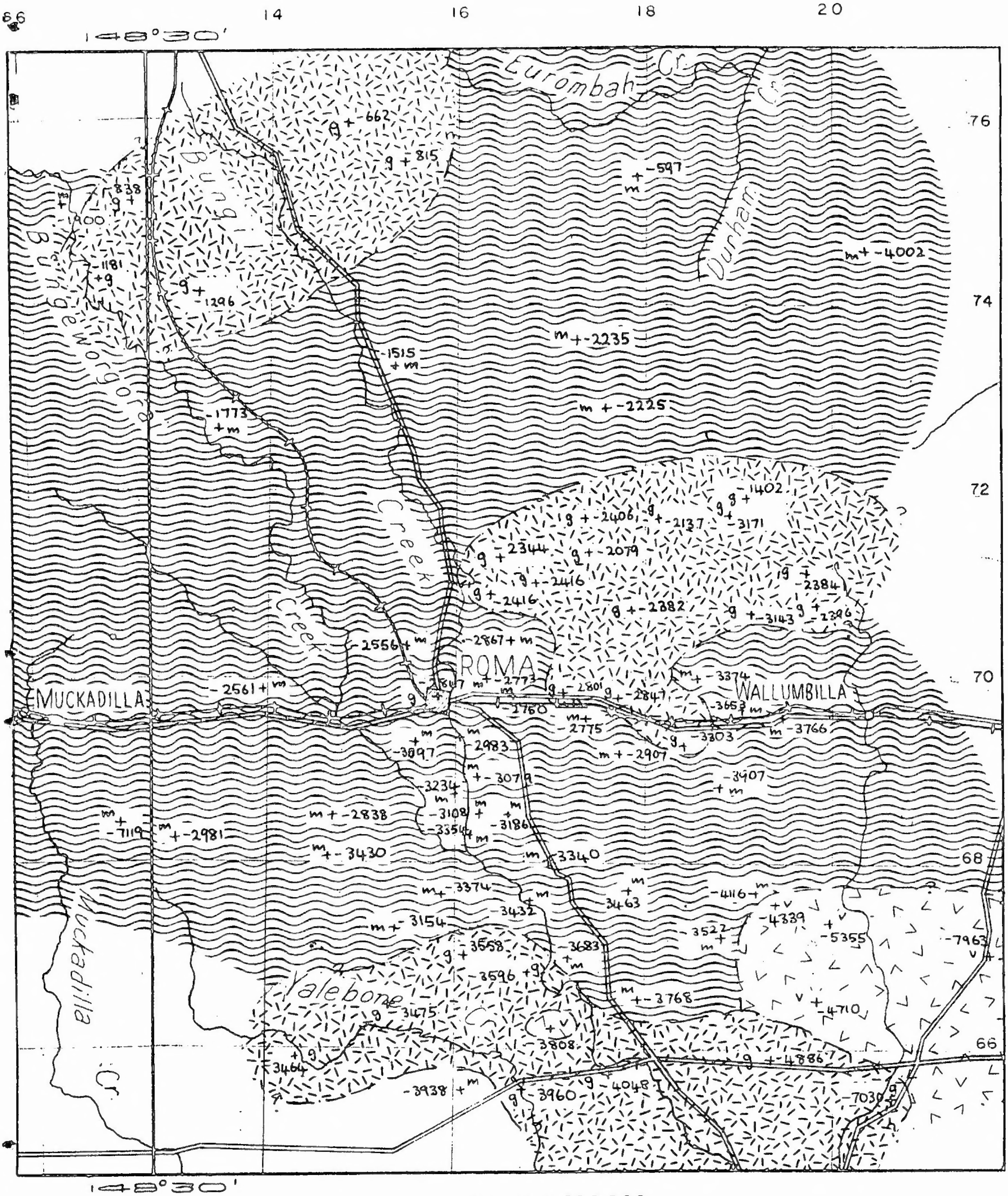
A brief discussion of the various units is given below.

Timbury Hills Formation

This name (from A.A.O. Timbury Hills No. 2) is used for any metamorphic, sheared or steeply dipping basement rocks in this part of the Surat Basin. The formation generally consists of sandstone, siltstone or

Fig. 2

BASEMENT IN ROMA AREA



SCALE 1:500,000

LEGEND

+ −597 Well Location & M.S.L. Top of Basement

Granite Basement

Volcanic Basement (Combarngo Volcanics)

Metamorphic Basement (Timbury Hills Formation)

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shale, or their metamorphosed equivalents. The plant fossil Leptophloeum australe was found in the unit in A.F.O. Purbrook No. 1, and psilophyton remains in A.A.O. Pickanjinnie No. 2. These plants indicate an Upper Devonian age for at least part of the unit.

This is the most widespread basement type struck.

Granite

The "Roma granites" are dealt with extensively in Houston (1964). She examined twelve plutonic rocks in thin section; all were granite or adamellite, and except for the adamellite in A.A.O. Brucedale No. 1, all were micaceous. Potassium/argon radioactive age determinations from intrusives in five A.A.O. wells in the Roma area, and Amoseas Scalby No. 1 on the Mitchell Shelf, range from 298 to 350 million years (Lower Carboniferous). These rocks intruded the Timbury Hills Formation, and produced hornfels by contact metamorphism (e.g. in A.A.O. Winnathoola No. 1) in Lower Carboniferous times.

Granite basement masses (see Fig. 2) occur in three major bodies in the Roma area: north-east of Orallo, north-west of Wallumbilla, and east of Yalebone Creek. Granite also occurs in Amoseas Donnybrook No. 1 (30 miles north of Mitchell, and Amoseas Scalby No. 1, 30 miles south-south-west of Mungallala).

Combarngo Volcanics

These andesitic volcanics occur in wells in a fairly large area south of Wallumbilla, and also in the Trinidad wells further west. They are named from the andesites and andesitic tuffs found in the interval 5628 feet to 5985 feet in A.A.O. Combarngo No. 1 well. They may be equivalent to the andesitic volcanics in the wells on the eastern flank of the basin (e.g. U.K.A. Crowder No. 1, Yarrol Creek No. 1), which are believed to be of Carboniferous or Lower Permian age.

Reids Dome Beds

The type section of this unit, a very thick siltstone-shale-coal measure sequence, is in A.O.E. (Reids Dome) No. 1. This unit was deposited in lakes in areas that were subsiding slowly but deeply in Lower Permian times (e.g. Denison and Arbroath Troughs).

The best development of it in this area is in A.A.O. Arbroath No. 1 where there is 3680 feet of section in the interval 4595 to 8275 feet. This consists of a monotonous sequence of sandstone, siltstone and shale with lesser polymictic conglomerate and coal. Microfossil evidence suggests that it is entirely non-marine and of Lower Permian age (well completion report), although glauconite was reported in some cores. Glossopteris was the only plant identified.

It is likely that the unit was also deposited in the Mimosa Syncline, and is preserved at great depths. The sandstone, siltstone, and shale sequence from 8605 to 8947 feet in A.A.O. Lorelle No. 1 on the western margin of the syncline, may possibly be Reids Dome Beds (or basal Peawaddy Formation).

Peawaddy Formation

This name, from Peawaddy Creek in the Springsure Sheet area, was introduced by Mollan, Kirkegaard, Exon and Dickins (1964) for a lithic sandstone and siltstone sequence which was deposited during an Upper Permian marine transgression.

In this area the unit is preserved in and near the Mimosa Syncline. The Section 8085 to 8605 feet in A.A.O. Lorelle No. 1 is fairly typical. It consists of a lower sequence of siltstone, carbonaceous shale and some coal, and an upper sequence of calcareous shale, siltstone and some sandstone with shelly fossils. Tissot (1963a) has noted tuffaceous sediments in this upper part of the sequence. Further south-east Tissot (op. cit.) has noted a still lower sequence consisting of shale, clayey siltstone and minor sandstone with some marine fossils; this was not deposited on the Roma Shelf.

The Peawaddy Formation on the Roma Shelf was lacustrine at first, becoming marine later, and overlapped the Lower Permian sequence; it thickens into the Mimosa Syncline. It contains shelly Fauna IV (Dickins, Malone and Jensen, 1964) and spores of Evans' division P3b (Evans, 1964).

Blackwater Group

The coaly, non-marine Blackwater Group (Malone, Olgers and Kirkegaard, in press) is named from the town of Blackwater in central Queensland. In outcrop in the Springsure area it is the upper coaly part of the superseded 'Bandanna Formation' of Hill (1957).

Near the margin of the Mimosa Syncline, it consists of the siltstone, shale and coal with some tuffaceous sandstone. It thickens eastward into the syncline (e.g. 1400 feet + in U.K.A. Wandoan No. 1) and contains abundant tuffs in the lower part. A sandstone in the lower part of the formation produced some gas in A.A.O. Sunnybank Nos. 1 and 2.

The unit varies from lacustrine to paludal in this area, and there was contemporaneous volcanism in the east. Its distribution is similar to that of the underlying Peawaddy Formation, although it probably transgressed further west onto the Roma Shelf. Its relationship to the Black Alley Shale which separated the Peawaddy Formation and the Blackwater Group in outcrop, is obscure (see Tissot, 1963a); Black Alley lithologies are not present in this area.

The group contains an abundant Glossopteris flora and spores of Evans' (1964) division P4.

Rewan Formation

The type area of the Rewan Formation (Hill, 1957) is near Rewan Homestead in the Springsure Sheet area. Lithologies in the Roma area are similar to those in the outcrop area consisting of varicoloured, in part tuffaceous, mudstone, siltstone, lithic sandstone and polymictic conglomerate.

Although the unit is generally conformable on the Blackwater Group (except on the southern part of the Roma Shelf), detailed petrological work by Fehr (see Tissot, 1963a) shows that Rewan deposition commenced at different times (with different sediments) in different areas. Fehr's basal unit (So) which consists of thick-bedded tuff, conglomerate and sandstone is present only in the north of this area; elsewhere younger sediments rest on the Permian. The unit has produced gas (e.g. A.A.O. Latemore No. 1) and oil (e.g. A.A.O. Sunnybank No. 1).

The formation thickens into the Mimosa Syncline from about 300 feet in the Pickanjinnie wells to 4356 feet in U.K.A. Wandoan No. 1. It contains Lower Triassic spores (Evans, 1964).

Clematis Sandstone

The Clematis Sandstone (Jensen, 1926a) is named after Clematis Creek in the Expedition Range where it consists mainly of quartzose sandstone with minor siltstone. In the Roma Sheet area it is the Showgrounds Sandstone of Minad, and the lower part of the Wandoan Formation of U.K.A.

It occurs in places on the Roma Shelf and throughout the Mimosa Syncline. On the Roma Shelf it is thin and discontinuous, probably being deposited in originally low areas, and consists of quartzose sandstone and siltstone, and minor polymictic conglomerate and shale. Oil and gas shows have been recorded in a number of wells (e.g. A.A.O. Bardloming No. 1, A.A.O. Combarngo No. 1).

In the Mimosa Syncline the thousand feet and more of clayey quartzose sandstone, carbonaceous siltstone and mudstone, and lesser polymictic conglomerate, between the Rewan Formation and the Precipice Sandstone (U.K.A.'s Wandoan Formation) is difficult to correlate, on electric logs, with the typical sequences of Clematis Sandstone and Moolayember Formation. However, Bastian and Arman (1965), by detailed examination of samples from U.K.A. Wandoan No. 1 and comparison with outcrop material, have correlated the unit between 4298 feet and 4817 feet with the Clematis Sandstone, and that between 3530 feet and 4298 feet with the

Moolayember Formation. They describe the Clematis Sandstone as consisting largely of "fine to medium-grained protoquartzite which is fairly well sorted and has angular to subangular grains". It contains some chamositic pellets.

The "Wandoan Formation" sequence in U.K.A. Conloi No. 1 contains a large proportion of sandstone and is, in part at least, Clematis Sandstone equivalent.

The environment of deposition generally varied from fluviatile to lacustrine. The chamositic pellets suggest marine interludes. The unit conformably overlies the Rewan Formation. Spores in the unit are of Lower to Middle Triassic age (Evans, in prep.).

Moolayember Formation

This unit was named by Reeves (1947) from Moolayember Creek in the Carnarvon Ranges. In the type area it is largely mudstone with some lithic sublabile sandstone, carbonaceous shale and tuff.

It laps over a large part of the Roma Shelf and thickens into the Mimosa Syncline. It consists of quartzose to sublabile sandstone, calcareous in part, and argillaceous siltstone and mudstone. In the Mimosa Syncline it is the upper part of U.K.A.'s Wandoan Formation; in U.K.A. Wandoan No. 1 it is 768 feet thick. Bastian and Arman (1965) report common chamositic pellets in U.K.A. Wandoan No. 1, and Evans (pers. comm.) has found scattered horizons containing acritarchs in wells in the syncline. Probably the dominant lacustrine conditions gave way to marine for short periods in the subsiding basin. Spores in the unit are of Middle to Upper Triassic age (Evans, in prep.).

Precipice Sandstone

The name "Precipice Sandstone" was first used by Whitehouse (1952) and later he (Whitehouse, 1954) stated that the type section was in the gorge of Precipice Creek. In outcrop it is largely cross-bedded, commonly clayey, quartzose sandstone, with a thin-bedded upper part.

The Precipice Sandstone unconformably overlies the earlier units in this area. It was very widely deposited throughout this area, but not on local high areas. It can be divided into a lower coarse grained fluviatile part consisting largely of thick-bedded, cross-bedded quartzose sandstone, and an upper fine-grained lacustrine part consisting of thin-bedded, well-bedded quartzose sandstone and siltstone. The lower part especially is locally porous, and permeable and much of the Roma gas comes from it.

It is less than 200 feet thick over much of the Roma area but thickens gradually into the Mimosa Syncline where it is about 450 feet thick in U.K.A. Conloi No. 1. Spores in the unit belong to Evans division J1 regarded as Lower Jurassic in age, and marked by the first appearance of abundant Classopolis.

Evergreen Formation

The formation name is derived from the name "Evergreen Shales" introduced by Whitehouse (1952). The type area is in the valley of the Dawson River near Evergreen Homestead. The various outcrop lithologies are discussed in detail in Mollan, et al. (in prep.). In the type section (op. cit.) a lower lacustrine shaly sequence and a largely fluviatile quartzose sandstone sequence (Boxvale Sandstone Member) are exposed. West of there, the upper part of the formation crops out, and an oolitic ironstone (Westgrove Ironstone Member) overlies the Boxvale Sandstone and an upper lacustrine shaly sequence completes the formation.

In the subsurface in this area the Boxvale Sandstone Member is only readily identifiable in the eastern part of the Mitchell Sheet, and across the south of the Roma Sheet. However, the chamositic colitic ironstone of the Westgrove Ironstone, which is associated with acritarch swarms, is generally present. In U.K.A. Wandoan No. 1 two pelletal beds were noted by Bastian (1965a) - a 10-foot thick upper one, and a 40-foot thick lower one, in the interval 2750 feet to 2840 feet; the upper one is believed to be equivalent to the Westgrove Ironstone Member. Correlation through U.K.A. Wandoan No. 1 and U.K.A. Burunga No. 1 (Bastian, op. cit.) indicates that the lower pelletal horizon is the "oolite member" of outcrop

(Mollan et al., in prep.). The "oolite member" contains acritarchs in BMR Mundubbera No. 29, and its equivalent in this area contains the same acritarchs. This horizon is at the base of Evans' spore division J2.

It is probable that both oolitic horizons represent marine incursions. In some areas they were separated by lacustrine Evergreen-type sediments, in others by fluviatile and lacustrine Boxvale-type sediments.

The typical siltstone, mudstone and minor fine-grained labile sandstone of the Evergreen Formation is present practically everywhere in the subsurface, except on some local highs (e.g. Amoseas Scalby No. 1). It is generally between 300 and 400 feet thick, but thins west of the Arbroath Trough (78 feet in Amoseas Strathmore No. 1).

It contains acritarchs and oolites east of the Nebine Ridge, and is partly marine in the Surat Basin. Marine shales of the Evergreen Formation are widely considered to be the source beds of the hydrocarbons in the Precipice Sandstone, and also in the Boxvale Sandstone (A.A.O. Anabranch No. 1). De Jersey (1965) has presented evidence that Moonie oil from the Precipice Sandstone contains Evergreen spores.

The lower shaly part of the formation contains J1 spores (Evans, 1965) and the "oolite member" and above contains J2 spores (op. cit.). Both are considered to be Lower Jurassic in age.

Hutton Sandstone

The name "Hutton Sandstone" was first used by Reeves (1947); the type section was measured near Hutton Creek east-north-east of Injune (Mollan et al. in prep.). In the type section it is almost entirely fine to medium-grained, thick-bedded quartzose to sublabile sandstone. Scour cross-bedding is very characteristic of the Hutton Sandstone in outcrop.

In the subsurface the unit as picked herein is dominantly sandstone but there is some siltstone and mudstone. This is only the lower part of Minad's "Hutton Sandstone". The upper part of Minad's "Hutton Sandstone" is here called the Eurombah Beds, which first appear in outcrop east of Injune. This is dealt with in more detail under Eurombah Beds. In the subsurface the interbedded sandstone, siltstone and mudstone of the Eurombah Beds is generally readily distinguished in the electric logs in particular, from the sandy Hutton Sandstone. The authors do not know whether the sandstones of the subsurface Eurombah Beds are more labile than those of the Hutton Sandstone (as they are in outcrop).

If the Eurombah Beds are, in fact, a valid subsurface unit, this eases the problem of great thicknesses of Hutton Sandstone. In outcrop the unit is consistently 400 to 500 feet thick. Thus subsurface thicknesses of around 600 feet are quite reasonable. However, if the Eurombah Beds (as shown here) are included with the Hutton Sandstone, the thickening basin-ward is excessive as compared with other Jurassic units. The combined thickness of 900 feet in A.A.O. Kalima No. 1 must contain the adjacently outcropping Eurombah Beds, and electric log correlations can be run quite readily south from there.

The Hutton Sandstone is conformable on the Evergreen Formation. It contains spores of Evans' (1966) division J2-3, of Lower Jurassic age.

DESCRIPTION OF OUTCROPPING ROCK UNITS

Rocks of Middle Jurassic to Cainozoic age crop out in this area.

The oldest unit exposed is the Middle Jurassic Eurombah Beds (new name), which is overlain by the Injune Creek Group. The Injune Creek Group in the Mitchell Sheet area is subdivided into the lower calcareous and coaly Birkhead Formation with the Springbok Sandstone Member at the top, and the upper silty Westbourne Formation. These names were published in Exon (1966). Eastwards the group becomes more sandy and is mapped as undifferentiated Injune Creek Group.

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 Kirkegaard, 1966), has led to changes in the previous correlations in the Middle and Upper

Jurassic and the Lower Cretaceous sequences between the Surat and Eromanga Basins. This correlation is discussed in Exon (1966). The correlation used initially on the Eddystone Sheet (Mollan, Exon and Forbes, 1965a) was the conventional one whereby the Adori Sandstone, "Upper Intermediate Series", and Hooray Sandstone, of Woolley (1941) (defined in the Tambo area) were equated, respectively, with the Gubberamunda Sandstone (Reeves 1947), Orallo Formation (Day, 1964) and Blythesdale Formation (Day, 1964) (defined in the Surat Basin).

Recent mapping has shown that facies changes occur near the Maranoa Anticline (the surface expression of the Nebine Ridge which separates the Eromanga and Surat Basins. The various units and their relationship are shown in Table 3. The Adori Sandstone is confined to the Eromanga Basin, and the "Upper Intermediate Series" (Westbourne Formation) is the upper part of the Injune Creek Group in the Roma area. The Hooray Sandstone is equivalent to the interval Gubberamunda Sandstone/Orallo Formation/ Blythesdale Formation.

The Lower Cretaceous Blythesdale Formation consists of four members in the Roma area, but changes to east and west as shown below.

Mitchell area	Roma area	Jackson area
Minmi Member	Minmi Member	
Nullawurt Sandstone Member	Nullawurt Sandstone Member	Minmi Member
Claravale Sandstone Member	Kingull Member	
Southlands Formation (upper part)	Mooga Sandstone Member	Mooga Sandstone Member

The overlying Wallumbilla Formation (Vine, Day, Milligan, Casey, Galloway and Exon, 1967) is divisible into the Doncaster and Coreena Members in areas of reasonable outcrop.

JURASSIC

Eurombah Beds

This unit was mapped as the upper part of the Hutton Sandstone by Reeves (1947) and Jensen, Gregory and Forbes (1964). It is shown as Hutton Sandstone on the Taroom 1:250,000 Sheet, by Mollan et al. (in prep.). However, this several hundred feet thick sequence of thickly bedded, crossbedded labile sandstone and interbedded siltstone and mudstone is quite unlike the underlying fine grained quartzose Hutton Sandstone, or the overlying mudstone and minor lithic sandstone sequence of the Birkhead Formation. B. Thomas (pers. comm.) has traced it on the airphotos in the Taroom Sheet area, from where it first appears just east of the Hutton Sandstone type section near Injune, to the Eurombah Dome, and thence north-east to the Mimosa Syncline. It is shown on the Roma map as Jme. As yet not enough work has been done to define this unit properly but a description of it in the Eurombah Dome follows.

The Eurombah Beds (named from Eurombah Creek) crop out in the Eurombah Dome in the extreme north of this area. It is a fairly resistant unit, and forms tree-covered benches and scarps which are readily distinguished from the scrub-covered unresistant Birkhead Formation. Soil cover is generally reddish brown and fairly clayey. The beds are widely traceable in the subsurface (Plates 5, 6) as an interbedded sandstone, siltstone, mudstone sequence between the dominantly sandstone sequence of the Hutton Sandstone and the dominantly mudstone sequence of the Birkhead Formation.

The dominantly outcropping rock type is brown, greenish brown or buff, slightly calcareous, soft, friable, somewhat leached clayey labile sandstone, which is generally poorly thick-bedded. There is lesser mudstone and siltstone, and a little coal occurs in seismic shot hole debris from within the unit.

A typical exposure is in a gully one-third of a mile north-east of Eurumbah Homestead. Here there is twenty feet of thickly bedded, crossbedded, fine grained sublabile sandstone with feldspar and clayey rock fragments, overlain by twenty feet of laminated to thinly bedded, ferruginised siltstone and mudstone with some plant remains. This is overlain by twenty feet of thickly to very thickly bedded, graded bedded, poorly sorted, fine to coarse grained sandstone, with abundant clay clasts and quartz and quartzite granules, and some pebbly sandstone. The subangular pebbles in the sandstone are mostly less than one inch in diameter, with larger pebbles confined to the base of each bed. Half the pebbles are quartz and quartzite; the remainder are very fine "cherty" volcanics with flow structure, fine grained siliceous sediments and porphyritic acid volcanics. The larger pebbles and cobbles are almost entirely acid and intermediate flows.

Three typical samples were examined in thin section. They consist of about 60% quartz, 5% plagioclase feldspar, 10% rock fragments (shale, quartzite, volcanics) and up to 5% biotite, in a calcareous or clayey cement (20%). Tourmaline is an ubiquitous accessory. Sandstones in the Birkhead Formation (see Birkhead Formation) contain much more labile material, and much less quartz.

The Eurombah Beds is regionally conformable within the Jurassic sequence, overlying the Hutton Sandstone and underlying the Birkhead Formation; neither contact has been seen. It is transitional in nature between the clean quartzose Hutton Sandstone and the mudstones sequence of the Birkhead Formation. Conditions changed from largely fluviatile in Hutton times, to lacustrine with sporadic fluviatile interludes in Eurombah times, to largely lacustrine in Birkhead times. At the same time the provenance changed from non-volcanic (possibly granitic) to intermediate volcanic; the source was mixed during Eurombah deposition. A few crossbedding readings suggest deposition by north-westerly flowing streams.

Shallow dips are discernable in the unit, and a domal culmination is visible about six miles east of Eurumbah Homestead. The western side of the unit is truncated by a fault two miles west of the culmination.

The beds are greater than 200 feet thick in outcrop, but no accurate estimate of thickness is possible in this area. In the subsurface (see Plates 5, 6) the unit thins from about 350 feet in the centre and central north of the Roma Sheet to perhaps 50 feet in the south. It maintains its thickness westwards to the Arbroath Trough; beyond there, by facies change, it becomes the upper part of the Hutton Sandstone. Eastwards, it becomes hard to distinguish in the Mimosa Syncline.

Only unidentifiable plant remains have been seen in the unit, but it underlies the Middle Jurassic Birkhead Formation and is the upper part of the lower to middle Jurassic "Hutton Sandstone". Its age is hence probably Middle Jurassic. D. Burger (pers. comm.) has examined some samples from the Eurombah Beds in the subsurface and has found spores of Exons' (1966) division J4. Thus the J3/J4 boundary is not at the base of the Injune Creek Group; it could conceivably be at the base of the Eurombah Beds.

INJUNE CREEK GROUP

In this area the Injune Creek Group includes the Birkhead Formation, the Springbok Sandstone Member, 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 Table 3 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 correlation shown in Table 3.

TABLE 3: NOMENCLATURE AND CORRELATES IN JURASSIC SEQUENCE EROMANGA AND SURAT BASINS

New nomenclature and correlation (after Exon, 1966)			Recent usage
Eromanga Basin (Tambo area)		Surat Basin (Roma area)	Surat Basin e.g. AAO Blyth Creek No. 1 (Minad, 1964)
"Hooray Sandstone"*		Blythesdale Formation++	Transition Member Mooga Member
	Southlands Formation	Orallo Formation++	Fossil Wood Member
		Gubberamunda Sandstone	Gubberamunda Member
Westbourne Formation+ (Upper Intermediate Series*)		Westbourne Formation+	Injune Creek Beds
Adori Sandstone*		Springbok Sst. Member	
Birkhead Formation (Lower Intermediate Series*)		Birkhead Formation	
Hutton Sandstone		Hutton Sandstone	Hutton Sandstone

++ After Day (1964)
+ After Gerrard (1964)
* After Woolley (1941)

In the unpublished 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 lithic sandstone body, which crops out in the eastern part of the Eddystone and Mitchell Sheet areas between the Westbourne Formation and the Birkhead Formation, is probably equivalent to the Adori Sandstone. Exon (1966) named this sandstone body the Springbok Sandstone Lens. This name is modified to Springbok Sandstone Member in Mollan et al. (in prep.). Exon also renamed the "Injune Creek Beds" the Injune Creek Group. The Injune Creek Group was deposited in freshwater, lacustrine and fluviatile conditions.

In the Mitchell Sheet area the three fold subdivision of the Injune Creek Group can be everywhere applied. However, the three fold subdivision is no longer mappable east of the Alicker Anticline, in the north-western corner of the Roma Sheet. East of here the Birkhead Formation is quite sandy in its upper part and lack of outcrop prevents its separation from the Springbok Sandstone Member; this largely sandy sequence is mapped as undifferentiated Injune Creek Group. Twenty-five miles east of here (south of Tallawalla Homestead) the Westbourne Formation loses its diagnostic silty character, and is no longer recognizable. Between the Westbourne Formation and Eurombah Beds, in the west, and below the Gubberamunda Sandstone in the east, the undifferentiated group is mapped.

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). The unit is named after Birkhead Creek, in the Tambo Sheet area. Because of the paucity of the 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 and as far east as the Alicker Anticline in a belt of undulating plains up to 8 miles wide. East of the Alicker Anticline in the Roma Sheet area the formation cannot be distinguished from the Springbok Sandstone; the two are mapped as undifferentiated Injune Creek Group as the sequence is quite sandy. However the lower part of the group is still mudstone. The formation 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 this 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 predominate in the subsurface but they weather readily and are rarely exposed. Thin coal seams have been noted (e.g. in BMR Mitchell No. 3, see Fig. 3).

Three fine grained sandstones from the Birkhead Formation, or its equivalent in the Roma area, examined in thin section, are extremely labile. They contain 20 to 40% quartz, 15 to 30% fresh plagioclase feldspar, 10 to 50% rock fragments (intermediate volcanics, shale, quartzite), and 5 to 25% calcite cement. Abundant accessory minerals are biotite and tourmaline.

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 Mitchell Sheet 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. 5), near the Maranoa Anticline, in the west of the Mitchell Sheet 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 per cent lithic fragments (?volcanic), 20 per cent quartz, 10 per cent plagioclase, 10 per cent chlorite and glauconite grains, and 10 per cent chlorite matrix.

The Birkhead Formation conformably overlies the quartzose Hutton Sandstone in the Eddystone Sheet area, (Mollan et al., in prep.). In the north of the Roma Sheet area it conformably overlies the Eurombah Beds, which thicken eastwards from western Taroom Sheet area. The Springbok Sandstone Member is included in the top of the Birkhead Formation, as the sandstones in both are similar.

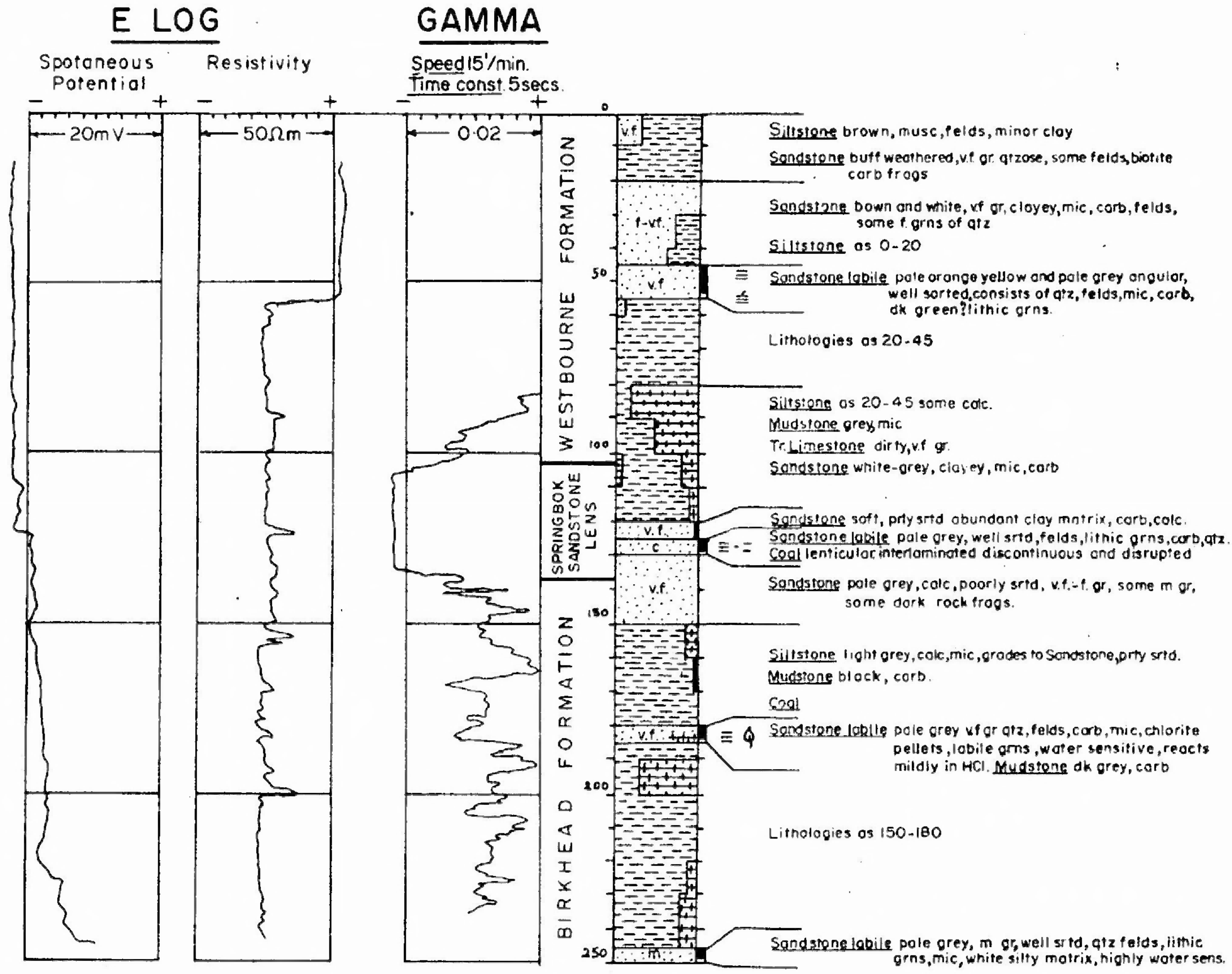
The calcium carbonate content of the Birkhead Formation indicates deposition in an area of restricted drainage. Conditions of deposition were largely lacustrine, with deltaic and fluviatile interludes. The coal seams indicate paludal conditions for some of the time. The large amount of volcanic detritus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

Coal was mined at the Maranoa Colliery near Injune, north of this area, for many years. However there it is no longer considered economic and the colliery is closed. The coal was weakly coking and of high volatile bituminous rank. Thin seams have been seen during this survey, but none of any significance.

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., in prep.). Approximate subsurface thicknesses from west to east (see Plate 5) are:

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

	316 feet in Amoseas Alba No. 1,	
and	155 feet in Amoseas Strathmore No. 1,	(both on Mitchell shelf area)
	504 feet in A.A.O. Arbroath No. 1	(Arbroath Trough);
	843 feet in A.A.O. Apple Grove No. 1	(Roma Shelf);
and	1423 feet in U.K.A. Conloi No. 1	(Mimosa Syncline).

Thus it is thickest on the Roma Sheet, especially in the east. The Arbroath Trough and the Roma Shelf were not marked features in Birkhead times.

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 2). 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 Member

The Springbok Sandstone Member, in the top of the Birkhead Formation, was named and defined as the Springbok Sandstone Lens by Exon (1966), after the Parish of Springbok in the north-eastern part of the Mitchell Sheet. It was renamed the Springbok Sandstone Member, and the definition was modified, by Mollan et al. (in prep.). The type section is the interval 125 feet to 165 feet in shallow drill hole BMR Mitchell 3 (lat. 26°04'S, long. 148°22'E).

The member extends westwards from the Alicker Anticline at the Roma/Mitchell Sheet boundary, to the eastern flank of the Maranoa Anticline in southern Eddystone Sheet. It swings north into the Eddystone

Sheet in the Merivale Syncline, and south into the Mitchell Sheet in the Forest Vale Anticline. The member may sometimes be distinguished, in the airphotos, from the rest of the Birkhead Formation in that it has higher relief and slightly different (more sandy) soil and vegetation.

The member is better exposed than the underlying more muddy sediments of the Birkhead Formation. Sandstone is the dominant sediment and there are lesser amounts of interbedded siltstone and mudstone.

The sandstone is generally labile, but ranges from feldspathic to lithic; it is generally calcareous. It is largely very fine to fine grained, but coarser poorly sorted beds, ranging to "grit" and fine conglomerate, also occur. Bedding varies from medium to very thick, being thicker in coarser grained beds. Scour and planar cross beds are very common (see Plate 1).

In outcrop the sandstone commonly forms ovoid calcareous concretions and is greenish or yellowish brown in colour. In the subsurface it is white or pale green, tight and clayey. It generally contains green and black volcanic fragments, clayey fragments, feldspar and weathered biotite. Minor constituents such as carbonaceous fragments and plant remains, muscovite, magnetite, zircon, rutile, tourmaline and rarely garnet and glauconite, may also be present. Pebbles are largely quartz, but there are some green volcanic fragments. Sorting and roundness vary considerably.

Eight sandstone specimens were examined in thin section. Calcite cement content is highly variable, and some specimens also have a silty matrix. The average quartz: labile content changes from one side of the Merivale Syncline to the other. In the east it is roughly 1:1; in the west it is roughly 2:1. As the rock fragments are largely intermediate volcanics, and the feldspar (plagioclase) is fresh and angular, a volcanic source to the east is indicated. One western sample contains approximately 2% colourless garnet.

PLATE 1

(a) General view of crossbedded Springbok Sandstone showing large calcareous accretions. East bank of Maranoa River (602, 759).

(b) Scour crossbedding in Springbok Sandstone at above locality.

Siltstone is generally grey to greenish, carbonaceous and micaceous, and may be calcareous. Grey carbonaceous mudstone and coal seams (generally less than one foot thick) are also common constituents. Section M10 below (Mitchell Sheet, grid reference 663, 759) is a fairly typical section in this unit.

Top: Grassed hill, no outcrop.

55 feet: Thickly to very thickly bedded, crossbedded, poorly bedded labile to sublabile sandstone as below. Crossbed azimuths largely to south-west. Contains mudclasts and calcareous accretions throughout. Abundant mudballs and ferruginised fossil wood in lower ten feet.

15 feet: Grey, laminated to thinly bedded siltstone and mudstone with plant remains. Some carbonaceous mudstone. Grades to coal at top, with seams to one foot thick.

15 feet: Thickly bedded, crossbedded, in part calcareous, very fine to fine grained brown labile sandstone containing clayey and dark rock fragments, and feldspar. Grades to siltstone and has some carbonaceous, micaceous partings. Crossbedding azimuths to south-west, south, south-east.

Bottom: Creek.

The sandstones of the member are similar lithologically to the few sandstones of the underlying Birkhead Formation, and different from those of the overlying Westbourne Formation, and so the unit is considered a member of the Birkhead Formation. The base of the member is taken above the highest thick mudstone sequence in the formation. East of the Alicker Anticline, Springbok-type sandstone occurs throughout the sequence, and the whole has been mapped as undifferentiated Injune Creek Group as the typical Birkhead Formation contains comparatively little sandstone. The member pinches out westwards against the Maranoa Anticline.

Abundant angular intermediate volcanic fragments and fresh plagioclase suggest a fairly close source area, and possible contemporaneous volcanism in that area. Deposition was largely in a fluviatile enviroment, but quiet lacustrine and paludal periods are suggested by the abundant lime, and some coal seams. Periods of marine influence are indicated by glauconite.

The decrease in labile constituents westwards, and crossbedding readings which indicate southerly flowing streams, point to an easterly or north-easterly source area. Conditions of deposition are very similar to those in the equivalent Adori Sandstone, which is west of the Nebine Ridge in the Eromanga Basin. The difference between the two sandstone units is the source area.

In the subsurface the Springbok Sandstone is recognizable from the Arbroath Trough to the Mimosa Syncline, and as far north in the Roma Sheet area as A.A.O. Timbury Hills No. 2 (see Plates 5, 6). In much of the Mitchell Sheet area it is very difficult to distinguish from sandy Westbourne Formation, and in the north of the Roma Sheet the entire Injune Creek Group is sandy. In general it is the Proud Sandstone (unpublished name) of Mines Administration Pty. Ltd. It is generally about 100 feet thick in the subsurface but appears to be much thicker to the south in the Roma Sheet area.

In outcrop the unit is 40 feet thick in the type section, but it is considerably thicker (150 feet plus) farther west in the axial region of the Merivale Syncline. No fossils have been identified from the unit, although some plant remains are present. Two samples were examined for foraminifera, with negative results. On stratigraphic grounds it is probably late Middle Jurassic in age.

Westbourne Formation

Gerrard (1964) proposed this name for the sequence from 1279 to 1651 feet in Amoseas Westbourne No. 1 in the Augathella Sheet area. Mapping in the Tambo Sheet area (Exon, Galloway, Casey and Kirkegaard, 1966) has confirmed that this is the "Upper Intermediate Series" of Woolley (1941), as suggested by Gerrard, and the name was published in Exon (1966). The type section in Amoseas Westbourne No. 1, contains very fine grained sandstone, siltstone and shale identical with those of the Westbourne Formation in the Eddystone Sheet area.

The unit crops out around the eastern margin of the Eromanga Basin, and the north-western margin of the Surat Basin. In this area it forms a belt from one to eight miles wide, from Wineba Homestead eastwards along the northern Mitchell Sheet boundary. It swings north in the Merivale Syncline, and is then traceable across the north-western part of the Roma Sheet as far east as Tallawalla Homestead. This is a very widespread subsurface unit with a distinctive high intensity gamma ray log.

This non-resistant unit generally forms a slope below the hills of the overlying sandstone units. The unit, where it is not cleared, is covered with fairly open brigalow scrub.

The most common rock types of this poorly exposed formation are siltstone, in places calcareous, and very fine grained, soft, friable quartzose to sublabile sandstone. The siltstone is grey, carbonaceous and micaceous, laminated to thin bedded, and grades into mudstone. The sandstone is buff, thin to thick bedded and contains feldspar, a little muscovite and biotite, and some black chert fragments. In places it contains large calcareous nodules. Commonly it is interbedded with siltstone and shows some crossbedding and contemporaneous slumping. Both the siltstone and the sandstone contain plant debris. Some thin beds of hard calcareous siltstone, fine sandstone, and cone-in-cone limestone occur.

In the Mitchell Sheet area the Westbourne Formation consists of two different rock assemblages, in roughly equal proportions, hereafter known as the "carbonaceous sequence" and the "crossbedded sequence". The first consists of dark grey to greenish grey, carbonaceous, micaceous well bedded siltstone and mudstone; the second consists of buff, weathering to brown, friable crossbedded quartz-rich siltstone and very fine grained sandstone. Each rock type generally occurs in a fairly homogeneous sequence, a few feet or more thick; each sequence is itself more thinly bedded.

Sediments of the "carbonaceous sequence" 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. 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 azumiths. 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.

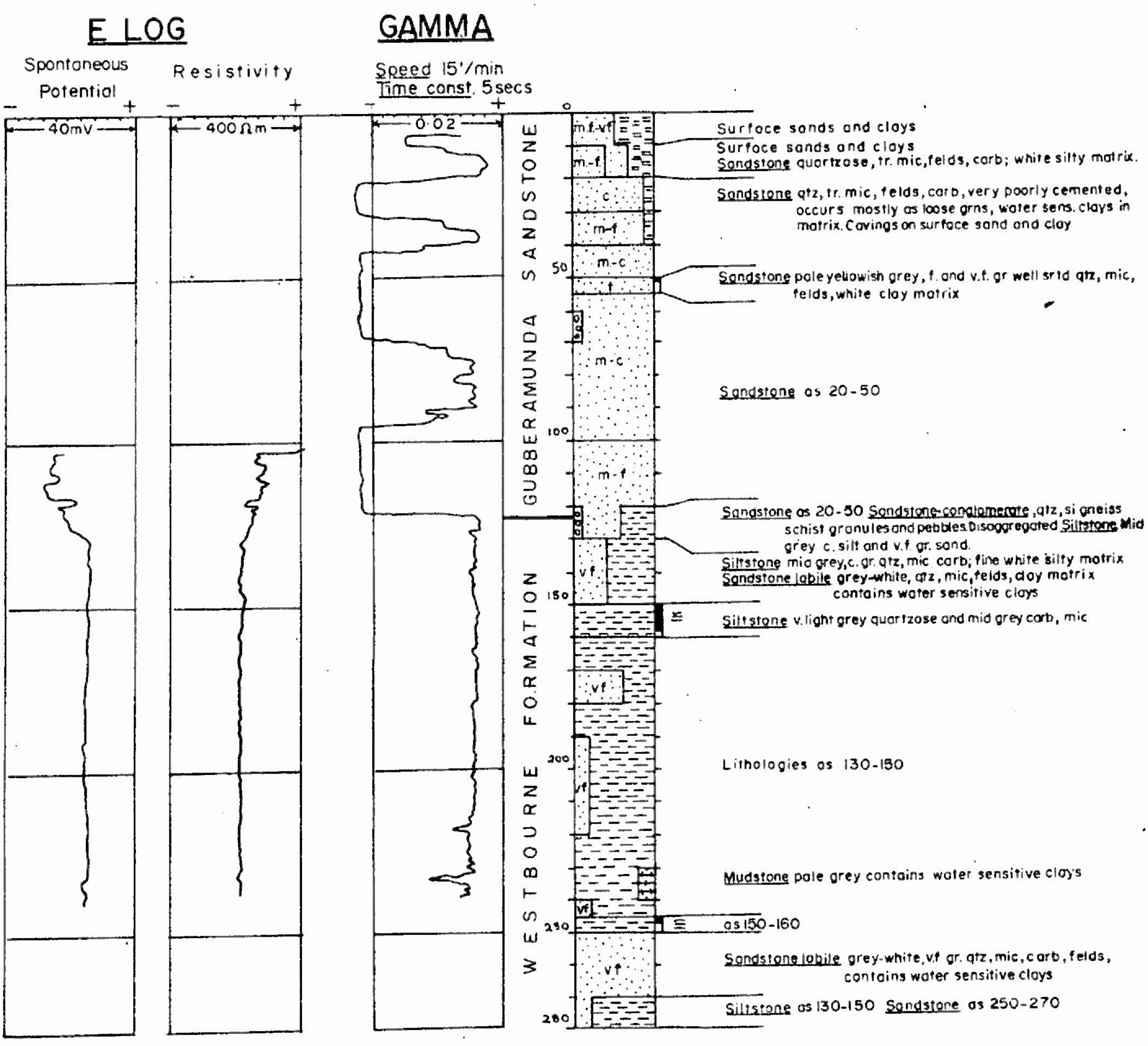
Thin calcareous beds and concretions occur in the "crossbedded sequence" in places. Calcareous siltstone is generally in thin beds or tabular concretions; sandstone forms thicker, more rounded concretions. The calcareous beds are largely of secondary origin, forming after leaching of the original clay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

In the Roma Sheet area the sequence is fairly thin, and although all the typical lithologies are present, no discrete "crossbedded" or "carbonaceous" sequence can be recognized. Claystone is an additional lithology in this area.

Four thin sections of very fine grained sandstone, from the Mitchell and Roma Sheet areas, and three from the adjacent Eddystone Sheet area, contain abundant angular quartz, minor feldspar and generally some shale and quartzite fragments. Accessory green biotite, muscovite,

SHALLOW DRILL HOLE LOG

B. M. R. MITCHELL No. 2



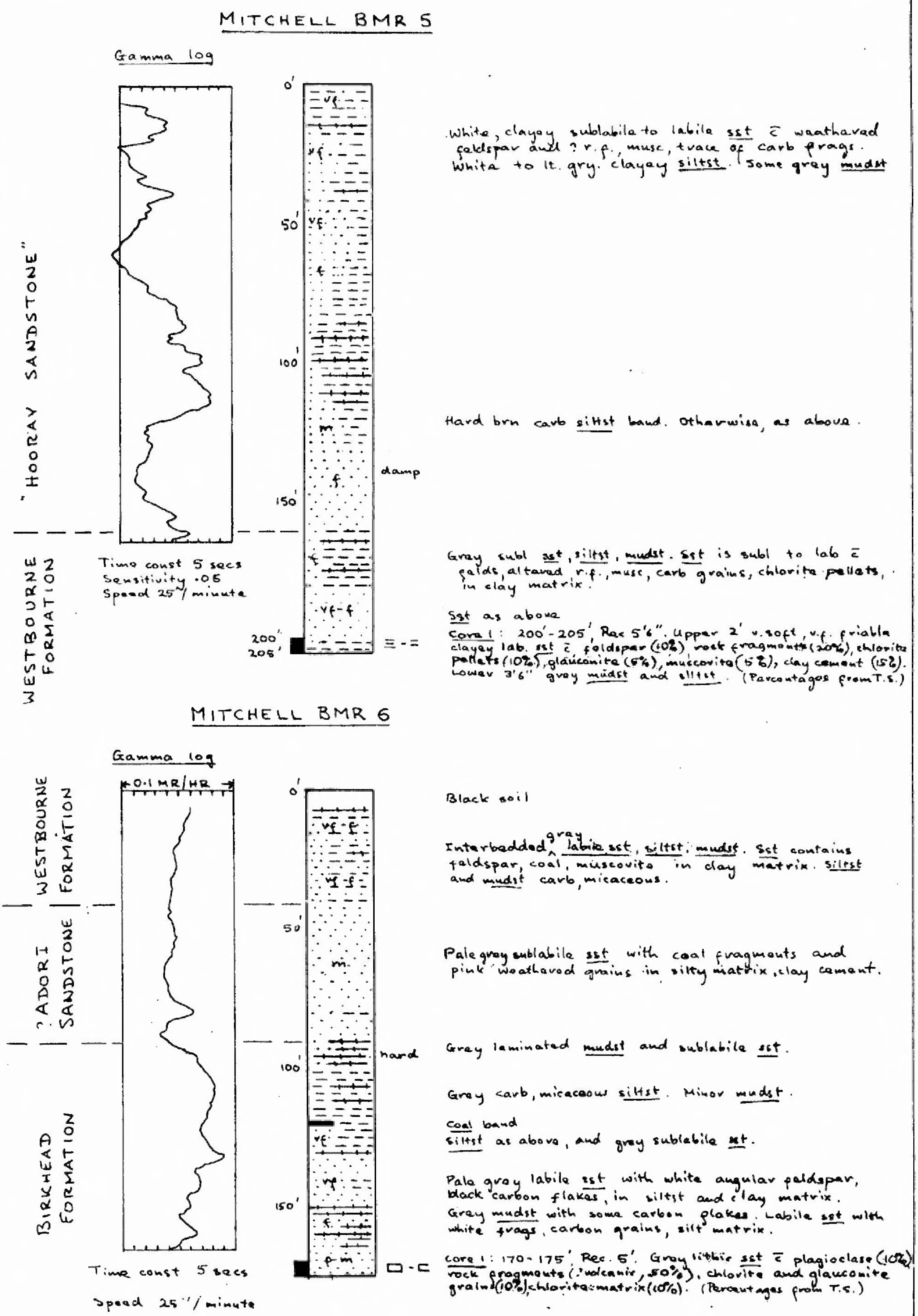
WESTBOURNE FORMATION, GUBBERAMUNDA SANDSTONE

FIG. ~~3~~ 4

G55/A11/7

To accompany Record 1966/90

FIG. 5.



SHALLOW DRILL HOLE LOGS MITCHELL 5 & 6

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

G55/A11/6
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iron ore, tourmaline, zircon and rutile also occur in some specimens. This lithology is characteristic throughout the outcrop area in the Surat Basin.

Four shallow drill holes, BMR Mitchell No. 2 and No. 3 (Figs. 4, 3), and No. 5 and No. 6 (Fig. 5), 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 intensity 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 per cent quartz, 20 per cent rock fragments, 10 per cent feldspar, 10 per cent chlorite pellets and 5 per cent glauconite, 5 per cent muscovite and 15 per cent 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., in prep.), penetrated virtually the whole 400 feet of the unit. They consist dominantly of carbonaceous, micaceous siltstone and mudstone with lesser sandstone (see Plate 7). 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. Although the Adori Sandstone is not present here, there is no evidence of a disconformity. The boundary with the Birkhead Formation is taken, in outcrop, immediately above the highest calcareous lithic sandstone bed, or immediately below the lowest very fine grained, 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 labile sandstone. In the Roma Area Westbourne lithologies give way eastwards to coarser labile "Birkhead-type" sandstone near Tallawalla Homestead. Lack of outcrop prevents any examination of this facies change. East of here the Injune Creek Group is not subdivided.

In the subsurface the characteristic high intensity gamma ray log is generally identifiable. However west of the Arbroath Trough, the Westbourne Formation becomes more sandy, and only the upper part of the unit shows the typical gamma ray log. In this area the Westbourne Formation and Springbok Sandstone have not been differentiated and are called undifferentiated Injune Creek Group (see Plate 5). The formation is also not distinguishable in the north of the Roma Sheet.

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.

In outcrop the unit thins from about 350 feet in most of the Mitchell Sheet area to 50 feet east of the Merivale Syncline. In parts of the Roma Sheet area it may be even thinner. Further north it may be up to 1000 feet thick in the Merivale Syncline (Mollan et. al., in prep.). In the subsurface (Plate 5) it thickens gradually eastwards from 355 feet in A.A.O. Lorne No. 1 to 550 feet in A.A.O. Lorelle No. 1.

No marine macrofossils have been found in this unit, and none of the poorly preserved plant remains found have been identified. Evans (Appendix 2) 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.

Undifferentiated Injune Creek Group

In most of the Roma Sheet area owing to similarity of sediments and very poor outcrop, it is impossible to subdivide the Injune Creek Group in outcrop. This sequence is more sandy, throughout, than that to the west. The siltstones, mudstones and fine grained quartzose sandstones of the Westbourne Formation are distinguishable as far east as Tallawalla Homestead in the north-west of the area but in the east of the area the sandstone below the Gubberamunda Sandstone is quite labile and grades upwards into that unit. The three constituent units of the group to the west are distinguishable only in the extreme north-west of the Roma Sheet area. East of here, where the Westbourne Formation is still identifiable, the term "undifferentiated Injune Creek Group" for the underlying sequence is preferred to Birkhead Formation, as this sequence is much more sandy than a typical Birkhead sequence.

The undifferentiated group covers much of the northern quarter of the Roma Sheet. It swings north into the broad warps of the Mimosa and Merivale Synclines.

The group consists essentially of a monotonous sequence of interbedded mudstone and sandstone. In general the sandstone crops out better, especially when it is highly calcareous, although calcareous siltstone and mudstone also form prominent outcrops at some places.

The topography of the area is generally gently undulating, with resistant beds forming small buttes. These normally consist of 10 to 20 feet of outcrop above a scree slope. The natural vegetation is dense brigalow, but this has been extensively cleared. Narrow steep-sided gullies characterize the drainage pattern. No dips are visible on the air photographs, but a regional dip to the south of more than half a degree is indicated by outcrop width and group thickness in the subsurface.

In the lower few hundred feet of the sequence mudstone greatly predominates, with intercalations of thin-bedded siltstone, very fine grained labile sandstone and occasional limestone, and coal. Some clay pebble, mud ball and quartzite pebble horizons occur. This sequence is equivalent to the lower part of the Birkhead Formation.

The remainder of the sequence is similar but contains much more sandstone and has greater relief. Mudstone crops out only in gullies or immediately below the hard capping on buttes. The sandstone is generally brown in colour, crossbedded and fine grained. It is calcareous and contains abundant intermediate volcanic fragments, quartz and plagioclase feldspar, (and some glauconite in places), in a silty matrix. It is generally even grained and the grains are largely subrounded.

A thin section of a sandstone from the upper part of the sequence, south of Glen Arden Homestead, consists of 20% quartz, 20% plagioclase feldspar, 30% rock fragments (largely volcanic) and 30% calcite cement.

The group is more sandy in the north, near the basin margin, making subdivision at this scale impossible. The subdivisions are generally evident in the subsurface, where the siltstones and mudstones of the Birkhead Formation and Westbourne Formation are readily distinguished from the sandstones of the Springbok Sandstone Member.

The group conformably overlies the Eurombah Beds. The base of the group is taken at the base of the thick mudstone sequence. In the east it is conformably overlain by the Gubberamunda Sandstone, and the contact is somewhat transitional, with the sandstone becoming less labile upward, and the proportion of siltstone and mudstone decreasing. The transitional zone is included in the Injune Creek Group. In the west the typical Westbourne sequence appears at the top of the group, and further west again the Springbok Sandstone and Birkhead Formation become distinguishable.

The undifferentiated group was deposited largely in lacustrine conditions with stream deposition increasing with time. The detritus is largely derived from intermediate or basic volcanics, and there may have been contemporary volcanism in the source area. The few crossbedding readings taken suggest deposition by westerly-flowing streams. A few glauconitic beds indicate periods of marine influence.

The unit is not a good aquifer, although some sandstone beds provide small quantities of brackish water. Coal is largely confined to the lower part of the group, and has been worked in the equivalent Birkhead Formation to the north-west near Injune.

The group thickens eastwards into the Mimosa Syncline (see Plate 5) from 1101 feet in A.A.O. Dirinda No. 1 in the west of the Roma Sheet, to 1494 feet in A.A.O. Combarngo No. 1 in the centre, to 2127 feet in U.K.A.

Conloi No. 1 in the east. Thicknesses in the outcrop area are probably comparable.

Plant fossils were collected from immediately north of Lyndon Homestead in the west. The group contains the equivalents of the Birkhead Formation and Westbourne Formation, and hence extends from Middle to Upper Jurassic in age.

UPPER JURASSIC-LOWER CRETACEOUS

Gubberamunda Sandstone

The name Gubberamunda Sandstone was first used for this unit by Reeves (1947) who did not nominate a type area. Day (1964) designated the type area as along the main Roma-Injune road from 20 to 24 miles north of Roma, where he described it as being a medium to coarse-grained, virtually uncemented, quartz sandstone.

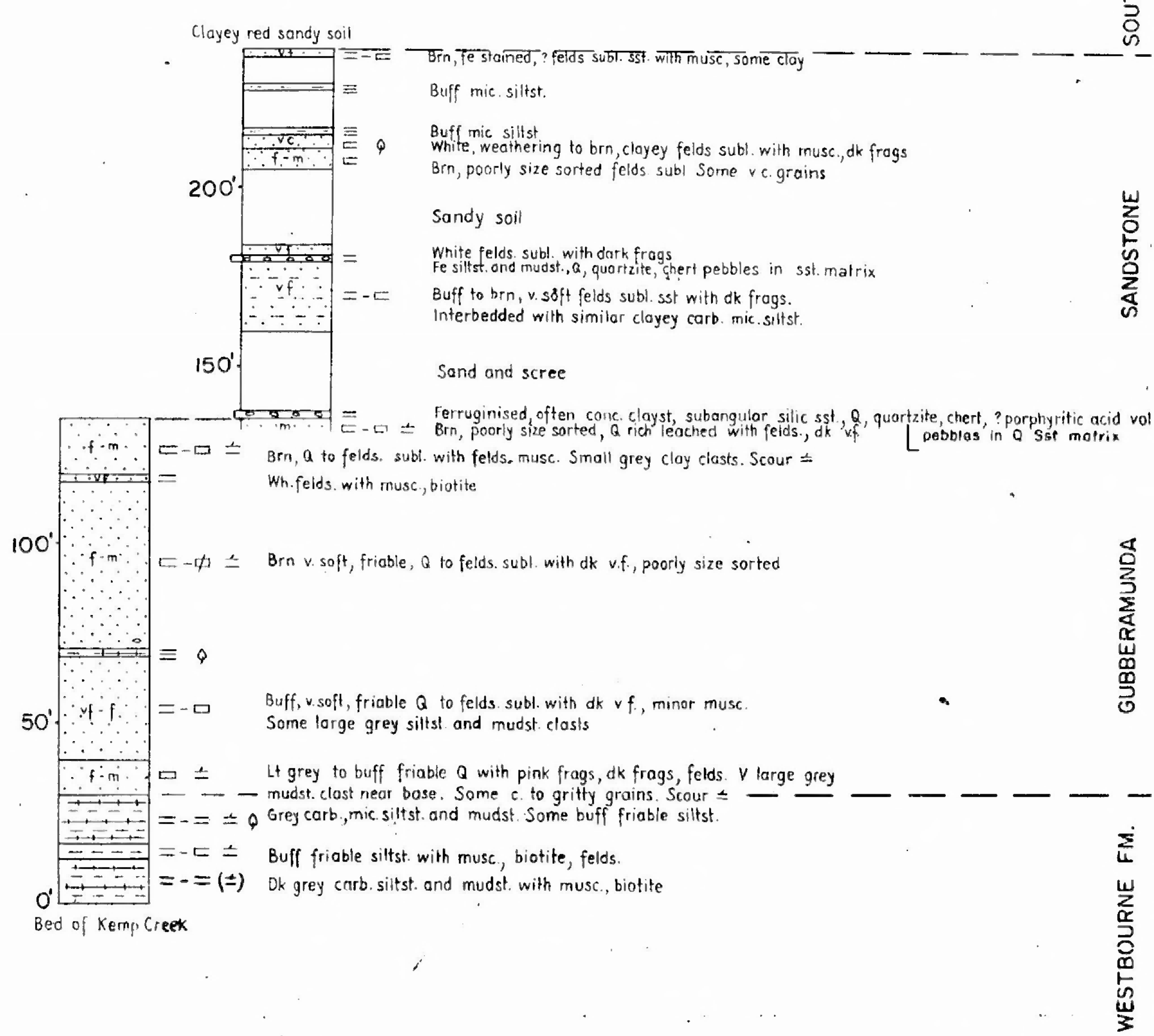
The unit crops out in the Roma, Mitchell and Eddystone Sheet areas. It extends latitudinally across the northern part of this area, in a belt up to four miles wide, as far west as the Maranoa River. The unit erodes easily, but forms low rises and cuestas above the plains developed on the Injune Creek Group. It is covered by white, grey or red sand, which is clayey in places and generally supports small eucalypts or pines. The boundary with the overlying Orallo Formation is impossible to define accurately in the airphotos (and frequently on the ground).

The unit consists of sandstone and lesser conglomerate, siltstone, mudstone and claystone. Sandstone is poorly size sorted, and quartz grains are fairly angular. It varies from quartzose to sublabile and in hand specimen consists essentially of grains of quartz, feldspar, white rock fragments, and minor but widespread black chert, sporadic muscovite and occasionally red ?garnet, set in a clay matrix. In thin section the rock fragments are shown to be siltstone, shale and quartzite, and biotite and iron ore are often also apparent. The sandstone is generally white or buff in colour, but is frequently red and ferruginized. The clay

Fig 6

GUBBERAMUNDA SANDSTONE - MEASURED SECTION M I

Measured up cliff to W, 1 mile NW of "Currawarra Homestead" and to S along road E of there. (Mitchell Run I, Photo 5030, points Mit E 600 and Mit E 623) Measured by N.F. Exon using Abney Level, set on 2°



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matrix has often weathered out. Beds are generally thick to massive, and strongly scour or planar crossbedded (Plate 2a). Asymmetrical ripple marks are fairly common. Some beds contain abundant plant impressions or clay clasts. Clayey laminae may separate sandstone beds or lie in the crossbedding. Mudballs, which weather concentrically, commonly occur in pebble beds (Plate 2b).

The conglomerate has a sandstone matrix, as above. In the Mitchell Sheet area (Fig. 6) the upper part of the formation contains abundant micaceous, and commonly carbonaceous, siltstone and mudstone.

The formation becomes thicker, finer-grained and cleaner westwards, suggesting an easterly source area. West of Roma it is dominantly fine-grained quartzose sandstone with few pebble bands and conglomerates. East of Roma it is largely poorly sorted fine to coarse grained sublabile sandstone, with more common thin conglomerate and pebbly sandstone bands which contain some cobbles.

The western conglomerate contains abundant quartz, chert and porphyritic acid volcanic pebbles, and fewer chalcedony and sedimentary pebbles. The eastern conglomerate contains, in places, nearly as many fine-grained basic volcanic pebbles and cobbles as all other pebble types combined.

The unit is very heavily iron-stained north of Roma, but is practically unstained in the west, and only in some beds in the east. Calcareous bands and concretions occur at some horizons in the east, but none have been seen in the west. These calcareous beds could have formed during weathering of calcareous horizons in the underlying and overlying units.

Shallow drill hole BMR Mitchell No. 2 (Fig. 4) in the eastern flank of the Merivale Syncline shows the lower 120 feet of the unit in that area to be almost entirely fine to coarse grained quartzose sandstone with a little mica, feldspar and clay matrix. The formation is a good aquifer.

The Gubberamunda Sandstone rests conformably on the Westbourne Formation and, where that is not identifiable, on a sandy sequence at the top of the Injune Creek Group. The contact between the Gubberamunda Sandstone and the Westbourne Formation is transitional. Typical Westbourne siltstone intertongues with medium grained quartz-rich sandstone beds, over a vertical interval of 20 feet, at an outcrop in the Maranoa River (Plate 3). 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 Gubberamunda 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.

In the east the basal sandstones of the Gubberamunda Sandstone are quite similar to those in the underlying Injune Creek Group. However, they are less labile, and contain no glauconite. Although an easterly source area for the formation is suggested by the more labile, coarse grained and thinner sequence in outcrop in that direction there is little corroborating evidence. Crossbedding readings vary almost at random; many more would be needed to get any real picture of stream patterns. Also, the subsurface thickness is quite uniform throughout the area (Plates 5, 6).

The large scale crossbedding and fairly coarse grainsize indicate that the Gubberamunda Sandstone was largely deposited in a fluviatile environment, which became lacustrine late in Gubberamunda times, in some places, away from the source area. The considerable amounts of feldspar suggest a fairly close source area, as do the basic volcanic cobbles in the east. Much of the matrix clay may have been derived from the underlying mudstones, but there has been little sorting during transport.

In outcrop the unit is about 200 feet thick in the type area, slightly thicker in the Merivale Syncline, and thins gradually west of there.

PLATE 2

(a) Scour crossbedding in Gubberamunda Sandstone; east bank of Maranoa River (609, 752).

(b) Pebbles and concentrically weathering mudclasts in Gubberamunda Sandstone in creek crossing just east of Maranoa River (610, 754).

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PLATE 3

Contact between Gubberamunda Sandstone and siltstones of Westbourne Formation in eighty foot cliff forming east bank of Maranoa River (609, 754).

It is more than 150 feet thick east of Jenavale Homestead, although on the Roma/Durham Downs road just west of the homestead it appears to be only 50 feet thick (cf. Day, 1964); the apparent thinning in this area of poor outcrop may be related to the Hutton/Wallumbilla Fault. It thins eastwards to 80 feet in the centre of the Roma Sheet (238, 750) and 10 feet beside the Jackson/Wandoan road (274, 737). It may disappear east of here but outcrop is very limited along the Sheet boundary. In the subsurface, thicknesses are about 200 feet on the Roma Shelf and to the west, and 300 feet in the Mimosa Syncline.

No shelly fossils have been found in this formation, and no diagnostic plant fossils. Spores in the unit belong to Evans' (1966) spore division J6, which is of Upper Jurassic 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 latitudinally in the northern half of the Roma Sheet area. Its surface expression is mostly a gently undulating plain with an open forest or scrub cover, but it does form distinct scarps in places. In this area it is everywhere present in the subsurface.

The formation contains abundant fine to medium grained grey, brown or greenish-brown lithic to lithic sublabile sandstone, which is commonly clayey or calcareous. It is generally medium to thick-bedded and contains both low and high-angled crossbeds. Large calcareous accretions are widespread, being particularly well developed in Bungeworgorai Creek at Johnson's Crossing (136, 725). Siltstone and mudstone, which are frequently carbonaceous, are also abundant, especially high in the unit; these grade to lignitic mudstone and coal. A little thinly bedded limestone occurs in places. Whitish clay beds near the top of the unit are bentonitic in part. Rubble of fossil wood is a feature of the unit.

The sandstone is quite variable in composition, but clasts of quartz, clayey rock fragments, hard green and black rock fragments, and feldspar, often set in a clay matrix or calcite cement, are generally apparent in hand specimen. Common accessories are muscovite, biotite, iron ore and carbonaceous fragments. Pink garnet and glauconite have been tentatively identified (in hand specimen only). In thin section (e.g. Day, 1964) the important clasts are shown to be quartz, argillaceous, andesitic and trachytic rock fragments, and both potash and plagioclase feldspar; quartz grains are quite angular, but rock fragments are generally well rounded. The sandstone varies from very fine to coarse grained. Thin pebbly beds and conglomerates are especially common near the base of the unit. Pebbles and cobbles include fossil wood, quartz, quartzite, argillite ("chert"), andesite, trachyte and porphyritic acid volcanics.

The bentonitic clays and bentonites in the top part of the formation, discovered during this survey (see Appendix 5) are described by Duff and Milligan (1967). The best samples come from near Yuleba Creek (230, 725). One sample was of excellent quality, but others examined to date have been disappointing. The table in Appendix 5 summarizes lithologies found in outcrop and in four shallow drill holes (BMR Roma Nos. 2, 3, 4, 5) in the sequence.

The Orallo Formation conformably overlies the Gubberamunda Sandstone, and is overlain by the Mooga Sandstone with regional conformity. The change from the quartzose to sublabile Gubberamunda Sandstone to the partially calcareous lithic sandstone, siltstone and mudstone of this unit is obvious in bulk, but somewhat transitional. Paucity of outcrop complicates the problem. The contact is taken as the top of the uppermost quartzose sandstone bed. Forty feet of the lowermost Orallo Formation is well exposed in an erosion gully 5 miles north-north-east of Diebert Park Homestead (199, 735). Here it consists of thick-bedded, crossbedded, fine to medium grained, pale brown, in part calcareous, lithic sublabile to lithic sandstone. Thin pebble bands contain subrounded intermediate and acid porphyrys and flows, quartz, fine sediments and clay clasts. The scour crossbedding and thick beds are reminiscent of the Gubberamunda Sandstone. In thin section the sandstone contains abundant rock fragments (volcanic, quartzite, shaly fragments) and quartz, and lesser feldspar (largely potash) iron ore and biotite.

The upper preserved sediments vary from place to place, but there is not enough evidence to determine whether this is due primarily to erosion or depositional thinning. The sediment types observed in Bungeworgorai Creek (138, 723) - carbonaceous mudstone, lignite, claystone - predominate in most of the Sheet. However, in the far east, where the contact is faulted, the top claystone/mudstone unit is apparently largely replaced by sandstone.

West of the Alicker Anticline the characteristic crossbedded quartzose sandstones of the basal Mooga Sandstone pinch out, and the three units Orallo Formation, Mooga Sandstone and Kingull Member are not readily mappable, although they are still distinguishable in the subsurface. These units are mapped together as Southlands Formation west of the anticline.

The essentially non-marine sediments of the Orallo Formation were deposited in conditions ranging from high-energy fluviatile, to deltaic, to lacustrine, to paludal. Crossbedding readings point to deposition by south-flowing streams. Possible marine influence is indicated by glauconite. The abundant calcite suggests restricted deposition, and coals suggest reducing conditions. The Orallo Formation is probably largely derived from pre-existing lithic sandstones. The upper part of the unit is probably tuffaceous in part, with bentonitic clays and some very clayey, sand sized ?tuffs.

The thickness of the formation is estimated at 350 to 450 feet (cf. Day, 1964), and subsurface thicknesses (Plates 5, 6) are comparable. The unit is sandier in the south of this area and further south the entire Mooga/Orallo/Gubberamunda sequence may have to be considered as one unit.

No plants were identified during this survey. Day (1964) listed numerous plants previously identified 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 Evans' 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 sandstone, 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 Roma area. Day (op. cit) designated the junction of Blyth and Twelve Mile Creeks as the type area of the formation. In the Roma area the unit is subdivided into four members in ascending order: Mooga Sandstone, Kingull, Nullawurt Sandstone and Minmi Members. In outcrop east of Yuleba Creek only the Mooga Sandstone and Minmi Members are present. In outcrop west of the Alicker Anticline the lower two members are not distinguishable from the Orallo Formation, and the three units are mapped together as Southlands Formation. A few miles further west a new unit, the Claravale Sandstone Member (of the Blythesdale Formation) appears between the Southlands Formation and the Nullawurt Sandstone Member; this is confined to the Merivale Syncline (a broad feature which includes lesser structures within it). The variations are illustrated as follows:

Mitchell area	Roma area	Jackson area
Minmi Member	Minmi Member	Minmi Member
Nullawurt Sandstone Member	Nullawurt Sandstone Member	
Claravale Sandstone Member	Kingull Member	
Southlands Formation (upper part)		
	Mooga Sandstone Member	Mooga Sandstone Member

The Mooga Sandstone, Kingull and Claravale Sandstone Members were apparently deposited entirely in freshwater environments. Deposition of the Nullawurt Sandstone was generally in freshwater, but was in a paralic environment in the Merivale Syncline. Deposition of the Minmi Member varied from paralic to marine environments.

West of the Maranoa River only the Minmi Member can be differentiated; the remainder of the sequence was mapped as undifferentiated Blythesdale Formation. In the Mount Scott Syncline the Southlands Formation pinches out and the Gubberamunda/Blythesdale sequence is mapped as Hooray Sandstone. In this area, the Minmi equivalent has been mapped as a sandy facies within the Doncaster Member of the Wallumbilla Formation.

In the subsurface (Plate 5) it is possible to trace all the members of the Blythesdale Formation (excluding the Claravale Sandstone) as far west as Amoseas Strathmore No. 1. Beyond there the Orallo Formation pinches out, and the Mooga Sandstone cannot be distinguished from the underlying Gubberamunda Sandstone. However the Minmi, Nullawurt Sandstone and Kingull Members can be identified right across the area.

Three shallow drill holes penetrate parts of the formation. BMR Roma No. 1, near Roma town and BMR Mitchell No. 11 in the Merivale Syncline, penetrated parts of the Doncaster Member of the Wallumbilla Formation, and the Minmi, Nullawurt Sandstone, Kingull and Mooga Sandstone Members. BMR Mitchell No. 1, near the Maranoa River, penetrated the basal Doncaster Member and the upper part of the Blythesdale Formation.

Eight measured sections in the formation in the Merivale Syncline are illustrated in Plate 7.

Mooga Sandstone Member

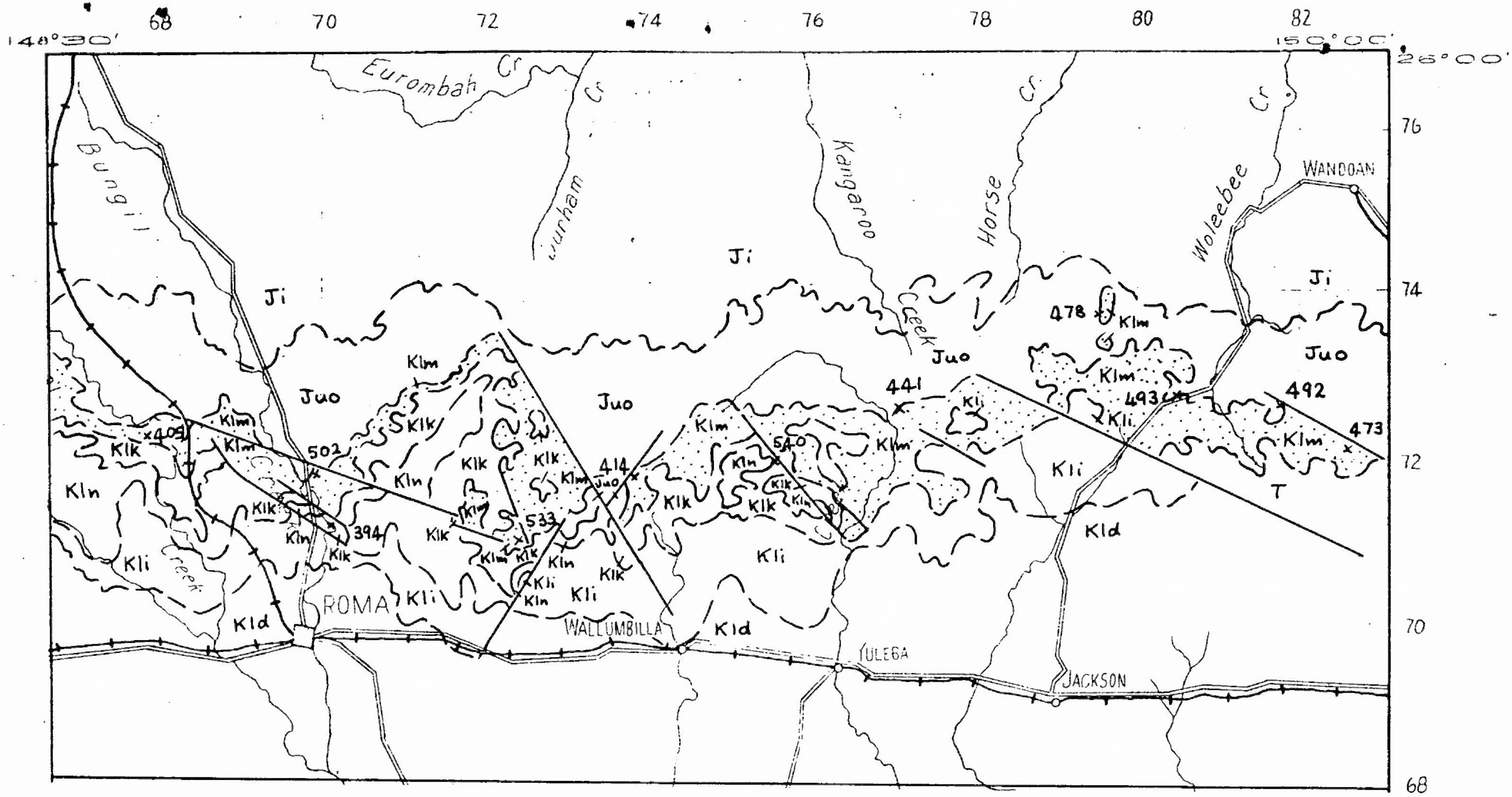
Day (1964) nominated the type area of this unit as near the junction of Bungil and Mooga Mooga Creeks. Its mapped extent is from the Alicker Anticline east to the boundary of the Roma and Chinchilla 1:250,000 Sheets. It has been reliably identified from wire-line logs as occurring in deep wells in the southern part of the eastern Mitchell and western Roma Sheet area. In outcrop it forms long low cuestas, rising above the plains of the Orallo Formation.

In the type area, the member comprises a fairly uniform sequence of over 100 feet of dominantly grey to yellowish brown, moderately hard, fine grained quartzose and sublabile sandstones. Away from the type area, particularly to the east, intervals of soft labile sandstones and mudstones form a more significant part of the member. Nearly 40 feet of continuous outcrop occurs at Bungeworgorai Creek, and three units can be recognised.

<u>Top</u>:

Unit 3	46 feet: (top 28 feet not well exposed)	<u>sandstone</u>; sublabile, firm to hard, medium to fine grained, thin bedded. Some thin shaly siltstone beds, scattered pebbles and small conglomerate lenses. Concretionary near the top.
Unit 2	11 feet:	<u>mudstone</u>; massive, dark grey. Some carbonaceous laminate beds.
Unit 1	10 feet:	<u>sandstone</u>; sublabile to quartzose, fine grained, conglomeratic, massive, cross bedded.

These units can be traced over a large part of the outcrop area in the Roma Sheet area. At Blyth Creek, part of unit 3 is replace by soft, slightly muddy labile sandstones; east of this area the middle part of the unit becomes increasingly muddy and a distinctive sequence (unit 3b) of soft, greenish labile sandstones (occasionally calcareous) and laminated and massive dark grey carbonaceous mudstones is developed.



LOCATION OF BLYTHESDALE SECTIONS

ROMA SHEET

G 55/A12/10

Stratigraphic referance

Kld	Doncaster Member (Wallumbilla Formation)	
Kli	Minmi Member	Blythesdale Formation
Kln	Nullawurt Sandstone Member	Blythesdale Formation
Klk	Kingull Member	Blythesdale Formation
Klm	Mooga Sandstone Member	Blythesdale Formation
Juo	Orallo Formation	
Ji	Injune Creek Group	

Scale (miles)

10 0 10

General referance

— — — geological boundary

——— fault

x 394 location of section (with reference no.)

Locality 540 is "Starfish" hill of text

Fig. 8

To Accompany Record 1967/63

The top of the unit (3b) is a distinctive marker horizon of thick bedded cross bedded, pebbly sublabile sandstone (pebbles are quartz). The basal part of the unit (3c) becomes more pebbly towards the north-east and, with the lensing out of unit 2, becomes indistinguishable from unit 1. A comparison of the thicknesses of the various units is given below. The location of the sections is given in Fig. 8.

THICKNESSES OF UNITS WITHIN THE MOOGA SANDSTONE

Unit	405	502	533	414	441	478	493	492	473
3 a			10'	25'	6'	?	?	18'	6'
3 b	46'	80'	25' ca	30' ca	25'	24'	40'	30' ca	80'
3 c		faulted		20'	26'				
2	11'	0'	?	6'	6'	40'	36'	30'	25'
1	10'	20'		10'	25'				
	67'	100'		91'	88'+	64'+	76'+	78'	111'

The contact with the underlying Orallo Formation is visible at a number of localities and is especially well exposed at Bungeworgorai and Yuleba Creeks. As the Orallo section is essentially similar in areas some eighty miles apart it is evident that there is no regional unconformity between the two formations. Local scouring is in evidence however, and the fact that there is a strong contrast in the sediments, from coaly mudstone and claystone to conglomeratic sandstone, suggests the possibility of a local diastem.

Near the Alicker Anticline unit 1 pinches out and, west of here, with this distinctive marker unit missing and poor outcrop, it has not been possible to maintain the division into Orallo Formation, Mooga Sandstone Member and Kingull Member. The three are there mapped together as Southlands Formation. However fine grained Mooga-type lithologies are present at the corresponding level in the Southlands Formation.

At the commencement of Mooga times there was rapid deposition of fairly clean sands on the muddy Orallo sediments, by south flowing streams. Then followed a quieter period of deposition, largely in lakes. Streams returned in some areas late in the period of Mooga deposition.

The Mooga Sandstone thickens southwards into the basin in the subsurface, from the outcrop thickness of about 100 feet, to about 500 feet in A.A.O. Brucedale No. 1.

The member contains remains of long-ranging plant types which are of little use for dating (those collected from one locality during this survey are of probable Lower Cretaceous age - Appendix 4). Spores in the unit belong to Evans' (1966) spore division Kla which is of probable Lower Cretaceous age (Evans, in prep.).

Kingull Member

Day (1964) nominated the type area of this member as the area near Bungeworgorai Creek extending from about 1 mile north of Kingull Siding, southwards to where the Roma-Orallo Road crosses the Creek. It has a characteristic development throughout the 'Roma-Wallumbilla' area described by Day, but west of this area it loses its distinctive nature and grades into the Southlands Formation. It probably lenses out to the east. Due to the incoherent nature of the sediments, outcrop is not widespread, but is localised in steep undercuts of the major streams. The gentle slopes of the unit are covered with clayey soil and calciphile vegetation.

The member comprises a wide variety of lithologies but is readily identified by the friable nature of the non-calcareous sandstones and the common occurrence of angular quartz grains, cross-bedding, scour channels, lenses with heavy mineral concentrations, and concentrations of calcium carbonate.

Over 80 feet of section typical of the member is exposed 8 miles north-north-east of Roma (locality 394, Fig. 8) and comprises mainly fine to very fine grained sublabile sandstone and grey carbonaceous mudstone.

Top:	Nullawurt Sandstone Member overlying:
10 feet of	sandstone; medium to very fine grained, sublabile to labile, soft. Some grey mudstone. Concretionary bed at base rich in wood.
12 feet of	mudstone; grey, interlaminated with minor labile siltstone.
1 foot of	sandstone; quartzose (angular), granular in the top 1-2 inches scouring medium grained quartzose sandstone below.
12 feet of	mudstone; light grey, irregularly bedded.
22 feet of	sandstone; quartzose to sublabile (angular quartz; rounded lithics and feldspar), medium grained (grading to very fine grained at the top), thin bedded to laminate. Scoured basal contact. One discontinous (ca 1 foot) calcareous lens with rich pockets of heavy minerals.
10 feet of	siltstone; muddy, massive, with some thin laminae of grey mudstone and carbonaceous material.
8 feet	unexposed.
4 feet of	siltstone; as above, but laminated.
79 feet of section, base not exposed.	

BMR Roma No. 1 penetrated 55 feet of similar sediments. Scour and fill structures, cross bedding, poor sorting and accumulations of plant material (including entire leaves and pinnules) are common throughout this section of the core.

The contact with the underlying Mooga Sandstone Member is not exposed, but was observed in BMR Roma No. 1 to be gradational.

West of the Alicker Anticline, Kingull-type sediments are found in the equivalent upper part of the Southlands Formation. The Kingull member, which was deposited in lakes, is remarkably constant in thickness throughout the area, being about 100 feet thick in outcrop, and between 100 and 150 feet thick in the subsurface. The unit contains abundant plant remains and, in BMR Mitchell No. 11, spores of Evans' (1966) spore division Kla, of Lower Cretaceous age Evans (in prep.).

Claravale Sandstone Member

This unit is named from Claravale Homestead in the Mitchell Sheet area and is defined in Mollan et al. (in prep.). The type section (Plate 7) is in the lowermost scarp on the western side of Long Gully, 4 miles north-west of Claravale Homestead (627, 752). There the unit consists of 23 feet of very fine to medium grained brown quartzose sandstone with some feldspar grains, clayey rock fragments, and clay matrix. It contains small scale crossbedding and ripple marks, and is poorly medium to very thickly bedded. There are some coarse grains and a few pebbles of quartz and quartzite. Wood impressions, carbonaceous plant remains and worm casts are common.

The member is confined to the Merivale Syncline. It forms low scarps at the base of stepped mesas, and contrasts with the low relief of the underlying formation. It extends from Landreath Homestead in the north-east of the Mitchell Sheet, north-west to the Eddystone Sheet boundary, and thence south-west to the Maranoa River. It is sand covered, and supports calciphobe vegetation.

The Claravale Sandstone Member is dominantly a sandstone as in the type section, with some siltstone and mudstone (often containing plant remains). The sandstone varies from white to brown, and is porous in outcrop. In places it contains quartz pebbles and bands of clay clasts. Accessories in the sandstone include quartzite and shale fragments, minor magnetite, and very minor muscovite and tourmaline.

Five thin sections of sandstones from the unit are of clayey quartzose sandstone. These consist of about 80 per cent quartz (including some quartzite) and 10 per cent clay matrix; lesser constituents include shaly rock fragments, feldspar (dominantly potash feldspar) and, in some specimens, muscovite, biotite, and minor magnetite, tourmaline, rutile and zircon.

The Claravale Sandstone is a member of the Blythesdale Formation. It is structurally conformable on the Southlands Formation. A six-inch ferruginized zone at the top of the Southlands Formation (630, 770), and the marked change from the fine grained, incompetent sediments of the Southlands Formation to the Claravale Sandstone, suggest disconformity with possibly a brief period of sub-aerial weathering. The member is conformably overlain by the Nullawurt Sandstone Member which is thinly and well bedded, and very fine grained. The Claravale Sandstone is probably equivalent to the upper part of the Kingull Member in the Roma area. The onset of quiet lacustrine conditions under which the Nullawurt Sandstone was deposited probably occurred at the same time everywhere, and the base of the Nullawurt Sandstone would thus be a time line. East of the furthest extent of the Claravale Sandstone, the Nullawurt Sandstone directly overlies the Kingull Member. West of the furthest extent of the Claravale Sandstone Member undifferentiated Blythesdale Formation directly overlies the Southlands Formation.

The observed thickness of the member ranges up to 80 feet, but is generally about 30 feet. Crossbedding attitudes have a wide range, but generally deposition seems to have been from easterly-flowing streams. Claystone beds may represent deposition away from the main channels during floods. The fairly coarse deposits of this member were confined to the downwarp of the Merivale Syncline; equivalents elsewhere are much finer grained. There is no evidence of this member in the subsurface (even in BMR Mitchell 11, only 4 miles south-west of the nearest outcrops) and it was probably confined to the marginal area of the syncline.

The unit contains wood impressions. Leaf fragments are common in the finer beds. None of this material has been identified. The age of the member is probably Lower Cretaceous; it overlies the conventionally Lower Cretaceous Mooga Sandstone equivalent. Its equivalents fall within Evans' (1966) spore division Kla, of probable Lower Cretaceous age (Evans, pers. comm.).

Nullawurt Sandstone Member

The type area of the member was nominated by Day (1964) as the area near the Injune Railway line extending from 0.25 miles south of Kingull Siding, southwards as far as Nullawurt Siding. The member was recognized as a distinctive marker in the field near the type area where strong benches have been formed by stream erosion. Away from the type area, the member becomes increasingly difficult to map as resultant beds are much thinner. The member has been identified only as far east as 'star-fish' hill (Fig. 8) north-north-east of Wallumbilla.

Day (op. cit. p. 12) described the member as 'about 50 feet of non-calcareous, yellowsih-brown fine to very fine orthoquartzites...'. This lithology does in fact form most of the outcrop, but occurs commonly only at the top and the base of the member; the remainder of the member comprises thin calcareous labile sandstone, soft labile sandstone and carbonaceous grey mudstone. These lithologies crop out only poorly and their presence is inferred in most cases by the appearance of a belt of brigalow scrub between the top and bottom sandstone benches.

BMR Roma No. 1 penetrated 61 feet of this member. A summary of the lithologies encountered is:

Top:	Mudstone of the Minmi Member overlying:
6 feet of	sandstone; fine to very fine grained, sublabile. Undulate bedded at top grading to massive below.
2 feet of	mudstone and siltstone interlaminated; grey to dark grey, shaly.
1.5 feet of	sandstone; fine to medium grained, very hard, silicified.
4 feet of	mudstone and siltstone interlaminated; as above. 4 inches of chert with plants.
5 feet of	sandstone; sublabile medium grained, poorly sorted, massive, common plant material.
5 feet of	mudstone; interlaminated hard, light grey and soft dark grey. Sandy mudstone and rare sandstone cross laminae.

10.5 feet of	sandstone and mudstone interbedded; sandstone - medium to coarse grained and granular, quartzose to sublabile; mudstone - fine to very fine, very carbonaceous laminae.
12 feet of	siltstone and mudstone interlaminated; siltstone - labile, cross laminated with carbonaceous material.
15 feet of	sandstone; fine grained, sublabile, poorly sorted, massive faintly cross laminated, very carbonaceous at the base.
61 feet of	Nullawurt Sandstone Member overlying Kingull Member.

Day (op. cit.) estimated the Nullawurt Sandstone Member was about 50 feet thick at the type locality. An estimated 80 feet of this member was penetrated in BMR Mitchell No. 11, which is some 20 miles east of its western mapped limit. At its eastern mapped limit ('star-fish' hill) its thickness is approximately 45 to 50 feet.

West of the type area, in the Merivale Syncline, which was apparently a low area in Nullawurt times, the environment of deposition was paralic. The sediments are still largely white to buff, well-bedded, thin to medium bedded, fine grained clayey quartzose sandstone and siltstone, showing low angle crossbeds and ripple markings. However, marine pelycepods and glauconite are abundant in some beds in the upper half of the unit.

That conditions were transitional between lacustrine and shallow marine is shown by the assemblage at S210 (627, 748), where abundant freshwater pelycepods were preserved in fine sandstone in their growth positions with the valves closed, and associated with marine forms. It is suggested that the freshwater forms were living in a back shore lagoon protected by a sand bar from the sea. The bar broke, the sea rushed in and the fauna was engulfed.

In this area the thickness of the member varies between 50 feet (Section M6) and 100 feet (Section M11). Eleven thin sections of sandstones were examined, 9 from outcrop samples, and 2 from cores in BMR Mitchell 11. In all, quartz is the dominant clast and feldspar is virtually absent. The quartz clasts are angular and elongate, suggesting little reworking. The rock fragment content (quartzite and mudstone) varies from absent to 25% and averages 10%. Clay matrix is generally present, and varies widely in quantity.

Glauconite is a common accessory, varying from absent to 10% of the rock. It is generally abraded and altered, and is not at all obvious macroscopically in these very fine grained sediments. Minor accessories are muscovite, biotite, magnetite, carbonaceous debris, and occasionally, tourmaline, rutile and zircon.

The marine fauna consists largely of pelycepods with a few gastropods. These are probably of Neocomian age (see Appendix 1). Spores in BMR Mitchell No. 11 (Appendix 3) belong to Evans' (1966) division Kla of Lower Cretaceous age (Evans, in prep.). Plants and freshwater pelycepods are of little use for precise dating of the unit (plants collected during this survey are of Lower Cretaceous age - Appendix 4).

Minmi Member

The Minmi Member was described by Day (1964, p. 13) as '..... dominantly fine and medium grained calcareous and glauconitic protoquartzites which often have clayey shale fragments, coarse grained lenses and bands, and large ovate fontainebleu sandstone concretions. In places marine fossils and fossil wood are abundant. Minor clayey and silty shales, and siltstones are also common and thin intraformational mud pebble conglomerates occur occasionally .....'. The type locality was designated as the area near Bungil Creek at Minmi crossing extending approximately 0.5 miles north and south of the crossing.

The sandstones of this member crop out well, but significant sections of soft siltstones and mudstones crop out rarely (except in scarps developed in deep weathered sediments) and even approximate thicknesses cannot be measured from surface exposures. The ratio of sandstone to siltstone and mudstone in BMR Roma No. 1 was three to one and this is comparable with the ratio generally observed in 'deep weathered' scarp outcrops. In the north-west of the Merivale Syncline sandstone predominates.

The member is not mappable far west of the Forest Vale Anticline. Its absence in surface outcrop west of the Maranoa River is due to widespread Cainozoic cover, as sandstone typical of the Minmi Member was recovered from BMR Mitchell No. 1 and Amoseas Dulbydilla No. 1. The few small glauconitic sandstone outcrops found in this area may be part of the Minmi Member or sands within the Doncaster Member. They have arbitrarily been included in the Doncaster Member and stippled on the map. Outcrop of the member has been traced as far east as the eastern edge of the Roma Sheet area.

Overall, the member is characterised by the features resulting from the marine environment of deposition i.e. glauconite, marine shelly fossils and bioturbidites. In only one area (north of Amby) do these features definitely occur in the underlying Nullawurt Sandstone Member. In the east, it is possible that marine sediments mapped as Minmi member are Nullawurt equivalents.

BMR Roma No. 1 penetrated a typical section of the member. Glauconite occurred throughout the section.

Top:	Grey mudstone of the Wallumbilla Formation overlying:
10 feet of	sandstone; very fine to fine grained, argillaceous, thin to medium bedded. Minor mudstone and siltstone.
47 feet of	sandstone and mudstone interlaminated. Sandstone - very fine to fine grained, labile, argillaceous, poorly sorted. Mudstone - grey, with cross laminations with plants.
2 feet of	sandstone; medium grained - as above. Minor mudstone with 'pull apart' structures.
5 feet of	siltstone; labile, bioturbidites common; some shelly fossils.
40 feet of	sandstone; fine grained, labile argillaceous, massive with bioturbidite intervals. Minor mudstone with shelly fossils near base.
15 feet of	sandstone and mudstone interlaminated - as above. Bioturbidites and shelly fossils.
10 feet of	sandstone; labile, argillaceous; hard calcareous and soft interbedded.

9 feet of	sandstone; argillaceous, grading to mudstone, sandy. Plants with pyrite coating. Some bioturbidite intervals.
4 feet of	sandstone; quartzose to sublabile, medium to coarse grained, poorly sorted.
21 feet of	sandstone; argillaceous, as above. Minor siltstone with bioturbidites and shelly fossils.
10 feet of	siltstone; sublabile interlaminated with mudstone. Bioturbidite intervals common.
7 feet of	sandstone very fine grained, sublabile. Vertical worm tubes.
10 feet of	mudstone and siltstone; interlaminated. Minor sandstone lenses; shelly fossils.
2 feet of	sandstone; sublabile argillaceous. Minor mudstone interlaminations.
9 feet of	mudstone; laminate. Silty and sandy interbeds. Plant impressions with pyrite replacement.
201 feet of	Minmi Member overlying Nullawurt Sandstone Member.

In the Merivale Syncline the sediments are somewhat different from elsewhere, representing a change of facies. In the north-western part of the syncline around Eastern Creek Homestead (e.g. Section M5, Plate 7), there is several hundred feet of fine to medium-grained, thick-bedded crossbedded quartzose sandstone. Although there is some glauconite and marine fossils in this sequence, much of the member must be of fluviatile origin; crossbedding readings indicate deposition by south-easterly flowing streams. Marine fossils are mainly water worm Tatella and Fissilunula. There is a little siltstone and mudstone in this sequence. A particularly good exposure of thick-bedded, planar crossbedded sandstone is in a creek north of Heather Downs Homestead (638, 732).

Further south and east the sandstones become more clayey and slightly more labile, and siltstones and mudstones predominate. Burrowing shelly fossils become locally abundant. In a gully at SB246 (645, 720) there is ten feet of thick-bedded, crossbedded, poorly sorted, pebbly in part, sandstone. Banks of shell grit, consisting almost entirely of Inoperna valves occur in this sequence. A typical exposure of the more argillaceous sequence occurs in the bank of Taboonbay Creek at 647, 717. Here there is 35 feet of thinly interbedded very fine grained, greenish glauconitic quartzose sandstone and similar siltstone, and grey carbonaceous siltstone and mudstone. Areas of intermingled silty and muddy sediments due to burrowing organisms, are common (as also in BMR Mitchell No. 11). There is also 3 feet of thick-bedded, fine grained sandstone with some pebbles. Calcareous beds and lenses are confined to the sandstone and coarser siltstone.

Although the proportions of fine and coarse material change southwards the rock types are all quite similar. It seems that the sea level fluctuated in the syncline, with marine conditions more common basin-wards.

Sandstone is commonly quartzose to sublabile, weathered and friable; it is clayey or silicified in places. It is thick-bedded, very poorly bedded, and strongly crossbedded (both low and high angled). It contains glauconite, clayey rock fragments, clay clasts, fossil wood, and lesser feldspar, muscovite, biotite and iron ore in some beds. Pebble bands with subangular pebbles of quartz, quartzite, "chert", fine metasediments (including green phyllite), and fine grained and porphyritic acid and intermediate volcanics occur sporadically. Small worm tubes are especially common near the contact with the Nullawurt Sandstone, and larger burrows are also common. Interference and current ripple marks are well developed in places. Siltstone and mudstone are laminated to thin-bedded and frequently carbonaceous and micaceous. Very clayey white, very fine grained glauconitic sandstone and siltstone is a characteristic lithology. In the south-east some fine to medium grained sandstones are very clayey and contain smeared-out glauconitic mudstone clasts; the mudstone was probably not fully consolidated when scoured and incorporated in the overlying sandstone.

Day (1964) examined thin sections of "friable protoquartzites" from the Roma area. He stated "70-80 per cent of the clastic fraction is rather angular quartz". The remainder "is composed of rounded ..... glauconite (10-15 per cent), rounded argillite and quartzose sandstone fragments (7-10 per cent), fresh lath-shaped plagioclase feldspar

(3-5 per cent), and occasional coal fragments".

In this survey, twelve thin sections of sandstone from the Merivale Syncline were examined. These are very similar to those in the Roma area, with abundant quartz, 0-15 per cent rock fragments (quartzite, shale, occasional volcanics), and very minor plagioclase. (The fragments called "quartzite" and "shale" are probably the same as those called "quartzose sandstone" and "argillite" by Day). Common accessories are glauconite (0-20 per cent) and minor muscovite, biotite, iron ore, zircon and tourmaline. Rutile and possible garnet also occur. Some rocks have up to 5 per cent clay matrix, others up to 30 per cent calcite cement. These quartzose to sublabile sandstones contain less feldspar than those near Roma, and quartz grains are perhaps slightly better rounded.

The sequence in BMR Roma No. 1 is an unusually thick development of Minmi Member for the area north of Roma. Day (1964) estimated the thickness of the member to be in the vicinity of 50-70 feet. This figure is comparable to that estimated from outcrop observations in the present survey in most of the area. However, in the Merivale Syncline, thicknesses of greater than 200 feet occur (e.g. Section M5, Plate 7). In the Roma area the unit thickens rapidly into the basin to a maximum of 233 feet in A.A.O. Apple Grove No. 1. Most Roma Shelf wells have about 200 feet of the member, but it thins gradually westwards to 71 feet at Amoseas Scalby No. 1.

The marine macrofossils (Appendix 1) are of Aptian age. Core 1 in BMR Mitchell No. 11 contains spores of Evans (1966) division klb-c, and Core 2 spores and dinoflagellates of division kla (Appendix 3). Thus the boundary between the two spore divisions lies within the upper half of the member in this hole. Both divisions are of Lower Cretaceous age.

Undifferentiated Blythesdale Formation

Between the Maranoa River and the pinch-out of the Soutlands Formation, the sequence between the Minmi Member and the Southlands Formation cannot be readily subdivided. This sequence has been mapped as undifferentiated Blythesdale Formation.

The lower part of the unit forms several benches and crops out well. It consists largely of fine grained well-bedded quartzose sandstone and is probably the continuation of the Nullawurt Sandstone Member (see Plate 4b). This distinctive sandstone can be traced for some distance into the Hooray Sandstone, west of the arbitrary boundary between the Blythesdale Formation and that unit.

Above the scarps, outcrop is generally poor and sand cover is extensive. However the upper part of the unit 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 cross-bedding 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.

This upper sequence is probably equivalent to the lower part of the Minmi Member in the Maranoa River (612, 726), where there is 40 feet of fresh outcrop of thin to medium-bedded, very fine grained, calcareous glauconitic lithic sublabile to quartzose sandstone, and laminated grey gypsiferous mudstone. This is overlain by 30 feet of weathered, fine grained, medium to thick bedded, crossbedded quartzose sandstone. The whole sequence contains plant remains. As glauconite is quite rare overall in the Minmi Member in this area, especially in weathered exposures, it is quite likely that the similar sediments further west, which are further from the low of the Merivale Syncline, do not contain any glauconite.

The undifferentiated Blythesdale Formation is generally overlain by Cainozoic sediments, but north of Dunedin Homestead there is some definite Minmi Member overlying it. The unit in this area is probably 200 to 300 feet thick.

Blythesdale Formation; environment of deposition, fossils, age

Environment of deposition

The Blythesdale Formation (and the upper Orallo Formation) provides a record of deposition of carbonaceous muds and muddy sands, interrupted by intervals of deposition of moderately to very clean sands i.e. Mooga Sandstone Member units 1, 3a and 3c, Claravale Sandstone Member, basal and upper sands of the Nullawurt Sandstone Member, and sands in the Minmi Member in the Merivale Syncline. The clean nature of these sandstones deposited in an essentially muddy environment indicates periodic transport of the sands from another area and winnowing by strong currents. These periods of strong current action persist into Wallumbilla times where there is some evidence of communication to the open sea. The Merivale Syncline has an exceptionally high proportion of clean sands around the basin margins. It was apparently a low area, in which fairly fast flowing streams deposited mainly sand; muds were deposited further out into the basin.

The persistence of uniform sandstone beds (especially in the Mooga and Nullawurt Sandstones) over large distances indicates that the basin of deposition was large and uniform. The Kingull Member, by contrast, is characterised by ephemeral sandstone bodies and is more typically an area of fluviatile environment. It may represent local deltaic deposition.

The low area of the Merivale Syncline is the only place in which marine conditions (glauconite and marine fossils in the Nullawurt Sandstone Member) are known to have definitely occurred before the time of Minmi deposition in the type area. The same could have applied west of the Roma-Wallumbilla area where the Kingull Member lenses out. Sandstone with a Nullawurt lithology directly overlie the Mooga Sandstone Member but they are interbedded with glauconitic and fossiliferous beds. The faunal content cannot be distinguished in age from the Minmi Member fauna in the Roma-Wallumbilla area, and these beds have been mapped as Minmi Member. It is possible that marine conditions existed in the east while the fresh water Kingull Formation and Nullawurt Sandstone Member were being deposited in the Roma area.

At the time of deposition of the Minmi Member, a widespread marine incursion allowed the formation of glauconite, and the introduction of a marine fauna, but otherwise this member is similar in overall content to the mudstone and sandy mudstone of the other members.

Fossils and age

Marine shelly fossils are not known from any sediments below than the Minmi Member, with the exception of the Nullawurt Sandstone Member north-east of Mitchell. The only shelly fossils recorded before this time are fresh water unionid pelecypods in the Mooga Sandstone Member and the Nullawurt Sandstone Member. Well preserved plant material occurs in all the members. Day (1964, p. 15) has listed the fossils identified up to that date from the Blythesdale Formation.

Collections from the Minmi Member and the Nullawurt Sandstone Member made during this survey are described in Appendix 1 of this report. All marine shelly fossils in the formation are of Lower Cretaceous age. Those in the Minmi Member are Aptian. Those in the Nullawurt Sandstone are Aptian or possibly Neocomian.

Plants are generally long-ranging species, some of which can be assigned to the Lower Cretaceous (see Appendix 4). Dinoflagellates occur in the upper part of the formation, and spores throughout the sequence (see Appendix 2, 3); these belong to Evans (1966) spore divisions Kla and Klb-c. Klb-c is definitely Lower Cretaceous, and Kla probably is (Evans, pers. comm.). For convenience the Mooga Sandstone is conventionally regarded as lowermost Cretaceous.

Southlands Formation

This formation, defined in Mollan et al. (in prep.) is named after Southlands Parish and Holding. The type section (Fig. 7) is in the western slope and cliffs of the Great Dividing Range, four miles west of Hidden Springs Homestead on Eddystone Sheet, just north of the Mitchell Sheet area.

The formation forms a belt of country, generally of fairly low relief, from the Alicker Anticline near the eastern margin of the Mitchell Sheet area, westwards across the Mitchell and Eddystone Sheets. It pinches out about eight miles west of the Forest Vale Anticline, in the central north of the Mitchell Sheet. It is generally covered with brigalow-wilga-belah-sandalwood-bottle tree scrub, but more sandy areas have calciphobe vegetation.

The lower half of the formation is largely fine to medium grained calcareous clayey sublabile to labile sandstone containing dark rock fragments and a few pebbly bands. It is generally thickly bedded and crossbedded.

The upper half is finer grained and less labile. It consists largely of thinly bedded mudstone, siltstone and very fine grained quartzose to sublabile sandstone. There are also some calcareous beds and some coarse gritty sandstone beds. The lower part of this half is quite clean, but the upper part is clayey and more labile.

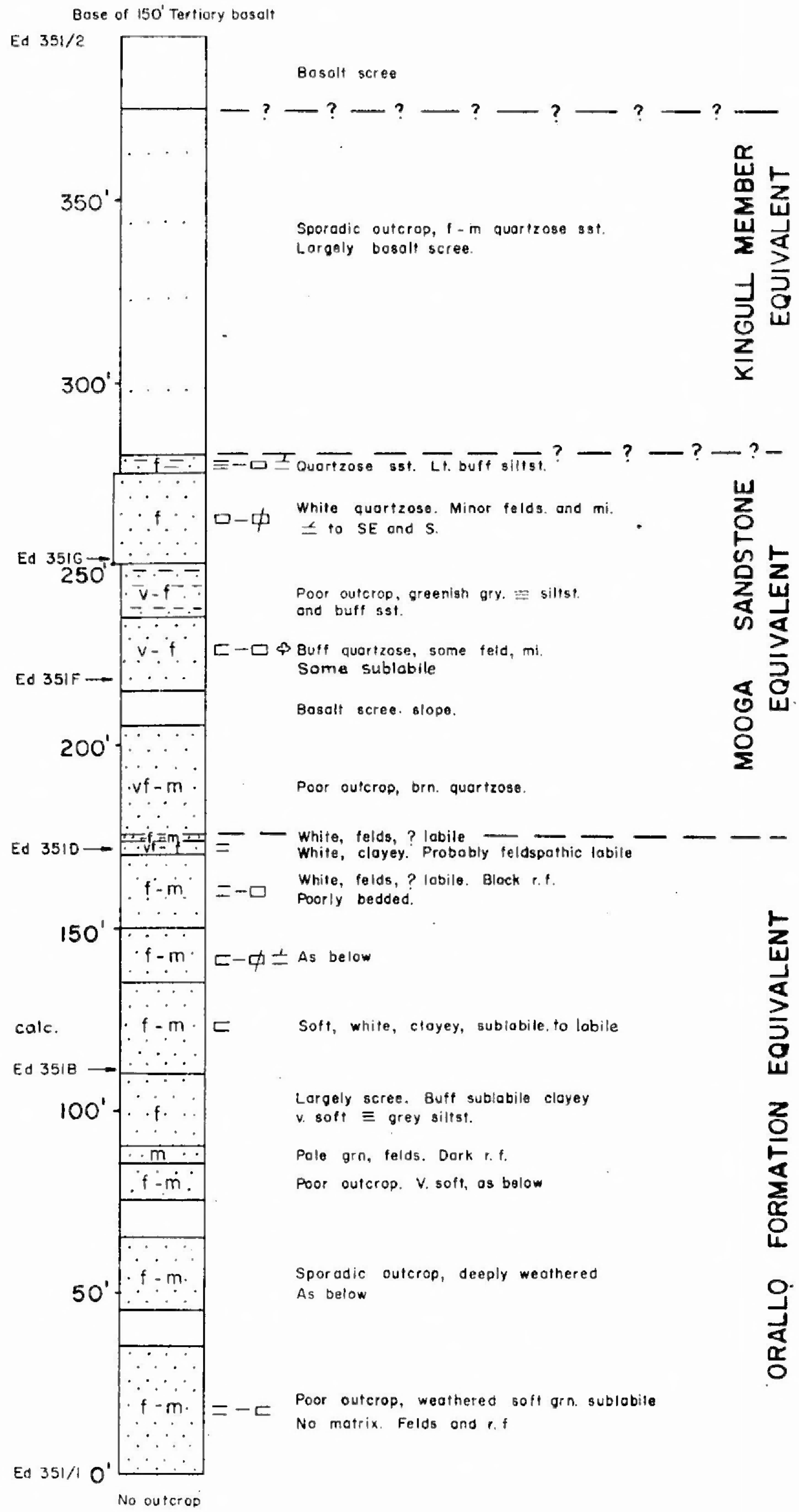
The Southlands Formation includes the equivalents of the Orallo Formation, and the Mooga Sandstone Member and the Kingull Member of the Blythesdale Formation. On the Alicker Anticline, west of the type area of these three units, the distinctive coarse crossbedded sandstone in the lower part of the Mooga Sandstone pinches out. West of the Alicker Anticline it is not possible to map the three units separately. However, they are still readily distinguished in the subsurface to the south. It is likely that the lack of distinctness in outcrop is related to facies changes normal to the nearby basin margin. In general terms, in outcrop

Fig. 7

SOUTHLANDS FORMATION - TYPE SECTION

Measured up western side of Great Dividing Range
2 miles north of Mitchell Sheet (645,772). Measured
by N.F. Exon using anaeroid barometer

Section E 6



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the upper part is equivalent to the two Blythesdale members; the lower part to the Orallo Formation. This correlation is consistent with the gross lithological characteristics of the sediments involved.

In the Eddystone Sheet area six thin sections of sediments from this formation were examined and estimates of proportions of constituents were made. Five, from the type section E6 (Fig. 7) illustrate the change from lower 175 feet of clayey, in part calcareous, labile sandstone to the upper clear quartz-rich sandstone. In all five thin sections, the labile content remains fairly constant (feldspar less than 10 per cent average 5 per cent; shaly rock fragments less than 15 per cent, average 10 per cent). The quartz content increases above the lower 175 feet and the clay content falls correspondingly (quartz from about 30 to 75 per cent, clay from about 50 to 5 per cent). A thin section from the upper part of the unit, some eight miles farther east, is of a quartz-rich sandstone similar to those from the top part of section E6. The Kingull equivalent does not outcrop in this section.

A thin section of a sandstone from low in the Orallo equivalent in the Mitchell area contains 40 per cent quartz, 40 per cent rock fragments (quartzite, shale), and minor feldspar, biotite, iron ore and very minor, muscovite, in a clay matrix. Two thin sections from the Kingull equivalent contain an average of 55 per cent quartz, 30 per cent rock fragments (quartzite, shale, lesser acid volcanics) and 15 per cent clay matrix. Minor constituents include feldspar (largely potash feldspar), biotite, muscovite and tourmaline.

An interesting outcrop of partially silicified lithic sandstone from the Orallo equivalent crops out in a gully beside the track from Ventura Homestead to Kilmorey Homestead on the Mitchell Sheet (648, 756). This is medium to very coarse grained, thickly to very thickly bedded and graded bedded. It contains large fragments of clay-replaced fossil wood. In thin section it is shown to contain 40 per cent quartz, 35 per cent rock fragments (quartzite; fine grained acid and intermediate volcanics, some with relict shard structures; composite porphyritic acid volcanic fragments; shaly and silty fragments), in a brownish siliceous matrix. Minor constituents are feldspar, biotite and magnetite.

West of the Forest Vale Anticline the unit thins, and intertongues with the lower part of the coarser, cleaner Hooray Sandstone and becomes unrecognizable near Mount Elliott Homestead, about eight miles east of the Maranoa Anticline area. Siltstone beds low in the Hooray Sandstone west of here may be equivalent to the Southlands Formation.

The Southlands Formation is apparently conformable with the underlying Gubberamunda Sandstone. The labile sandstone of the basal Southlands Formation contrasts with the quartz-rich Gubberamunda Sandstone.

The thickness of the unit is generally 400 to 500 feet, but it thins rapidly west of the Forest Vale Anticline. In the type section it is about 400 feet thick.

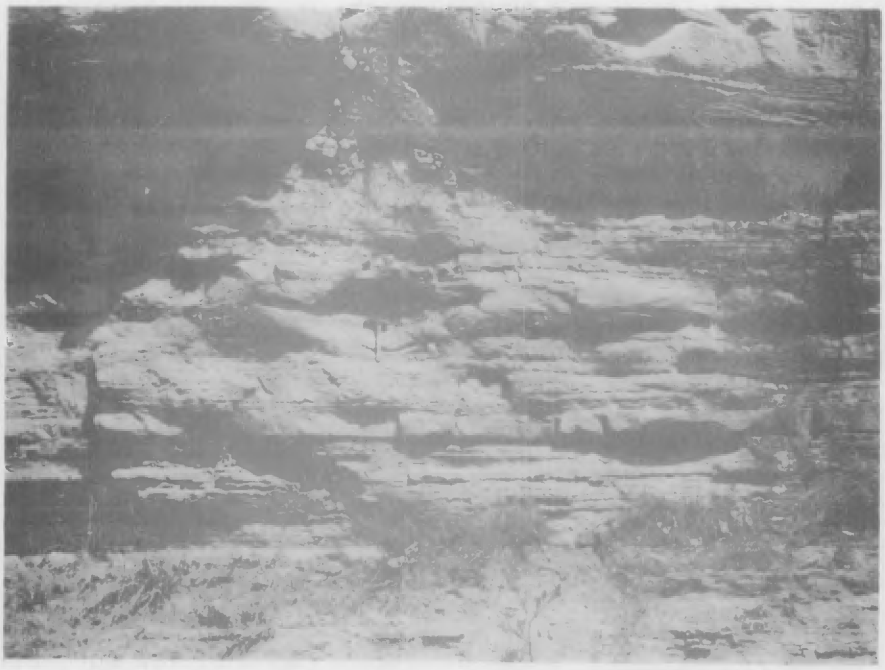
The lower 200 feet of the sequence is thick bedded, crossbedded, medium grained, labile and commonly calcareous sandstone. It was probably deposited in fluviatile and lacustrine enironments relatively close to the source area. The upper finer-grained part, which is generally thin-bedded and contains low-angle crossbedding (Plate 4a) was probably deposited in a restricted lacustrine environment. The source for the unit was pre-existing sediments. Leaf fragments and fossil wood are abundant, but none of this material has been identified. Microfossils found in the equivalent Orallo/Mooga/Kingull sequence (Evans, pers. comm.) belong to Evans' spore divisions J5-6 and Kla (Evans, 1966). These divisions are believed to range from Upper Jurassic to Lower Cretaceous (Evans, pers. comm.).

Hooray Sandstone

Woolley (1941) named this unit from Hooray Creek. The name was first published in Hill and Denmead (1960). The type section, in Hooray Creek 12 miles east-north-east of Tambo, was illustrated by Exon (1966). It consists of 250 feet of very fine to pebbly, white sublabile sandstone and conglomerate. With further work, the unit in the type area could probably be subdivided into two formations (Exon, op. cit.).

PLATE 4

(a) Low angle crossbeds high in Southlands Formation just east of Maranoa River (613, 735).



(b) Well bedded basal undifferentiated Blythesdale Formation (Nullawurt equivalent) in Maranoa River (610, 735).

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. In this area it is confined to a broad belt in the western half of the Mitchell Sheet 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 sandstone, with considerable grey to white siltstone. There is also some white claystone 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, et al., in prep.) are very uniform. They contain 40 to 60 per cent quartz and quartzite, 5 to 10 per cent feldspar, and up to 15 per cent 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. 5) penetrated 170 feet of this sequence - a monotonous succession of 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 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 8). 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 in the Roma area. Between the Maranoa and Forest Vale Anticlines, the Gubberamunda Sandstones gives way to the lower part of the Hooray Sandstone. A little further west the Southlands Formation becomes unrecognizable, and the upper part of 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 Southlands Formation, separates the Blythesdale Formation from the upper part of the Hooray Sandstone on the map. (For more detail of lateral relationships see sections dealing with individual formations).

In the subsurface (Plate 5) it is possible to trace all the subdivisions of the Blythesdale Formation (excluding the Claravale Sandstone) as far west as Amoseas Strathmore No. 1. Beyond there the Orallo Formation disappears, and the Mooga Sandstone cannot be distinguished from the underlying Gubberamunda Sandstone. However, the Minmi, Nullawurt Sandstone and Kingull Members can be distinguished at least as far west as the Mitchell/Charleville Sheet boundary. Although the situation may be different in the outcrop area nearer the basin margin, it is quite possible that only lack of good outcrop prevents subdivision of the Hooray Sandstone in this area.

The Hooray Sandstone was deposited in alternating fluviatile, deltaic and lacustrine conditions. Crossbedding azimuths indicate streams flowing generally 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 flattened southwards 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 Permain spores in the sequence (Appendix 2), indicates some derivation from earlier sediments. Periods of marine influence are suggested by the presence of acritarchs (see Appendix 2) and glauconite, in BMR Mitchell No. 4.

The outcrop thickness of the Hooray Sandstone is generally 400 feet, but it thins slightly across the Maranoa Anticline. It thickens rapidly out into the basin and away from the Nebine Ridge (Maranoa Anticline). Subsurface thicknesses (excluding the Minmi Member equivalent which has been included in the Doncaster Member in outcrop) are 647 feet in Amoseas Alba No. 1 just west of the Nebine Ridge, 430 feet in Amoseas Dulbydilla No. 2 on the Nebine Ridge, and 983 feet in Amoseas Scalby No. 1, east of the ridge and well to the south. 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 2) 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.

LOWER CRETACEOUS

Wallumbilla Formation

A succession of fossiliferous mudstone, siltstone and very fine grained sandstone lying stratigraphically above the Blythesdale Formation in this area was first referred to by Clarke (1865) and called the "Wollumbilla Formation". Later workers included these sediments in stratigraphic units of various names and extent but the most widely used nomenclature was that of Whitehouse (1926) who referred the section around Roma to the "Roma Series" defined largely on biostratigraphic evidence. This evidence was incomplete; Vine and Day (1965) discussed this, and proposed a subdivision of Casey's (1959) 'Wilgunya Formation' into several members. Two of these members have been recognized from later mapping to extend into the area originally described by Clarke (op. cit.). These members (and two others which do not crop out in the area) have therefore been included in a redefined Wallumbilla Formation (Vine, Day, Milligan, Casey, Galloway and Exon, 1967). They are the lower Doncaster Member (approximate lithological equivalent of the Roma Series of Whitehouse (op. cit.) and the Roma Formation used by Day (1964)) and the overlying Coreena Member. Current oil company usage is to include sediments of both these members in the Roma "Formation". This however conflicts with the palaeontological criteria used by Whitehouse (1954) in his invalid attempt to redefine Roma Series as Roma Formation.

The type section of the Wallumbilla Formation is defined by Vine et al. (1967) as "Wallumbilla Creek, from Wallumbilla Township, south for 12 miles...." The boundary between the members is a gradational one; the mudstone of the Doncaster Member becomes interbedded with, and finally replaced by, siltstone of the Coreena Member.

Doncaster Member

Vine and Day (1965) described the Doncaster Member as "..... mainly blue grey mudstone, with subsidiary glauconitic mudstone and glauconitic siltstone; the occurrence of beds rich in glauconite is diagnostic of the unit". The Doncaster Member in the Roma and Mitchell Sheet areas is essentially similar. Although glauconite is rarely seen in outcrop, beds rich in glauconite were encountered sporadically throughout the Doncaster Member section penetrated by BMR Mitchell No. 10. The most characteristic feature of the member in the Roma and Mitchell Sheet areas is the interlamination of fine and coarse mudstone.

The member crops out in an east-west trending belt up to 10 miles wide, which crosses the whole width of the Roma and Mitchell Sheet area s. It is continous in the west with outcrops of the Doncaster Member mapped in the Eromanga Basin by Vine, Jauncey, Casey and Galloway (1965), and Exon, Galloway, Casey and Kirkegaard (1966). The eastern extent of the member is not known.

Features of the member which occur only occasionally are black mudstone, fossiliferous and unfossiliferous dark grey, often spherical, limestone concretions, thin, lenticular coquinite bands, algal stromatolites, coarse-grained, calcareous, quartzose sandstone lenses, cone-in-cone limestone, gypsum and fibrous calcite and sideritic calcite.

The member 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, the Doncaster Member directly overlies yellow brown apparently weathered Hooray Sandstone. As typical Minmi lithologies are missing there may be an unconformity at this level. However, the lower hundred feet of the Doncaster Member in this area contains some fine-grained glauconitic siltstone and the mudstone contains angular quartz granules. These sediments may be equivalent to the Minmi Member.

The member is readily distinguished from the overlying Coreena Member by its weathering characteristics. It weathers initially to a soft mudstone which varies from dark grey to blue grey with yellow and white inflorescence and then to a light grey clay. The final product is referred to locally as 'black soil'. The topography developed on this member is typical 'rolling downs' country. The Coreena Member, by contrast, weathers initially to a firm, light brown siltstone and finally to a brown soil. The topography is marked by well defined low hills ringed by low tree-covered benches.

Outcrop is poor, the regional dip is low (to the south) and minor faults are common, so that the establishment of a composite section from outcrop information is impracticable. Certain features have been recognized as being peculiar to certain parts of the section and their general order of super-position is shown below (thicknesses are expected to be quite variable dependent on distance from the basin margin);

Top:

(3) Mudstone interbedded with siltstone beds up to 6 feet thick. Concretions oblate - ovoid or coalesced to form distinct beds - very rarely fossiliferous. Fossils few in number and type - including a rare pelagic element, i.e. belemnites. Small lenses of mudstone pebbles (and rarely fossils), woody material, fibrous calcite and cone-in-cone limestone common.

(2) A uniform succession of 'massive' mudstone. Concretions mostly dark grey, spherical - poorly fossiliferous. Fossils few in variety - Cyrenopsis and burrowers (Panopea, etc.) occur most commonly.

(1) Mudstone with rare calcareous quartzose sandstone lenses. Thin siltstone beds and coquinite lenses common. Algal colonies very near the base of the sequence. Concretions - large and oblate incorporating siltstone lenses, coquinite lenses and rarely fossil logs, or small and irregular. Fauna rich and characterised by sessile forms - brachiopods, entire crinoids, sponges and oysters - and by a pelagic element comprising ammonites and belemnites.

Unit 1 is the approximate equivalent of the 'Purisiphonia horizon' of Day (1964, p. 17). Its extent has now been traced from north of Mitchell to north of Drillham, a distance of some 150 miles. Unit 2 is the probable equivalent of the 'abundant Cyrenopsis' horizon of Day (op. cit. p. 17, and Appendix 1 of this report). Cyrenopsis was observed in the field to be the dominant form but was not collected.

At its northern outcrops (e.g. near Sawpit Creek and near Cypress Downs Homestead) the member appears to be less than 100 feet thick. South of this, the member thickens appreciably. The authors, from a study of electrical and lithological logs in oil bores, have found that the subsurface thickness is consistently about 300 to 400 feet. So the member thicknes rapidly at the basin margins, but then maintains the same thickness for some distance into the basin. However, further south again, in the Surat area, the thickness may be as much as 800 feet.

The molluscan fauna (see Appendix 1) indicates an Aptian age for the member. Fossil logs, to six feet in length, are commonly associated with the marine fossils in the Mitchell area. Spores and marine micro-organisms from shallow holes in the unit (Appendix 3) belong to Evans (1966) divisions Klb-c of Lower Cretaceous age.

Coreena Member

The Coreena Member has been formally defined by Vine et al. (1967). It is named from Coreena Station, some 20 miles north-east of Barcaldine in the Longreach Sheet area. In the type area, it comprises interbedded siltstone and mudstone. The siltstone is gradational to very fine and fine-grained labile sandstone.

In the Roma and Mitchell Sheet areas, siltstone predominates over mudstone. As in the type area, calcareous concretionary beds, glauconite, coquinite, intraformational conglomerate and cross lamination are common locally. Some intraformational conglomerates and coquinites near the base of the member contain reworked Aptian fossils as well as Albian fossils of Coreena age (see Appendix 1).

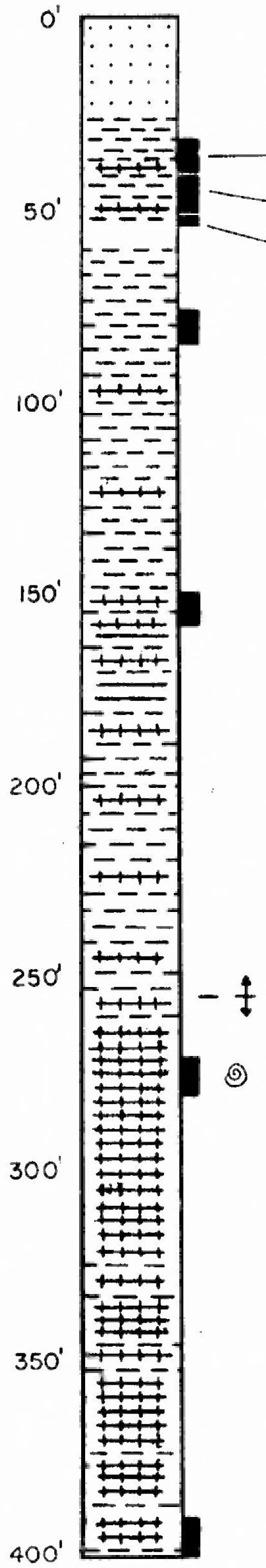
The member is exposed across most of the southern halves of the Roma and Mitchell Sheet areas. In the south of the south-eastern sector of the Mitchell Sheet area, however, exposures are poor and deeply weathered, and only a few outcrops of Coreena Member were identified.

The maximum thickness of the member measured in the area was 250 feet in BMR Mitchell No. 10, near Amby. 180+ feet of the member was measured at Mount Red Cap some 20 miles to the south. No great increase in thickness is expected in the south-east sector of the Mitchell Sheet area, as the slope of the topography developed in the old deep weathering profile is close to that of the regional dip of the sediments. The thickness in the Arbroath Trough in A.A.O. Arbroath No. 1 is 700+ feet.

The unit contains Albian macrofossils (Appendix 1). One sample was run for foraminifera, with negative results. Spores, and marine micro-organisms in the lower part of the unit belong to Evans (1966) division Klb-c; those in the upper part to division Kld (Appendix 3).

DRILL HOLE B.M.R. MITCHELL No. 10.

WALLUMBILLA FORMATION



Sst

Sltst
Core 1 32'-41' Rec. 4'6".
Sltst, v hd, calc, conc, gy-br, Xlamd; Mdst, Xlamd, Glau.
Core 2 41'-50'6" Rec. 9'3"
Sltst, br, v calc in part, mass-tk bdd & tn bdd Xlamd; Mdst, gy,
Core 3 50'6"-52'9" Rec. 2'3" lam <1 cm tk; Lst Bnds <10cm tk, slt, gy.
Sltst, br, mass; Mdst, gy, intermingled c̄ Sltst by organism burrowing.
Sltst, br-gy, ca. 50% Glau.

Core 4 77'-86' Rec. 6'6"
Sltst, gy-gr gy, glau, worm burrowed, tn fib Calc stringers, Xlamd;
Mdst, gy, lam <1".

90% Sltst; 10% Mdst.

Core 5 150'-159' Rec. 9'0"
70% Mdst, f, gy, lamd in part, v mass, sh; 30% Sltst, glau, lab, tn Xlam & lenses, disturbed bdg, dissmd Plt Rem & "vitrene" or ?bitumen.

80% Sltst, sft gy & gr gy, glau; 20% Mdst, gy, sh, sft-firm.

Coreena Member
— — —
Doncaster Member

Core 6 272'-281' Rec. 9'0".
100% Mdst, gy, uncommon slt Mdst Lam, mass but sh, Pelcp at 274'6" & 275'. Gradational conc lenses 1-2".

90% Mdst, gy, sh; 10% Sltst to slt Mdst, gy & gn gy, glau.

90%-100% Mdst, mnr Sltst, Glau at 360'-370'.

Core 7 392'-401' Rec. 3'3".
Mdst, lamd, mostly gy, some lt gy lam; Sltst, glau, glau, gy-gn gy, uncommon only at base of recovered intv.

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Undifferentiated Wallumbilla Formation

The Wallumbilla Formation is poorly exposed in the south of the south-western sector of the Mitchell Sheet area. Only a few small 'deep weathered' outcrops were observed, and in these, mudstone appeared to be predominant. BMR Mitchell Nos. 8 and 9 were drilled south of the most southern outcrops of the Coreena Member in the Maranoa River, and penetrated a section of mudstone. It is possible that much of the Wallumbilla Formation in the south western quadrant of the Mitchell Sheet area is, in fact, the lithological (and approximate time) equivalent of the Ranmoor Member (Vine and Day, 1965) which crops out in the northern Eromanga Basin. Palynological information (see Appendix 3) on the mudstone at BMR Mitchell No. 8 indicates that the age of the mudstones, at least in the vicinity of this hole, is no younger than the age of deposition of the Ranmoor and Coreena Members. It is not possible at the present stage of mapping in the south-east sector of the Mitchell Sheet area to preclude the possibility of there being mudstones of younger age (i.e. Allaru Mudstone - Vine et al., 1967).

Environment of Deposition in the Wallumbilla Formation

At the initial stage of deposition of the Wallumbilla Formation (Unit 1 of the Doncaster Member) in the area, current action was strong, as evidenced by lenses of winnowed deposits (coquinites, clean coarse sandstone lenses) and "scour and fill" and cross lamination structures. However, coarse sediment supply had fallen off since the deposition of the Minmi Member and the dominant sediment being deposited was mud. The strong currents also brought a pelagic fauna into the area.

The plentiful occurrence of sessile forms in the fauna (and flora) indicates that a stable substrate existed nearby, perhaps in the form of semi-consolidated sands of the Minmi Member or accumulations of (bio)clastics too coarse for the currents to shift. Littoral conditions prevailed locally enabling algal colonies to form.

The deposition of the second stage (Unit 2 of the Doncaster Member) apparently took place in a restricted, quieter water environment where the mud formed the substrate for a number of burrowing pelecypods. Cyrenopsis also occurred in large numbers (this genus has affinities with a number of brackish water forms, pers. comm. R.W. Day, Australian National University) and may be also indicative of a mud-flat environment.

The latter stage of deposition of the Doncaster Member in the area is transitional to the deposition of the overlying Coreena Member. Current action again became stronger and brought in a supply of coarser sediment and a significant pelagic element. Scouring of the Doncaster Member produced reworked fossils in intraformational conglomerates and coquina bands.

Current palynological evidence (Appendix 3) indicates that while silts were being deposited in northern and eastern Mitchell Sheet area, and Roma Sheet area, muds were being deposited in the south-east of the Mitchell Sheet area, i.e. further out from the basin margin.

CAINOZOIC

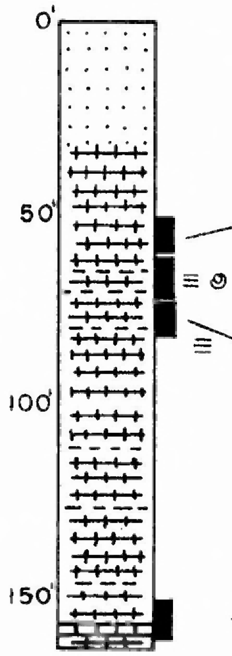
The Cainozoic rocks are represented by well bedded, coarse terrestrial clastic sediments, poorly bedded, poorly sorted muddy sandstones, chemical cementation products, and basalt flows and dykes.

For convenience in the field, in the Mitchell Sheet area, the well bedded sediments have been referred to as Tertiary, whereas the poorly bedded muddy sandstones, which are seen to post-date the well bedded sediments in two small unmapped outcrops in the Roma Sheet area, are mapped as undifferentiated Cainozoic. Where Mesozoic sediments have been markedly affected by Tertiary weathering the Cainozoic symbol is used in conjunction with that of the altered sediment.

DRILL HOLES B.M.R. MITCHELL Nos. 8 and 9.

WALLUMBILLA FORMATION

B.M.R. MITCHELL 8



Sd

Mdst, buff - gy.

[Core 1 52'-60' Kld sprs.
Mdst, slt gy - dk gy, pyr, 0.5" fib Calc.

[Core 2 62'-72' Rec. 8'4"
Mdst, gy; Sltst, gn - gy, glau, lamd; mnr micxl, gy, v slt Lst.
?lingulid brach Frags, Bdg disturbed by organisms.

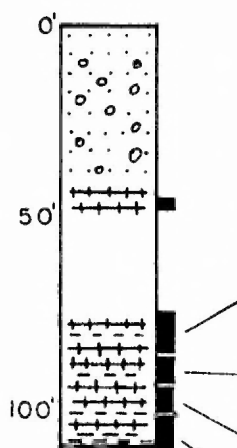
[Core 3 82'-87' Rec. 3'5". Kld sprs.
Mdst, dk gy; Sltst, v calc, gy.

Mdst, gy, sh, intlamd vf & f grnd.

Mdst 80%, Sltst 20%.

[Core 4 152'-162' Rec. 6' Kld sprs.
Mdst, gy, sh, mass. 2" conc Lst.

B.M.R. MITCHELL 9



Sd & Gvl.

Wthrd Mdst.

[Core 1 45'-47' Rec. 1'6"
Mdst, gy, sl ironstained Lam, intlam f & czs.
Plt Rems common on Lam.

[Core 2 75'-85' Rec. 9'5"
Mdst, intlamd dk gy & lt gy (f & czs Bnds). Sltst, lt gy - gn gy, glau, intlamd
& intbdd c̄ Mdst. Lst 1" Conc. ?Echinoderm spines, Pyr common.

[Core 3 85'-93' Rec. 4'6"
Mdst, gy, sh, pyr, intlamd c̄ Sltst or slt Mdst (1:1:1), Xlam, worm
burrows, Glau, Vugs c̄ Pyr & Gyp, tn Lst stringers.

[Core 4 93'-101' Rec. 6'8"
Sltst 6: Mdst 3: Lst 1, "Amby" type Xlam; as core 3 but less Glau & more Calc.

[Core 5 101'-110' Rec. 7'
Sltst & Mdst admixed, worm burrows, ?Nuculana sp.

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Tertiary Sediments

Well bedded cemented fluviatile deposits of quartz-rich to labile sandstone and pebble conglomerate which unconformably overlie the Wallumbilla Formation and, to a lesser extent, older rocks, have been designated 'Tertiary'. These sediments have their maximum development in the valleys of the larger rivers. They also form thin cappings to the high hills north-east of Morven and in the Great Dividing Range in the north-eastern sector of the Roma Sheet area. The maximum thickness measured in these sediments is 40 feet, at a locality four miles north of Amby Township. Although the Tertiary sediments are more widespread in the southern part of the area, their thickness does not appear to increase appreciably.

Undifferentiated Cainozoic Sediments

'Duricrust' - or the 'deep weathering profile': This has widespread development over the area, but has not been observed to exceed a thickness of 80 feet. True 'ferricretes' have not been observed; most of the weathered sediments are merely mildly leached of some of the original component minerals, and stained or lightly cemented by iron oxides. Pisolitic laterite has been observed in only one locality (approximately 5 miles north-west of Pickanjinnie). In this instance it was developed on the Minmi Member of the Blythesdale Formation.

Silcretes are commonly developed in the Merivale Syncline area, and are particularly well-developed in coarser sandstones of the Minmi Member. These form an extremely hard rock consisting of quartz and some rock fragments and, surprisingly, beautifully preserved glauconite, in a siliceous cement. Marine fossils and wood are also preserved in these silcretes (e.g. at SB226, west of Kilmorey Homestead). North of Kilmorey Homestead, on the Eddystone Sheet (643, 770), the old duricrust profile is preserved on a sharp hill with a capping of ten feet of silcrete formed from altered Claravale Sandstone.

Tertiary sediments have also been 'deep weathered', and silcrete has been observed in the Morven area and some 30 miles north of Yuleba.

The planation surface related to the deep weathering profile is seen to affect both Tertiary and Mesozoic sediments. Exon, Milligan and Day (1967), dealing with the central part of this area stated "although the land surface on which the duricrust formed was undulating, a regional southerly dip of the surface of less than $\frac{1}{2}^{\circ}$ prevailed.....". Langford-Smith, Dury and McDougall (1966) believed that weathered sediments at a quarry north of Roma were part of the duricrust profile. These were cut by a fresh dolerite dyke which hence gave (by K/Ar dating) a minimum age (early Miocene) for the "duricrust". Exon et al. (op. cit.) however, in reply to this paper, stated "neither on local or regional evidence can the weathered sediments intruded by basalt at this locality be regarded as duricrust". Thus the early Miocene age is unrelated to the deep weathering profile. They further stated "South of Amby, basalt flows are confined by a river valley cut in duricrust-altered Tertiary sediments. The situation in this vicinity is unambiguous, and dating of the basalt here would provide a minimum age for the duricrust". It is probable that the "deep-weathering" took place in early Tertiary times.

Clastic sediments: Included in this category are poorly bedded to massive, muddy and clayey sandstone (and breccia) consolidated in situ on Jurassic-Cretaceous sandy units in the Mitchell Sheet area. They are particularly common in the north-western part of the area. Similar sediments have been observed in outcrops north of Jackson and Dulacca in the Roma Sheet area. Here, they overlie the scoured surface of the older 'Tertiary' sediments, and are readily distinguished by the variety of the clasts, the abundant muddy matrix and the lack of sorting and regular bedding.

Tertiary basalt

Erosion residuals of finely porphyritic and glassy basalt occur, as plateaux 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 thickest along the axis. The basalt remanants are probably not more than 50 feet thick.

South of these plateaux, low flat-topped hills of the basalt line the valley of Amby Creek. The basalt south of Amby township occupies an old stream channel cut in "deep weathered" Mesozoic and Tertiary sediments. Basalt flows cap the Grafton Range north of Roma.

Low level basalt, which is probably a shallow intrusive, forms a dome in the Jurassic sediments near Gubberamunda Homestead, 20 miles north of Roma (153, 733). The bore at the homestead penetrates 200 feet of basalt, and the rock is quarried for road metal.

The igneous rocks in A.A.O. Brucedale No. 1 (4275'-4500') and A.A.O. Brucedale East No. 1 are believed to be intrusive (see Completion Reports). In A.A.O. Brucedale East No. 1 they occur low in the Evergreen Formation, but in A.A.O. Brucedale No. 1 they occur at the boundary between the Evergreen Formation and the overlying Hutton Sandstone, suggesting crosscutting relationships and intrusion rather than extrusion. These rocks include gabbro, diorite, and minor syenite. If they are intrusive it seems likely that they are of Tertiary age, as the Tertiary flows are the only igneous rocks in the Jurassic and younger stratigraphic column in outcrop. They are probably part of a sill-like mass comparable to that of the Tabor Gabbro in the Eddystone Sheet area (Mollan et al., in prep.).

Four thin sections of outcropping basalts were examined. One, from the basalt plateaux, contains about 30% augite phenocrysts and 45% anhedral andesine in the glassy groundmass. A rock from a probable dyke north-west of Mount Bindeygo, which has baked the enclosing mudstone, contains sparse phenocrysts of plagioclase and altered pyroxene in a very fine grained groundmass of plagioclase, pyroxene and an opaque mineral. Two, from the quarry north of Roma, are normal basalts with plagioclase and augite phenocrysts in a groundmass of plagioclase, augite, and minor opaques; there has been some serpentinization of augite.

An associated dolerite dyke near the quarry gave an early Miocene age, by K/Ar dating (Langford-Smith, Dury and McDougall, 1966). Similar basalts further north (Mollan, 1965) are also of Tertiary age. The basalts of this area are apparently all part of one period of volcanism, and as they unconformably overlie Aptian (and possibly Albian) sediments, are probably all of Tertiary age.

Quaternary sediments

Unconsolidated sands, gravels and clays deposited in the beds, flood plains and outwash fans of present-day rivers are considered to be Quaternary (Qa). Deposits on older terraces of present rivers, and general soil and sand cover is mapped as Qs.

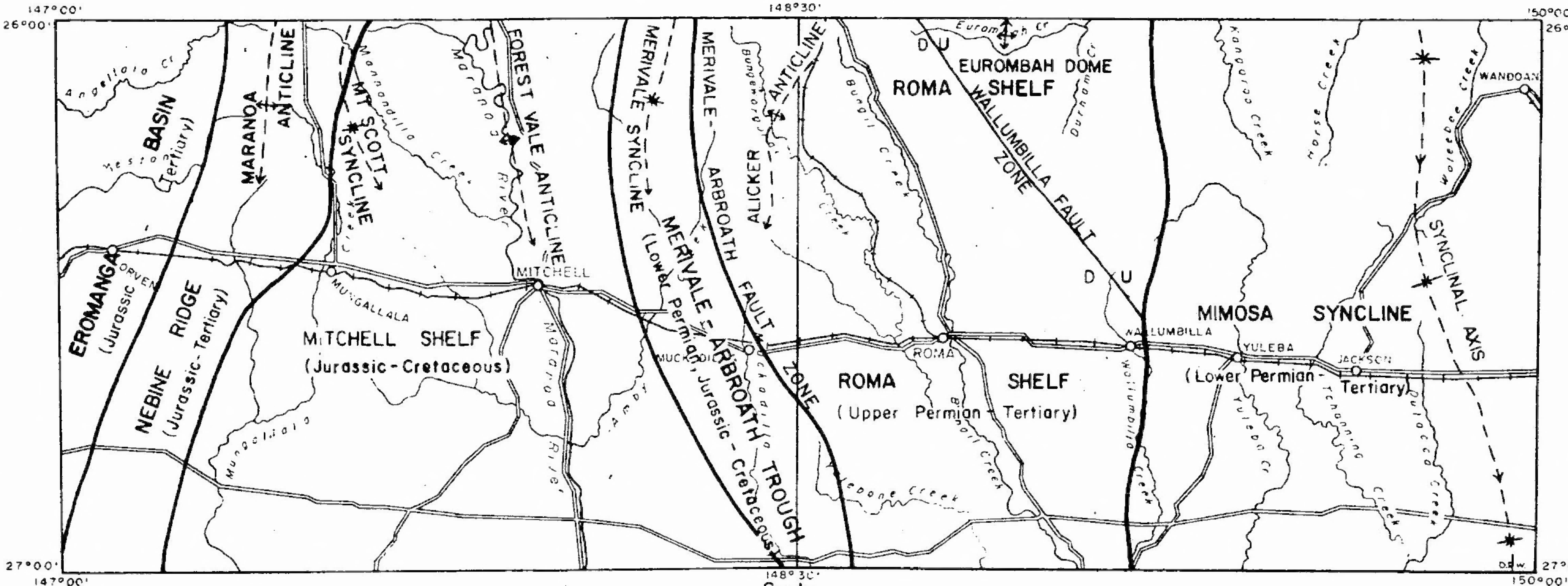
STRUCTURE

Most of this area forms part of the northern margin of the Surat Basin; changes in sedimentary facies and thickness are more pronounced parallel to the east-west trending basin margin than normal to it. The main structural divisions and the major structures in this area are shown in Fig. 11. These are reflected in the gravity and aeromagnetic maps (Plates 9, 10). These divisions had a profound effect on sedimentation. All are oriented roughly north-south and are affected by the regional dip to the south into the Surat Basin, thus progressively younger units are exposed southwards. The regional dip on both basement and sediments is very shallow in the shelf areas. The dip on the Lower Jurassic Precipice Sandstone is 40 feet to the mile (less than $\frac{1}{2}^{\circ}$) between A.A.O. Kalima No. 1 and A.A.O. Brucedale No. 1, and the dip is only about 20 feet to the mile on the Jurassic/Cretaceous Hooray Sandstone on the Maranoa Anticline.

The cross-sections on the two maps, and Plates 5, 6 indicate the general features of structure and sedimentation. All basement features are reflected throughout the sedimentary sequence and to the surface, but the effects diminish upwards. Except for areas where faulting is important, compaction of sediments would account for most of the folding in the Mesozoic and younger sequence. Basement consists of low grade

Fig. 11

STRUCTURAL AND SEDIMENTARY DIVISIONS



0 Scale 50 miles

LEGEND

MITCHELL SHELF	Structural (and sedimentary) divisions
(Jurassic - Tertiary)	Preserved sediments (all include Cz)
MARANOA ANTICLINE	Major surface structures

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metamorphics (Timbury Hills Formation) granite and volcanics (Combarngo Volcanics). The various structural features are discussed below.

Nebine Ridge

This gentle ridge in the metamorphic basement extends northwards to the Nogoa Anticline on the Springsure Sheet, and also well south of this area. It separates the Eromanga Basin from the Surat Basin. Basement of the ridge at Amoseas Dulbydilla No. 1 is at 420 feet below sea level. It falls about 1000 feet westwards to the Morven town bore, and 500 feet eastwards to the Mitchell town bore. In the north it is expressed at the surface as the Maranoa Anticline, and facies changes in the Jurassic and Cretaceous sequences from the Eromanga to Surat Basin occur on or near the anticline.

Eromanga Basin

The basement appears to dip gently south-westwards away from the Nebine Ridge, with various small baldheaded structures occurring. Amoseas Alba No. 1 and Amoseas Tregole No. 1 south-west of Morven, struck metamorphic basement.

Mitchell Shelf

This area is fairly flat overall, with basement heights about 500 feet below those on the Nebine Ridge. There are various significant structures in this area, including the Forest Vale Anticline, Mount Scott Syncline, and the baldheaded anticline on which Amoseas Scalby No. 1 was drilled. Most of the shelf probably consists of metamorphics but granites have been drilled in structurally high areas (Amoseas Donnybrook No. 1, Scalby No. 1).

Merivale-Arbroath Trough

This area is separated from the Roma Shelf on the east by the complex of the Merivale and Arbroath Faults, and various lesser faults, and is bounded on the west by the Mitchell Shelf. There is downthrow to the west of 4,000 feet on the basement on the eastern side, and gentle shallowing westwards. Faulting in Lower Permian times lowered the eastern part and this was compensated by gentle folding on the western side.

In the Eddystone Sheet area a seismic survey across the Merivale Fault by Austral GeoProsectors (1962) suggested downthrow to the west on a Permian reflector of about 3,500 feet. This fault continues southwards into the Mitchell Sheet area and is represented at the surface by a complex of small en echelon faults. The trough formed in Lower Permian times between the Roma and Mitchell Shelves and is the Merivale Syncline of outcrop. A number of longitudinal structures within the trough are related to the faulting, including the Katanga Anticline, Nade Syncline and Taboonbay Anticline. The Katanga Anticline is the strongest surface feature in the area, and parallels a fault which has displacement (down to the west) of less than 50 feet at the surface. It is related to the fault, and has westerly dips of up to ten degrees in the west flank, and shallow easterly dips in the east flank.

In the south a number of oil wells define the structure of the Arbroath Trough (Plate 5); all struck metamorphic basement. In contrast to the western areas, pre-Jurassic (Lower Permian) sediments are preserved in the trough. Fault movements since Permian times have been relatively minor, although there is some surface displacement along the Arbroath Fault, and the Amby Fault has a displacement (down to the west) of about 300 feet in outcrop.

Roma Shelf

In this generally high area basement (Fig. 2) consists largely of block-faulted metamorphics, with intrusive granites and extensive volcanics in some areas. A thin veneer of Permian and Triassic sediments overlies the basement in some areas, and the Triassic has yielded hydrocarbons in some wells. Frequently though, the Lower Jurassic directly overlies basement. Numerous small structures with closure in the Lower Jurassic have been drilled, and many provided hydrocarbons from Lower Jurassic sandstones.

In outcrop, significant folding is very limited. The Alicker Anticline is a well developed fold, with a small domal closure defined by the outcrop pattern of the Springbok Sandstone. The Eurombah Dome is also a prominent feature and several faults are related to it. Another possible anticline runs along Bungil Creek, and a small domal culmination coincides with a basic intrusion near Gubberamunda Homestead.

The north-west trending Wallumbilla Fault, which apparently joins the Hutton Fault further north, is downthrown to the west about 500 feet in the basement (see cross section). It has not had a great effect on sedimentation and probably moved slowly with time. Vertical movement of at least 100 feet is indicated in Jurassic and Lower Cretaceous sediments. Other smaller north-west trending faults are probably related to the movements which formed the Wallumbilla Fault.

North-east trending faults occur in outcrop in a zone extending from Warooby to Wandoan, (i.e. including the Mimosa Syncline). They are generally displaced down to the east; the fault between Warooby and Pickanjinnie has a vertical displacement of about 200 feet.

West-north-west trending faults are very common right across the Roma Sheet including the Mimosa Syncline. These have vertical displacements of less than 50 feet and some are little more than joints. They probably formed to accommodate epeirogenic movements affecting the artesian basin as a whole. They affect Tertiary sediments, and their good topographic expression compared to the larger faults may be because they are the youngest and least eroded.

Mimosa Syncline

This was a deeply subsiding trough in Permian and Triassic times and a great thickness of these shallow water sediments accumulated as it deepened. The deepest part of the basin from aeromagnetic work (25,000 feet) appears to be in the area west of Wandoan and north of Jackson (Aero Service Corporation, 1963 and Plate 10). The axis of the basin as defined by the aeromagnetic work, coincides with the northernmost outcrops of various Jurassic and Cretaceous units. Although the trough, which is elongated longitudinally, has a fairly broad flat bottom and comparatively steep sides, there is no conclusive evidence of important faulting in this area.

Subsidence ceased after Triassic times, apart from the slight thickening of Jurassic and younger sediments into the syncline.

North-east and west-north-west trending faults are common in outcrop, and are disqussed under Roma Shelf.

GEOLOGICAL HISTORY

Sand, silt and mud was deposited in this area in Devonian times; the lithified sequence was intruded by granite in the Lower Carboniferous. By the end of the Carboniferous these sediments (Timbury Hills Formation) had been regionall tamorphosed and eroded, and andesitic volcanics had been extruded in the east. The granites, which were more resistant, formed high areas.

Faulting and folding gave rise to the Merivale-Arbroath Trough which, in the Lower Permian, was rapidly filled with thousands of feet of sand, silt, mud, gravel and peat (Reids Dome Beds). To the east the related Wallumbilla Fault started to develop at this time, and the downwarp of the Mimosa Syncline also came into existence. This basin sank gradually through the Triassic, and more than 20,000 feet of conformable shallow-water sediments were deposited in the axial region. These sediments thin towards the Roma Shelf, and overlapped westwards with time.

The entire area west of the Mimosa Syncline acted as a relatively stable block from the Lower Permian on. Upper Permian and Triassic sedimentation gradually spread westwards onto this stable area, but no deposits of this age are preserved west of the Roma Shelf.

A great thickness of Reids Dome Beds was probably deposited in the Mimosa Syncline and should be preserved at depth. In the Upper Permian the sea entered the syncline and about a thousand feet of mud, silt and minor sand of the Peawaddy Formation was laid down; in late Peawaddy times contemporaneous volcanism to the east gave rise to some tuffaceous deposits. The younger Peawaddy sediments lapped onto the edge of the Roma Shelf. The sea then withdrew, and up to 1500 feet of freshwater (largely coal measure) sediments of the Blackwater Group were deposited in the syncline and further onto the shelf. These included tuffs at first, but silt, mud and peat were dominant overall.

The Lower Triassic Rewan Formation covered much of the Roma Shelf; in the Mimosa Syncline thousands of feet of varicoloured, in part tuffaceous, mud, silt, lithic sand and polymictic gravel, was deposited, largely in lakes. Uplift to the north and west was followed by stream deposition, and up to 600 feet of moderately clean sand of the Clematis Sandstone were deposited in the syncline; a veneer of this sand covered much of the shelf. Conditions then quietened and lake deposits of sand, silt and mud (Moolayember Formation) brought the Triassic to a close. These covered virtually the whole Roma Shelf and thickened to 800 feet in the syncline. Marine conditions may have occurred briefly in the deeper parts of the syncline.

At the end of the Triassic there was a period of erosion; from then on the entire area behaved as a stable block, although the Nebine Ridge in the west grew slowly and effectively separated the Surat and Eromanga Basins. (Deposits in the Mimosa Syncline were somewhat thicker than elsewhere, due to the compaction of the great thickness of underlying sediments.) Gentle folding (mainly draping over old high areas) and some faulting persisted into the Tertiary. The most important movements were along the old fault lines in the Merivale-Arbroath Trough, and on the Wallumbilla Fault.

Early in the Lower Jurassic, south-easterly flowing streams deposited several hundred feet of clean sands over most of the area; only the Nebine Ridge and some of the granitic highs were not covered. Several hundred feet of fine grained, dominantly lacustrine sediments of the Evergreen Formation then covered the whole area; two short-lived marine transgressions, which reached as far west as the Nebine Ridge, attested by chamositic oolites and acritarchs, occurred in Evergreen times. This was the last important period of pre-Cretaceous marine influence, and the hydrocarbons now found in the Precipice Sandstone may have formed in the Evergreen sediments.

Stream deposition of about 400 feet of clean Hutton Sandstone followed. Conditions changed slowly in the Middle Jurassic, to dominantly lacustrine, and andesitic debris (probably from contemporaneous volcanism) became abundant. The transitional Eurombah Beds were followed by up to 2,000 feet of Injune Creek Group sediments. These were initially coal-measure deposits, followed by alternating fluviatile and lacustrine deposits.

Two hundred feet of clean fluviatile Gubberamunda sand was then deposited followed by about 500 feet of poorly sorted lake deposits of the Orallo Formation. A short period of tuffaceous activity closed the Jurassic.

The Lower Cretaceous commenced with deposition of about 500 feet of the Blythesdale Formation - an alterating sequence of clean fluviatile sands and lacustrine muddy sediments. Late in Blythesdale times the sea returned to the low areas of the Merivale-Arbroath Trough and the Mimosa Syncline initially, and eventually to the whole area. The Orallo Formation pinches out just east of the Nebine Ridge; the Hooray Sandstone of the Eromanga Basin includes the equivalents of the Gubberamunda-Blythesdale sequence. Sedimentation continued with the deposition of perhaps 1000 feet of muddy sediments of the Wallumbilla Formation in a great shallow basin. Marine conditions, which gave rise to restricted shelly faunas, gave way to lacustrine on occasions. Silts and moderately clean fine sand become important in the upper part of this sequence, and there may have been a connection with the open sea.

In post Lower Cretaceous times the area was tilted to the south, and the earlier units were extensively bevelled to a fairly flat land surface. Tertiary sandstone was deposited by south-flowing streams. A period of "deep-weathering" led to leaching of Cretaceous and Tertiary sediments and the formation of duricrust. More erosion followed before basalt flows poured down valleys; related sills appeared in the subsurface. Erosion and deposition has continued until the present.

ECONOMIC GEOLOGY

Water

Underground water

The best aquifers in the Surat Basin are within the Precipice, Hutton and Gubberamunda Sandstones, and sandstone in the Blythesdale Formation, but some water can be obtained from elsewhere in the sequence (especially from within the Orallo Formation). In the Eromanga Basin aquifers include the Precipice, Hutton, Adori and Hooray Sandstones. Plate 11, which shows contours on the top of the Blythesdale Formation predicts the minimum depth of the first good aquifer in the south.

In general, the potentiometric surfaces of the aquifers are below the land surface in the elevated northern half of the area, and above the land surface in the south. Thus flowing bores are effectively confined to the south. Potentiometric surfaces are generally higher for the lower aquifers. All aquifers have a regional dip to the south.

Sub-artesian bores mainly tap the aquifers at much shallower depths than the artesian bores and generally are only equipped to provide much smaller supplies. They are, therefore much more numerous than the artesian bores.

In this area, in both basins, very few bores penetrate to the lower water supplies, and the Gubberamunda and Adori Sandstones are generally the lowest producing aquifers. In the east the best supplies, both for quality and quantity, come from the Gubberamunda Sandstone. Numerous bores have been drilled into the Injune Creek Group but only small brackish supplies are generally obtained. It would be better for owners of properties on this formation to drill to the extremely good aquifers of the Hutton Sandstone. This would require drilling of holes up to 1500 feet deep, but would be more economical than drilling three or four inadequate holes to 500 feet in the Injune Creek Group. A rough idea of the elevation of this aquifer, in the Roma area, can be got by assuming the first Hutton aquifer to be 400 feet above the levels shown in Plate 12.

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 Injune Creek Group and Wallumbilla Formation.

Oil and gas

Hydrocarbon exploration in the Roma area has been intensive and successful (see Previous Investigations and Table 1). Gas has been supplied to the Roma Power House for some years, and will shortly be piped to Brisbane. Oil, which is present in some wells, has yet to be commercially exploited.

Commercial gas flows in this area are confined to the Clematis (Minad's Showgrounds) and Precipice Sandstones, with the exception of the Back Creek wells where the gas comes from the Rewan Formation. The gas in the Richmond, Bony Creek, Tarrawonga, Maffra, Beaufort, Blyth Creek and Pine Ridge wells is from the Precipice Sandstone. That from the Snake Creek wells is from the Clematis Sandstone, and the Pickanjinnie wells produce from both horizons. Overall, the Precipice Sandstone is by far the greatest producer (Table 3 in Scorer, 1966). The gas is believed to come from the overlying Evergreen Formation. Unfortunately, as Scorer says, "In the Roma area the distribution of the Precipice Sandstone is

TABLE 2 - OIL DRILLING

NAME OF WELL	YEAR COMPLETED	COMMONWEALTH SUBSIDY	TOTAL DEPTH (feet)	HYDROCARBON SHOWS	STATUS
Queensland Government No. 2 (Hospital Hill)	1900	No	3710	3638'-3710', 72 Mc f/d gas	Abandoned; produced in 1906
" " No. 3 " "	1910	No	3713	3702', considerable gas	Abandoned
" " No. 4 " "	1922	No	3702	Numerous gas shows to T.D.	Abandoned
Landar Oilfields (Australia) Ltd. No. 1 (Orallo)	1924	No	2644	Minor gas	Abandoned
" " " " No. 2	1925	No	2839	2180'-2208', minor gas	Abandoned
" " " " No. 3	1926	No	2672	Minor gas	Abandoned
" " " " No. 4 (Hospital Hill)	1929	No	4158	Minor gas and oil	Abandoned
A.R.O. No. 1 (Hunterton) *	1929	No	2424	Minor gas	Abandoned
" No. 2 (Gubberamunda)	1929	No	2853	Minor gas and oil	Abandoned
" No. 3 (Mooga)	1929	No	3132	None	Abandoned
" No. 4 (Blythdale)	1929	No	3904	Some gas and oil; oil sand 3844'-3850'	Abandoned
" No. 5 (Blythdale)	1930	No	3848	Oil shows at 3830' and 3847'	Abandoned
" No. 6 (Cornwall) *	1930	No	2306	None	Abandoned
" No. 7 (Solitary Creek)	1932	No	3609	Minor gas and oil	Abandoned
" No. 8 (Blythdale)	1930	No	3988	Minor gas and oil	Abandoned
" No. 10 (Orallo)	1930	No	2863	Minor gas and oil	Abandoned
" No. 11 (Blythdale)	1931	No	4162	Minor gas and oil	Abandoned
" No. 12 (Euthulla)	1931	No	3020	Minor gas	Abandoned
" No. 13 (Euthulla)	1931	No	2705	Minor gas and oil	Abandoned
" No. 14 (Blythdale)	1931	No	3533	Minor gas and oil	Abandoned
" No. 15 (Bungil)	1931	No	4110	Traces gas and oil	Abandoned
" No. 19 (Wallumbilla)	1933	No	4968	Minor gas	Water well
Roma Alicker Ltd. No. 1 (Eumamurrin)	1929	No	912	Minor gas	Abandoned
Point Addis Oil Wells No. 1 (Mt. Abundance)	1929	No	854	None	Abandoned
Roma Dome Ltd. No. 1 (Alicker) *	1929	No	2255	Nothing significant	Abandoned
Roma Oil Corporation No. 1 (Hospital Hill)	1930	No	3875	Gas and light oil 3703'. Max. gas production 1.25 MMcf/d	Abandoned
" " " No. 2 (Hospital Hill)	1929	No	4005	Small gas flow and oil shows	Water well
" " " No. 3 (Hospital Hill)	1930	No	3732	Max. gas 73, Mcf/d, oil traces	Abandoned
" " " No. 4 (Blythdale)	1930	No	3839	Small gas flow, oil shows	Abandoned
Queensland Roma Oil Ltd. No. 1 (Gubberamunda)	1930	No	2841	Small gas flow, oil shows	Abandoned
Stewart's Mooga N.L. No. 1 (Mooga)	1930	No	3567	None	Abandoned
Oil Search Ltd. No. 1 (Warooby)	1934	No	3794	Max. gas flow 625 Mcf/d from 3629'-3645'	Abandoned
Roma Blocks Oil Co. N.L. No. 1 (Mt. Bassett)	1931	No	3561	Minor oil and gas	Abandoned
" " " " " No. 2 (Mt. Bassett)	1939	No	4050	Nothing significant	Abandoned

NAME OF WELL	YEAR COMPLETED	COMMONWEALTH SUBSIDY	TOTAL DEPTH (feet)	HYDROCARBON SHOWS	STATUS
Roma Blocks Oil Co. N.L. No. 3 (Mt. Bassett)	1940	No	3629	Max. gas flow 60 Mcf/d, oil shows	Abandoned
" " " " " No. 4 (Mt. Bassett)	1941	No	3660	Minor oil; gas traces	Abandoned
AAO No. 1 (Roma) (also called AAO Timbury Hills No. 1)	1952	No	3897	Minor gas flow	Abandoned
" No. 2 (Roma)	1953	No	3616	Oil and gas traces	Abandoned
" No. 3 (Roma)	1953	No	3644	Oil and gas traces	Water well
" No. 4 (Hospital Hill)	1954	No	3891	Max. gas flow 870 Mcf/d from 3693'-3714'	Producing gas well
" No. 5 (Hospital Hill)	1955	No	4079	Minor gas	Water well
" No. 6 (Hospital Hill)	1955	No	4285	None	Abandoned
AAO Timbury Hills No. 2	1960	E logging	4400	Max. gas flow 1.25 MMcf/d from 3697'-3733'	Producing gas well
" Pickanjinnie No. 1 (also 2-8)	1961	Yes	5213	Max. gas flow 6.54 MMcf/d from 3976'-4368'	Potential gas well (5 potential producers)
" Latemore No. 1	1960	Yes	4775	Max. gas flow 621 Mcf/d from 4249'-4449'	Abandoned
" Latermore East No. 1	1960	No	4724	Gas flow 197 Mcf/d from 4204'-4340'	Abandoned
" Combarngo No. 1	1961	Yes	5985	Oil indications	Water well
" Winnathoola No. 1	1961	lower part	5342	Some gas	Water well
" Meeleebee No. 1	1962	Yes	5075	None	Abandoned
UKA Wandoan No. 1	1962	Yes	10736	None	Abandoned
AAO Rosewood No. 1	1962	Yes	2075	None	Abandoned
" Kooringa No. 1	1962	Yes	1823	None	Water well
" Pleasant Hills No. 1	1962	Yes	3485	None	Water well
" Sunnybank No. 1 (also 2-5)	1963	Yes	7134	Oil from 5850'-5890'	Potential gas well
" Apple Grove No. 1	1963	Yes	4144	1.64 MMcf/d gas from 3919'-3989'	Potential gas well
" Arbroath No. 1 *	1963	Yes	8367	None	Abandoned
" Bardloming No. 1	1963	Yes	4695	Trace gas	Abandoned
" Bony Creek No. 1 (also 2-14)	1963	Yes	4583	Gas 2.35 MMcf/d	Potential gas well (9 potential producers)
" Brucedale No. 1	1963	Yes	5255	None	Abandoned
" Ingle No. 1	1963	Yes	4202	None	Abandoned
" Lorelle No. 1	1963	Yes	9065	Traces gas and oil	Abandoned
" Lorne No. 1 *	1963	Yes	4250	None	Abandoned
" Richmond No. 1 (also 2-24)	1963	Yes	4130	Oil 885 bbl /d from 4010'-4062'	Potential oil well 7 potential gas producers 2 oil wells)
" Roma South No. 1	1963	No	3854	Gas shows	Water well
A.P. Back Creek No. 1 (also 2-5)	1964	No	5295	4750'-4793'; 1.7 MMcf/d	Potential gas well (1 other gas well
" Duncan Creek No. 1	1965	No	4585	None	Water well
" Snake Creek No. 1 (also 2-7)	1964	Yes	5270	4969'-5079'; 6¼ MMcf/d	Potential gas well (2 other gas wells)
" Wallabella No. 1	1964	No	6350	Nothing significant	Water well
" Yalebone No. 1	1964	No	4909	None	Water well

NAME OF WELL	YEAR COMPLETED	COMMONWEALTH SUBSIDY	TOTAL DEPTH (feet)	HYDROCARBON SHOWS	STATUS
AAO Beaufort No. 1 (also 2-4)	1964	Yes	3836	3655'-3836', 914 Mcf/d; 3605'-3660', 100 Mcf/d	Potential gas well (2 other gas wells)
" Belbri No. 1	1964	No	3500	3415'-3500', 17.5 Mcf/d	Water well
" Bella Farm No. 1	1964	No	3911	Nothing significant	Abandoned
" Bindaroo No. 1	1964	No	4460	None	Abandoned
" Binya No. 1	1964	Yes	4318	None	Abandoned
" Blyth Creek No. 1 (also 2-7)	1964	Yes	3998	3786'-3820', 8.4 MMcf/d; 3622'-3835 400 Mcf/d	Potential gas well (1 other gas well)
" Blythewood No. 1	1964	Yes	4320	None	Abandoned
" Boondara No. 1	1964	Yes	5859	Nothing significant	Abandoned
" Bore View No. 1	1964	No	4960	Rewan oil show	Water well
" Buckenan Downs No. 1	1965	Yes	4052	None	Abandoned
" Bungil No. 1	1964	Yes	4103	Nothing significant	Water well
" Coolibah No. 1	1964	Yes	4313	4066'-4118', 166 Mcf/d	Abandoned
" Coolibah East No. 1	1964	No	4300	None	Abandoned
" Dalmuir No. 1	1964	Yes	4367	None	Abandoned
" Dirinda No. 1 (also 2)	1964	Yes	4296	3965'-4037', some oil and gas	Abandoned
" Duarran No. 1	1964	Yes	4315	4042'-4072', 0.472 MMcf/d	Abandoned
" Kalima No. 1	1964	Yes	2173	None	Water well
" Lamen No. 1 (also 2)	1964	No	4074	3925'-3947', 7.34 MMcf/d	Potential gas well
" Latemore East No. 2	1964	No	4751	None	Abandoned
" Mount Hope No. 1	1964	No	2562	None	Abandoned
" Quibet No. 1	1964	Yes	3555	None	Water well
" Raslie No. 1 (also 2-5)	1964	Yes	4387	3700'-3773', 4.1 MMcf/d	Potential gas well
" Sawpit Creek No. 1	1964	Yes	3753	Nothing significant	Abandoned
" Sleepy Creek No. 1	1964	Yes	3392	3280'-3306', 192 Mcf/d	Water well
" Timor No. 1	1964	Yes	3680	None	Abandoned
" Warooby South No. 1	1964	Yes	3890	Nothing significant	Abandoned
" Wattanooka No. 1	1964	No	4505	None	Abandoned
" Wyena No. 1	1964	Yes	3713	None	Abandoned
" Yanalah No. 1	1964	Yes	4136	3731-3983 3.2 MMcf/d	Potential gas well
UKA Cherwondah No. 1	1965	No	4598		
" Conloi No. 1	1964	Yes	6005	Production test: 4313'-4321', 400 bbl/d oil.	Potential well
" [illegible]lacca No. 1	1964	No	6469	Nothing significant	Abandoned
" [illegible]lligulgul No. 1	1964	Yes	6117	None	Water well
Amoseas Donnybrook No. 1 *	1965	No	1939	Nothing significant	Abandoned
Amoseas Dulbydilla No. 1 *	1965	Yes	2020	None	Abandoned
A.P. Oberina No. 1	1965	No	4966	5.65 MMcf/d gas from 4712'-4733'	Potential gas well
" Rockybank No. 1	1965	No	4452	None	Abandoned
" Trinidad No. 1 (also 2-9)	1965	No	4828	410' oil from 4590'-4638'	Potential oil well (1 other oil well)

NAME OF WELL	YEAR COMPLETED	COMMONWEALTH SUBSIDY	TOTAL DEPTH (feet)	HYDROCARBON SHOWS	STATUS
AAO Anabranch No. 1 (also 2)	1965	No	4566	1330' oil, minor gas, from 4190'-4215'	Potential oil well
" Blythdale North No. 1	1965	No	3670	None	Abandoned
" Brucedale East No. 1	1965	Yes	5120	None	Abandoned
" Chinchinbilla No. 1	1965	No	4222	None	Abandoned
" Cooreela No. 1	1965	No	4635	None	Abandoned
" Dirinda South No. 1	1965	No	4250	None	Abandoned
" Glenroy No. 1 *	1965	Yes	3931	None	Abandoned
" Hodgson No. 1	1965	No	3630	None	Abandoned
" Hollyrood No. 1	1965	No	4318	0.139 MMcf/d gas from 4184'-4267'	Abandoned
" Landor No. 1	1965	No	4827	None	Abandoned
" Maffra No. 1 (also 2-5)	1965	No	4440	7.3 MMcf/d gas from 4235'-4270'	Potential gas well (1 other gas well
" Pine Ridge No. 1 (also 2-11)	1965	No	3604	4.8 MMcf/d gas from 3415'-3460'	Potential gas well (7 potential producers)
" Winston No. 1	1965	No	3557	None	Abandoned
UKA Carinya No. 1	1965	No	7117	None	Abandoned
" Juandah No. 1	1965	No	8019	None	Abandoned
International Petroleum Service Tarrawonga No. 1	1965	No	4725	3.0 MMcf/d gas from 4400'-4725'	Potential gas well
A.P. Balgownie No. 1	1966	No	4772	Minor gas flows	Abandoned
" Inniscraig No. 1	1966	No	4732	None	Abandoned
" Springbank No. 1	1966	No	4958	None	Abandoned
" Yalebone Creek No. 1	1966	No	4862	None	Abandoned
A.P./AAO Tarrawonga No. 5	1966	No	4686	None	Abandoned
AAO Bardloming South No. 1	1966	No	4730	None	Abandoned
" Beaconsfield No. 1	1966	No	4459	None	Abandoned
" Glencoe No. 1	1966	No	4424	None	Abandoned
" Lochiel No. 1	1966	No	4212	None	Abandoned
" Lyndon Caves No. 1 (also 2)	1966	No	4600	None	Potential gas well
" Trafford Park No. 1	1966	No	5030	None	Abandoned
" Valley Downs No. 1	1966	No	4540	None	Abandoned
" Tarawonga No. 2 (also 4)	1966	No	5068	0.175 MMcf/d from 4287'-4340'	Potential gas well (both
AAO/A.P. Tarawonga No. 3	1966	No	4600	2.5 MMcf/d from 4430'-4495'	Potential gas well
Amoseas Scalby No. 1 *	1966	Yes	2832	None	Abandoned
" Tregole No. 1 *	1966	Yes	2475	None	Abandoned

highly variable and erratic, even on the same structure, and so far little success has been achieved in predicting trends". He continues "None of the presently available seismic methods is able to pick up a seismic reflector for the Precipice in this area. Since the oil and gas accumulations found to date do not appear to be structurally controlled, the search for stratigraphic traps probably offers the best prospect for further success, and it is possible that a detailed hydrodynamic study may assist in this search".

Major oil shows come from the Rewan Formation, Clematis Sandstone, Boxvale Sandstone (within the Evergreen Formation) and the Precipice Sandstone. Those in the Richmond and Trinidad wells come from the Precipice Sandstone; those in the Sunnybank wells from the Rewan Formation and the Clematis Sandstone.

Hydrocarbon shows have virtually been confined to the Roma Shelf, although oil was found in U.K.A. Conloi No. 1 in the Mimosa Syncline. The Roma Shelf appears to be the best area for continued search and development. The oil companies have drilled many of the structures and possible pinch-outs, which were defined largely by seismic work. The importance of stratigraphic traps, especially in the Precipice Sandstone, makes prediction of fields extremely difficult. The more easily predicted traps are pinch-outs against highs. The predominance of gas finds near anticlines is probably partly related to such pinch-outs, and partly to structural traps and, of course, largely to drilling density. The second common type of stratigraphic trap involves permeability changes which seem to be almost unpredictable, at present, in the Precipice Sandstone. Gas would tend to be trapped in old stream channel systems, where porosity is greatest. Each prospect needs detailed study, and no predictions can be made on the basis of the work done by the authors.

The deep Mimosa Syncline is costly to drill, and lack of defined domal structures is a problem. However, the syncline has some potential as is shown by the Conloi oil.

The complete lack of shows west of the Roma Shelf, and the shallow basement, are discouraging features of this area. West of the Merivale/Arbroath Trough targets would be confined to the Lower Jurassic Sandstones overlying basement. The best prospects are probably pinch-outs of the lower Precipice Sandstone against basement highs.

The surface mapping has revealed very little in the way of new structures in the Roma area. The seismic tool is probably the most effective in this area of poor outcrop and small amplitude structures. However, it is ineffective in areas of thick sand cover, such as the part of the Merivale Syncline mantled by Blythesdale sands.

The Merivale Syncline is probably the most interesting undrilled part of the area. No holes have been drilled near the Merivale/Arbroath Syncline between A.A.O. Killoran No. 1 north of this area, and A.A.O. Arbroath No. 1 in the south, a distance of 55 miles. The Forest Vale and Alicker Anticlines on either side of the syncline have been drilled, unsuccessfully, but these are areas of high granite basement with thin Jurassic cover, and are well away from the synclinal axis.

This longitudinal trough (see Structure) has a faulted eastern side (vertical displacement 4000 feet) and warped western side. At the surface, and probably at depth, it consists of a series of fault slices, and is 10 to 15 miles wide. Where it has been drilled west of the major fault zone (i.e. in the thickest sedimentary section) at A.A.O. Arbroath No. 1 in the south, there is some 4000 feet of Lower Permian freshwater sediments overlain by a normal Jurassic-Cretaceous sequence. No wells have been drilled in the syncline, west of the fault zone, in the north. However, in A.A.O. Killoran No. 1, just east of the fault, there is some marine Permian section. It is highly likely that both marine Permian and the porous Triassic Clematis Sandstone would be present on the downthrown side of this Lower Permian fault, near this well. There is also an excellent chance that they would persist southwards for 20 miles, to the area of folding and faulting near Katanga Homestead. The fairly strong fold of the Katanga Anticline (which would probably be stronger in the subsurface) just west of the outcrop of the associated fault (say at 644, 743) would be an interesting wildcat target;

unfortunately there is no northern closure apparent at the surface. An 8000 foot well should strike a thick Permian and Triassic sequence, and would yield valuable stratigraphic information, even if no hydrocarbons were present. Secondary targets would be the Jurassic Precipice and Boxvale Sandstones. It is important that such a hole should be west of the fault; a gravity survey being conducted by the Associated Group may define the subsurface position of the fault more accurately.

Other suggested well sites are on the culmination of the Eurombah Dome and possibly the Taboonbay Anticline. The targets in both cases would be the Precipice and Boxvale Sandstones.

Traces of oil were found in sandstone cores in two shallow drill holes in the Mitchell area, in the marine Minmi Member of the Blythesdale Formation (see Galloway and Duff, 1966; and Appendix 1 in Exon, Casey and Galloway, 1966). In future wells penetrating the Minmi Member, a drill stem test at this level could be justified.

Bentonite

During this survey, bentonite and bentonitic clays were discovered near the top of the Orallo Formation, in the Roma Sheet area. Both surface and drill samples were analyzed by the Petroleum Technology Laboratory of the Bureau of Mineral Resources. The final results were somewhat disappointing, but only a limited amount of work had been done. It is quite possible that further drilling could prove workable deposits. The best samples came from near Yuleba Creek (230, 725). The discovery is fully covered by Duff and Milligan (1967), and Appendix 5 is taken from that record.

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. Another large quarry is that near Gubberamunda Homestead 20 miles north of Roma. Other basalt flows in the area are also suitable for use as road metal if required.

Coal

The only important outcropping coal-bearing sequence in the area is in the Birkhead Formation. The major coal seams, one of which was worked in the Maranoa Colliery near Injune 10 miles to the north, are several hundred feet below the exposed sequence in this area. The Maranoa Colliery has closed, and at present there is no demand for this weakly coking, high volatile bituminous coal. Thin coal seams are also present in the Springbok Sandstone and the Orallo Formation.

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.1., showed it to contain kaolinite and illite, with kaolinite dominant.

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APPENDIX 1

APTIAN AND ALBIAN MACROFOSSILS

by

R.W. Day

(a) APTIAN MACROFOSSILS FROM THE NORTHERN HALF OF THE MITCHELL 1:250,000 SHEET AREA; 1965 COLLECTIONS

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 Doncaster Member. The collections from the Doncaster Member are reported in their approximate stratigraphic order.

MINMI MEMBER

Locality:	GAB 1942: Tributary of Pegleg Creek, just east 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 south-east 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 east about 2½ miles west-south-west of "Echo" (m.r. 652717)
Collector:	M.C. Galloway
Lithology:	Fine grained, glauconitic, calcareous sandstone
Determination:	Maccoyella barklyi (Moore) fossil wood
Age:	Aptian

DONCASTER MEMBER

Locality:	GAB 2162: E. bank of Maranoa River about 6 miles north-north-west 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 north-east 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.

Determinations: *Euspira reflecta*? (Moore)
Laevidentalium sp.
crinoid pinnules
fossil wood

Age: Aptian (Probably Upper Aptian)

Locality: GAB 2166: near roadside about 2½ miles east-north-east 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.
Perisiphonia clarkei (Bowerbank)
Lingula cf. *subovalis* Davidson
Isocrinius sp. ind.
Indet. rhynchonelloid brachiopod
worm burrows

Age: Aptian

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

Collector: M.C. Galloway

Lithology: Silty limestone concretions

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 east-north-east 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. naticoid gastropod
worm burrows

Age: Aptian

Locality: GAB 2156: About 5 miles E 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 north 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 south-south-west 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

Locality: GAB 2159: near earth tank about $5\frac{1}{2}$ miles north-east of "Dulbydilla" (m.r. 555731)

Collector: M.C. Galloway

Lithology: Limestone concretions

Determinations: *Maccoyella* sp. ind.
"*Nucula*" sp. 1
fossil wood

Age: Aptian

Locality: GAB 2098: south bank of Maranoa River, where the river curves from a south-east course to the east-north-east one, about $2\frac{1}{2}$ 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*" *regosostatus* (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)

Determinations: Laevidentalium sp.
crinoid pinnules
fossil wood

Age: Aptian

Locality: GAB 2152: earth tank about 3 miles east-north-east 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 Doncaster Member in the Tambo area. Similarities with faunas of the overlying Doncaster Member in the Mitchell area, and the Minmi Member and Doncaster Member 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.

"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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(b) A MARINE FAUNA OF POSSIBLE NEOCOMIAN AGE FROM THE NULLAWURT MEMBER OF THE BLYTHESDALE FORMATION IN THE MITCHELL 1:250,000 SHEET AREA; 1966 COLLECTIONS

Locality:	SB210: 3 miles west-south-west of "Claravale" (grid ref. 626746)
Lithology:	Fine grained, quartzose sandstone
Determinations:	*Tancredia* sp. cf. "*Corbicellopsis*" *nanutarraensis* Cox Unionid pelecypods cf. *Purpurina* ? *yanreyensis* Cox fossil wood
Age:	Probably Neocomian

Locality:	SB211: 3 miles west-south-west of "Claravale" (grid ref. 626747)
Lithology:	Fine grained, quartzose sandstone
Determinations:	*Tancredia* sp. cf. "*Corbicellopsis*" *nanutarraensis* Cox Unionid pelecypods Indet. natiooid gastropod
Age:	Probably Neocomian

Locality:	SB221: about 5 miles south of "Katanga" (grid ref. 639740)
Lithology:	Fine grained, quartzose sandstone
Determinations:	*Meleagrinella* sp. *Tancredia* sp. cf. "*Corbicellopsis*" *nanutarraensis* Cox ? *Tancretella* sp. *Leionucula* aff. *quadrata* (Etheridge Snr.) ? belemnite moulds ? gastropod trails
Age:	Probably Neocomian

Locality: SB230: about 3 miles south-west of "Katanga" (grid ref. 635740)

Lithology: Fine grained, quartzose sandstone

Determinations: *Meleagrinella* sp.
Tancredia sp.
cf. "*Corbicellopsis*" nanutarraensis Cox
aff. *Tatella* ? sp.
Modiolus aff. *tatei* Etheridge Jnr.
Leionucula aff. *quadrata* (Etheridge Snr.)
worm burrows
plant fragments

Age: Probably Neocomian

Locality: SB233: near Eastern Creek about $1\frac{1}{2}$ miles north of SB232 (grid ref. 619738)

Lithology: Fine grained, quartzose sandstone

Determinations: *Meleagrinella* sp.

Age: Probably Neocomian

Locality: SB239: about $2\frac{1}{2}$ miles north of "Walhallow" (grid ref. 651742)

Lithology: Fine grained, quartzose sandstone

Determinations: *Meleagrinella* sp.
plant fragments

Age: Probably Neocomian

REMARKS

The 6 collections made by N.F. Exon from the Nullawurt Member of the Blythesdale Formation in the Mitchell 1:250,000 Sheet area, provide the first record of marine macrofossils in this unit. In the Roma-Wallumbilla area to the east, where the unit was first defined, Day (1964, p. 12) reported only freshwater pelecypods, ? coprolites, worm tracks and burrows, and plant fossils. In that area the lowest stratigraphic horizon yielding a marine macrofauna was the Minmi Member, which immediately overlies the Nullawurt Member. As there are at present no records of post-Permian marine macrofossils in the Surat Basin, other than those from the Minmi Member at the top of the Blythesdale Formation and from the Wallumbilla Formation, the fossils reported herein probably represent the oldest Mesozoic marine macrofauna found in the Surat Basin to date.

Occurrences of a marine fauna as well as a freshwater one in the Nullawurt Member suggests that the member was deposited in near shore environments. The marine influence apparently did not extend as far eastwards as the Roma-Wallumbilla area, where at present only freshwater fossils are known.

Unfortunately, the collections contain no ammonites and it is not possible to assign the Nullawurt fauna a definite age. However, from the evidence considered below it is suggested that the age of this fauna is Neocomian.

Strong Neocomian affinities are displayed by the species from SB221, 230, 233 and 239, which is designated Meleagrinella sp. This form is represented by numerous internal and external moulds of left valves and a few right valves. In ornament and outline they show a close resemblance to Pseudomonotis sp. figured by Whitehouse (1946, Pl. 1, Figs. 7-8) from the Neocomian (? Valanginian) Stanwell Coal Measures. The species figured by Brunnschweiler (1960, p. 20, text-Fig. 15a-d, Pl. 1 Figs. 20, 22, 25) from the early Neocomian Jowlaenga Formation of Dampier Peninsula, Western Australia, as Meleagrinella cf. superstes is also similar. In addition, the single specimen described from the Minmi Member by Day (in press) as Meleagrinella sp. is comparable with the present form. However, all other Meleagrinella specimens at present known from the Minmi Member are relatively younger. They were referred by Day (in press) to a new species which closely resembles Pseudomonotis superstes Spitz (1914, Pl. 18, Figs. 6-7) from the Lower Cretaceous Guiemal Sandstone of the Himalayas.

Tancredia sp. from SB210, 211, 221 and 230 is more transversely elongated than the new species of Tancredia described from the Minmi Member by Day (in press). To date no comparable species has been observed.

A few large specimens from SB221 are doubtfully referred to the genus Tancrete Ludbrook (1966), the type species of which is the Aptian (Roma) Myacites planus More (1870, p. 254, Pl. 12, Fig. 10). In shape and musculature they are not unlike large forms identified by Woods (1963) from the Laura Basin at "crossing of Norman River, 1.5 miles north-east of Lakefield homestead" as "Macrocallista" sp. nov. At that locality "Macrocallista" sp. nov. was associated with the Neocomian (? Hauterivian) ammonite Hatchericeras lakefieldense Woods (1962).

A single specimen from SB230 designated aff. Tatella ? sp. is possibly congeneric with the Aptian species figured by Etheridge Jnr. (1892, Pl. 28, Figs. 2-5) and doubtfully referred by him to his species Corbicella ? maranoana. Day (in press) has proposed a new genus and species for this form. The Nullawurt specimen may have some affinity with ? Tatella sp. nov. As recorded by Woods (1963) from the same locality as "Macrocallista" sp. nov.

In shape and, to a certain extent, in dentition, several specimens from SB210, 211, 221 and 230 resemble an anteriorly incomplete specimen described by Cox (1961, p. 24, Pl. 2, Figs. 10a-b) from the Nanutarra Formation of Western Australia as "Corbicellopsis" nanutarraensis. Species of the Aptian-Albian genus Tatella are somewhat similar in outline, but have less prominent umbones, are not as inflated, and lack lateral teeth. Cox (1961) assigned the Nanutarra fauna a general Lower Cretaceous age, although Skwarko (pers. comm.) regards the age of the fauna as Neocomian.

A further possible link with the Nanutarra fauna is provided by two gastropods from SB210. In coiling and ornament these are quite like Purpurina ? yanreyensis Cox (1961, p. 33, Pl. 7, Figs. 6a-b).

Modiolus aff. tatei, represented by a single, carinate, internal and external mould of a left valve from SB230, is not unlike the Aptian species originally, described as Modiola tatei from "Stuart's (formerly Cooper's) Creek, Central South Australia" by Etheridge Jnr. (1902, p. 21, Pl. 2, Figs. 10-11). Day (in press) has referred specimens from the Minmi Member of the Roma-Wallumbilla area to this species.

A few internal moulds of left valves from SB221 and 230 have taxodont dentition and internal ligament pits. They are designated Leionucula aff. quadrata as they resemble in shape the Aptian species described by Etheridge Snr. (1872, p.341, Pl. 19, Fig. 5; Pl. 20, Fig. 3) from Maryborough.

Collections SB210 and 211 contain numerous, medium sized, strongly inflated internal and external moulds of pelecypods with closed valves. The shape, ornament of coarse concentric ribs and the eroded condition of the umbones recall features well displayed by freshwater Unionid pelecypods. They may have some relationship to "Unionid gen. & sp. nov." reported from the Blythesdale Formation in the Roma-Wallumbilla area by Day (1964, p. 15, Table 4).

Various collections also contain plant fragments, worm burrows, ? gastropod trails and ? belemnite moulds.

In view of the small number of species represented in the Nullawurt fauna, and the absence of ammonite species therein, it is difficult to determine the age of the fauna precisely. The difficulty is compounded by the lack of well documented faunas of late Jurassic early Cretaceous age in Australia. Probably the best evidence as to age is provided by Meleagrinella sp., which appears to be conspecific with an unnamed species of Meleagrinella in the Neocomian fauna from Stanwell. This form is quite distinct from late Jurassic species of Meleagrinella, which are markedly multicostate, and have emarginate posterior ears. Occurrences of ? Tancretella sp. and aff. Tatella ? sp. may indicate links with the Neocomian fauna of the Laura Basin, but this line of evidence is rather tenuous. If the specimens from the Nullawurt Member compared with "Corbicellopsis" nanutarraensis and Purpurina ? yanreyensis are conspecific with those Western Australian species, there is the possibility of correlation with the Nanutarra Formation. However, the age of the Nanutarra Formation is uncertain. Modiolus aff. tatei and Leionucula aff. quadrata suggest affinities with younger (Aptian) faunas, but the Nullawurt representatives are not necessarily conspecific with the Aptian species.

Except for similarities in Meleagrinella species, the fauna described by Day (in press) from the overlying Minmi Member of the Blythesdale Formation is quite distinct. The single specimen of Meleagrinella sp. found in the Minmi Member might be regarded as a remanie fossil. The other, more commonly occurring Meleagrinella species in the Minmi Member is specifically different. More than half the species in the Minmi fauna also occur in the overlying Doncaster Member, where they are associated with ammonites of late Aptian age. The remainder of the fauna comprises new species. Only Meleagrinella sp. nov. has definite Neocomian affinities. For this reason Day (in press) preferred an early Aptian age for the Minmi fauna. Negative evidence from the absence of Roma (Aptian) species and the stratigraphic occurrence below the Minmi fauna, suggest that the Nullawurt fauna is somewhat older.

Considering the evidence available at present, a Neocomian age seems the most likely possibility, although the Nullawurt fauna cannot be regarded as securely dated. A well dated marine horizon in the Nullawurt Member would be of value in placing the Jurassic-Cretaceous boundary in this part of the Surat basin.

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(c) APTIAN MARINE FOSSILS FROM THE MINMI MEMBER IN THE MITCHELL AND ROMA 1:250,000 SHEET AREAS 1966 COLLECTIONS

Mitchell 1:250,000 Sheet area (Collector N.F. Exon)

Locality:	SB200: near road about 1½ miles south-west of "Eastern Creek" (grid ref. 626739)
Lithology:	Medium grained, glauconitic sandstone
Determinations:	*Fissilunula clarkei* (Moore) fossil wood fragments
Age:	Aptian

Locality:	SB203: about 3 miles north-west of "Nade" (grid ref. 643735)
Lithology:	Medium grained, glauconitic sandstone
Determinations:	*Fissilunula clarkei* (Moore) "*Myacites*" *planus* Moore *Tatella maranoana* (Etheridge Jnr.) *Inoperna ensiformis* (Etheridge Jnr.)
Age:	Aptian

Locality:	SB207: about 3 miles north-east of "Eastern Creek" (grid ref. 631743)
Lithology:	Medium grained, glauconitic sandstone
Determinations:	*Fissilunula clarkei* (Moore) "*Myacites*" *planus* Moore *Tatella maranoana* (Etheridge Jnr.)
Age:	Aptian

Locality:	SB209: about 2 miles north of "Heather Downs" (grid ref. 638735)
Lithology:	Medium grained, glauconitic sandstone

Determinations: Fissilunula clarkei (Moore)
Tatella maranoana (Etheridge Jnr.)
Euspira reflecta (Moore)

Age: Aptian

Locality: SB226: about ¼ mile north-west of "Kilmorey" (grid ref. 635758)

Lithology: Medium grained, glauconitic sandstone

Determinations: Fissilunula clarkei (Moore)
"Myacites" planus Moore
Meleagrinella sp. nov.
Maccoyella subangularis Etheridge Jnr.
fish scale
worm tubes

Age: Aptian

Locality: SB227: about ½ miles west of "Kilmorey" (grid ref. 633758

Lithology: Medium grained, glauconitic sandstone

Determinations: Fissilunula clarkei (Moore)
"Myacites" planus Moore
Cyrenopsis sp. nov.
Inoperna ensiformis (Etheridge Jnr.)
Meleagrinella sp. nov.
Indet. trigoniid
Euspira reflecta (Moore)
fossil wood
fish scale

Age: Aptian

Locality: SB228: about 2 miles south-west of "Kilmorey" (grid ref. 633756)

Lithology: Medium grained, glauconitic sandstone

Determinations: "Myacites" planus Moore
Cyrenopsis sp. nov.
Meleagrinella sp. nov.
Maccoyella subangularis Etheridge Jnr.

Determinations:	"Nuculana" sp. nov. Euspira reflecta (Moore)
Age:	Aptian
Locality:	SB231: on a tributary of Eastern Creek, about 3 miles south-west of "Eastern Creek" (grid ref. 623735)
Lithology:	Medium grained, glauconitic sandstone
Determinations:	Fissilunula clarkei (Moore) "Myacites" planus Moore Tancredia (Corburella) sp. nov. Meleagrinella sp. nov.
Age:	Aptian
Locality:	SB232: about 4½ miles east of "Homeleigh" (grid ref. 618736)
Lithology:	Medium to coarse grained, glauconitic sandstone
Determinations:	"Myacites" planus Moore Cyrenopsis sp. nov. Euspira reflecta (Moore)
Age:	Aptian
Locality:	SB264: Burgagay Creek, about ½ miles south-east of where the Amby-"Walhallow" road crosses, (grid ref. 645720) (near locality GAB1950).
Lithology:	Fine and medium grained, glauconitic sandstone
Determinations:	"Myacites" planus Moore Tatella maranoana (Etheridge Jnr.) Inoperna ensiformis (Etheridge Jnr.) "Modiolus" linguloides Hudleston "Modiolus" tatei Etheridge Jnr. Thracia primula Hudleston Panopea maccoyi (Moore) fish scales fossil wood
Age:	Aptian

Roma 1:250,000 Sheet area (Collector E.N. Milligan)

Locality:	SB107: Sawpit Creek, about 5½ miles north-north-west of "Bindango" (grid ref. 678710)
Lithology:	Fine grained, calcareous, glauconitic sandstone
Determinations:	"Myacites" planus Moore Tatella maranoana (Etheridge Jnr.) Maccoyella barklyi (Moore) Panopea maccoyi (Moore)
Age:	Aptian
Locality:	SB118: Bungeworgorai Creek, about 1½ miles south of Eumina Siding (grid ref. 147706)
Lithology:	Coquina band in fine grained, calcareous, glauconitic sandstone
Determinations:	Peratobelus australis (Phillips) Tatella maranoana (Etheridge Jnr.) Tatella ? sp. 1 Maccoyella barklyi (Moore) calcareous annelid tubes
Age:	Aptian
Locality:	SB122: about 5½ miles south-south-west of "Lucky Downs" (grid ref. 248728)
Lithology:	Leached fine and medium grained sandstone
Determinations:	Tatella maranoana (Etheridge Jnr.) Tatella ? sp. 1 Onestia aff. etheridgei ? (Etheridge Jnr.) Meleagrinella sp. nov. fossil wood
Age:	Aptian
Locality:	SB124: about 12 miles north-east of "Bendemere" (grid ref. 238723)
Lithology:	Leached fine grained sandstone

Determinations:	*Meleagrinella* sp. nov. *Cyrenopsis* sp. nov.
Age:	Aptian

Locality:	SB127: about 5 miles east of "Muggleton" (grid ref. 216719)
Lithology:	Leached fine grained sandstone
Determinations:	*Palaeomoera* ? sp. *Meleagrinella* sp. nov. *Panopea maccoyi* (Moore) Goniasterid starfish plant fragments
Age:	Aptian

Locality:	SB128: about 8½ miles north-north-west of Jackson (grid ref. 243705)
Lithology:	Leached fine grained sandstone
Determinations:	*Tatella maranoana* (Etheridge Jnr.) *Tatella* ? sp. 1 *Meleagrinella* sp. nov.
Age:	Aptian

REMARKS

The fauna represented in these collections from the Minmi Member of the Blythesdale Formation in the Mitchell and Roma 1:250,000 Sheet areas is virtually identical with that described by Day (in press) from the Minmi Member in the Roma-Wallumbilla area.

Most of the species also occur in the overlying Doncaster Member of the Wallumbilla Formation. They include the belemnite *Peratobelus australis*, the gastropod *Euspira reflecta*, and the pelecypods *Tatella maranoana*, *Tatella* ? sp. 1, *Palaeomoera* ? sp., "*Myacites*" *planus*, *Fissilunula clarkei*, *Inoperna ensiformis*, "*Modiolus*" *linguloides*, "Modiolus" tatei, Maccoyella barklyi, Maccoyella subangularis and Panopea maccoyi. Onestia aff. etheridgei is known from the Doncaster Member, but it is not certain whether the Minmi specimens from SB122 are conspecific. Thracia primula has not been observed in collections from the predominantly mudstone Doncaster Member, but the species may occur in the sandy Coreena Member. The remaining identifiable species, "Nuculana" sp. nov., Tancredia (Corburella) sp. nov., Cyrenopsis sp. nov., and Meleagrinella sp. nov. are at present known only from the Minmi Member. Meleagrinella sp. nov. has strong Neocomian affinities, but in view of the preponderance of associated Aptian (Roma) species, an early Aptian age is preferred for the Minmi Member.

Meleagrinella sp. nov. is closely related to Pseudomonotis superstes Spitz (1914, Pl. 18, Figs. 6-7) from the Guiemal sandstone of India. M. sp. nov. has not been observed in collections from marine sandstones which conformably underlie mudstones of the Doncaster Member in the Tambo area in the Eromanga Basin. This may be due to collection failure. Alternatively its absence may suggest that the basal marine Cretaceous sandstones in the Eromanga Basin are slightly younger than sandstones of the Minmi Member in the Mitchell and Roma areas.

"Nuculana" sp. nov. has more anterior umbones than "Nuculana" elongata (Etheridge Snr., 1872, Pl. 20, Fig. 5) and "Nuculana" randsi Etheridge Jnr., (1892, Pl. 26, Fig. 10) from the Aptian Maryborough Formation.

Cyrenopsis sp. nov. is more elongate than described species of that genus.

Specimens of Fissilunula clarkei, "Myacites" planus, Tatella maranoana and Inoperna ensiformis found in medium grained sandstones, do not appear to differ from specimens of those species collected from finer grained lithologies.

A single left valve from SB127 has the same shape as specimens identified from SB129 in the overlying Doncaster Member as Palaeomoera ? sp.

Several rather large internal and external moulds from SB122 have equilateral shape and concentric ornament. In these respects they resemble the Aptian Maryborough species Onestia etheridgei (Etheridge Jnr., 1892, Pl. 27, Fig. 1). However, the hinge is not visible and the identification can only be tentative.

Collection SB128 contains an asteroid starfish which is probably referrable to the family Goniasteridae. The arms are short and the inter-radials of the oral surface bear ridges resembling the rod shaped ossicles of the Indian Jurassic genus Indiaster Rao. Unfortunately the matrix is too coarse for ready determination of the nature of the plates. Fragments of starfish arms were reported from the Minmi Member by Day (1964), but their relationship with the present material is not known.

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(d) APTIAN MACROFOSSILS FROM THE DONCASTER MEMBER IN THE MITCHELL AND ROMA 1:250,000 SHEET AREAS; 1966 COLLECTIONS

Mitchell 1:250,000 Sheet area (Collector E.N. Milligan)

Locality: SB104: near Maranoa River about 1.5 miles north-east of "Mulgavale" (grid ref. 622695)

Lithology: Fine grained calcareous sandstone with mud pebbles

Determinations: Panopea sp. ind.
plant fragments

Age: Probably Aptian

Locality: SB105: Maranoa River about 1 mile downstream from Mitchell (grid ref. 617708)

Lithology: Fine grained, glauconitic, silty sandstone

Determinations: Maccoyella reflecta (Moore)
Maccoyella corbiensis (Moore)
Cyrenopsis cf. meeki (Etheridge Jnr.)
Peratobelus oxys (Tenison-Woods)
? Dimitobelus sp. ind.

Age: Aptian

Locality: SB106: Sawpit Creek about 5.5 miles east-south-east of Mt. Bindango (grid ref. 670710)

Lithology: Concretionary limestone

Determinations: Maccoyella barklyi ? (Moore)
Camptonectes socialis ? (Moore)
"Myacites" planus Moore
Lima gordoni Moore
Inoperna ensiformis (Etheridge Jnr.)
Euspira reflecta (Moore)
Peratobelus sp. ind.
Purisiphonia clarkei Bowerbank
Isocrinus sp. ind.
algal structures
worm burrows

Age: Aptian

Locality: SB129: Maranoa River about 6 miles north-north-west of Mitchell (grid ref. 611720)(locality is close to GAB 2162-2163).

Lithology: Concretionary limestone with some coquina bands

Determinations:
Peratobelus australis (Phillips)
Maccoyella barklyi (Moore)
Maccoyella subangularis Etheridge Jnr.
Camptonectes socialis (Moore)
Camptonectes (Camptochlamys) aequilineatus (Moore)
Pseudavicula anomala ? (Moore)
Inoceramus sp. A
"Nuculana elongata" (Etheridge Snr.)
Leionucula cooperi (Moore)
Inoperna ensiformis (Etheridge Jnr.)
Cyrenopsis cf. meeki ? (Etheridge Jnr.)
"Ostrea" sp.
Panopea rugosa Moore
Thracia wilsoni Moore
Palaeomoera ? sp.
Laevidentalium sp.
Euspira reflecta (Moore)
Isocrinus sp. ind.

Age: Aptian

Locality: SB130: Maranoa River about 1 mile downstream from SB129 (grid ref. 609720) and about 0.5 miles east-north-east of "Brooklyn".

Lithology: Fine grained, silty sandstone

Determinations:
Leionucula cooperi (Moore)
Thracia wilsoni ? Moore
Crinoid fragments
plant fragments

Age: Aptian

Roma 1:250,000 Sheet area (Collector E.N. Milligan)

Locality: SB110: near Muckaby Creek about 4 miles north-north-east of Bindango Siding (grid ref. 1347C3)

Lithology: Coquina band in calcareous mudstone

Determinations: Maccoyella barklyi (Moore)
Inoperna ensiformis (Etheridge Jnr.)
Fissilunula clarkei ? (Moore)
Laevidentalium sp.
Indet. naticoid gastropod
crinoid fragments

Age: Aptian

Locality: SB112: Wallumbilla Creek about 4½ miles south-east of Wallumbilla (grid ref. 205689)

Lithology: Fine grained, friable sandstone

Determinations: "Modiolus" linguloides Hudleston
Cyrenopsis cf. meeki (Etheridge Jnr.)
"Nuculana" sp. ind.
Camptonectes sp. ind.
Laevidentalium sp.
Euspira reflecta (Moore)
plant fragments

Age: Aptian

Locality: SB114: Wallumbilla Creek, near SB112.

Lithology: Fine grained friable sandstone

Determinations: Peratobelus oxys (Tenison-Woods)
Inoceramus sp. A

Age: Aptian

Locality: SB115: Wallumbilla Creek about 4¾ miles south-south-east of Wallumbilla (grid ref. 205688)

Lithology: Concretionary limestone

Determinations: Maccoyella sp. ind.

Age: Aptian

Locality: SB116: Just west of Wallumbilla Creek, about 4 miles south-south-east of Wallumbilla (grid ref. 205690)

Lithology: Limestone concretions

Determinations:
Maccoyella reflecta (Moore)
Maccoyella umbonalis (Moore)
Fissilunula clarkei (Moore)
"*Modiolus*" *linguloides* Hudleston
Onestia aff. *etheridgei* (Etheridge Jnr.)
"*Gari*" *elliptica* ? Whitehouse
Thracia wilsoni Moore
Panopea maccoyi (Moore)

Age: Aptian

Locality: SB117: Wallumbilla Creek, about $4\frac{1}{4}$ miles south-south-east of Wallumbilla (grid ref. 206690)

Lithology: Limestone concretions

Determinations:
Peratobelus australis (Phillips)
Pseudavicula anomala (Moore)
Camptonectes socialis (Moore)
"*Mytilus*" *rugocostatus* Moore
Tatella maranoana (Etheridge Jnr.)
Onestia aff. *etheridgei* (Etheridge Jnr.)
Thracia wilsoni Moore
Euspira reflecta (Moore)

Age: Aptian

Locality: SB119: Roma-Orallo road about 6 miles from Roma (grid ref. 155703)

Lithology: Limestone concretions

Determinations:
Pinna sp. ind.
Laevidentalium sp.

Age: Aptian

Locality: SB120: Wallumbilla Creek $4\frac{1}{2}$ miles east of "Bundilla" (grid ref. 205684)

Lithology: Silty sandstone

Determinations: *Panopea maccoyi* (Moore)

Age: Aptian

Locality: SB121: near where road from Wallumbilla to Condamine highway crosses Pickanjinnie Creek (grid ref. 200677)

Lithology: Silty sandstone

Determinations: *Maccoyella reflecta* (Moore)

Age: Aptian

Locality: SB123: about 3½ miles west-north-west of Pickanjinnie (grid ref. 189770)

Lithology: Silty calcareous concretions

Determinations: *Tropaeum australe* ? (Moore)
Maccoyella corbiensis (Moore)
Onestia aff. *etheridgei* (Etheridge Jnr.)
Euspira reflecta (Moore)
Indet. belemnites
"*Rhynchonella*" rustica (Moore)
Isocrinus australis (Moore)
Purisiphonia clarkei Bowerbank
calcareous annelid tubes

Age: Probably Upper Aptian

Locality: SB125: about 5½ miles north-west of Drillham (grid ref. 284699)

Lithology: Coquinite band in calcareous silty sandstone

Determinations: *Maccoyella barklyi* (Moore)
Maccoyella corbiensis (Moore)
Camptonectes socialis (Moore)
Inoceramus sp. A
Leionucula sp. ind.
Indet. trigoniids
Indet. mytilid
Laevidentalium sp.
Euspira reflecta (Moore)
Purisiphonia clarkei Bowerbank
Isocrinus sp. ind.
Lingula cf. *subovalis* Davidson

Determinations: Indet. belemnites
calcareous annelid tubes
worm burrows

Age: Aptian

Locality: SB126: Dulacca Creek about 1½ miles south of Dulacca (grid ref. 265688)

Lithology: Fine grained silty sandstone

Determinations: "*Lucina*" sp.
Lingula cf. *subovalis* Davidson
Indet. shell fragments

Age: Aptian

REMARKS

The vast majority of the species identified in the present collections from the Mitchell and Roma 1:250,000 Sheet areas were previously reported from those areas by Day (1964a; 1966a). The fauna is a typical Roma (Aptian) fauna, with one possible Tambo element. This is a single, very small belemnite guard from SB105, which may be a representative of the Tambo genus *Dimitobelus*. However, the specimen is not well preserved and cannot be referred with confidence to that genus.

Collections SB106, SB110, SB119, SB123, SB125, SB129 and SB130 probably belong to the *Purisiphonia* horizon as their fauna corresponds closely to that reported by Day (1964a) from this horizon in the Roma area. The remaining collections are from stratigraphically higher horizons. Some of these may correspond to "the horizon with abundant *Cyrenopsis*", although *Cryrenopsis* is not abundant in the collections.

The new collections have shown that a few species range higher than was evident in collections from the limited area mapped by Day (1964a). Numerous specimens of the pelecypod *Pseudavicula anomala* (Moore) from SB117 indicate that species ranges above the *Purisiphonia* horizon.

P. anomala was reported from very near the top of the Aptian sequence in the Hughenden area (Day, 1964b) and from similar levels in the Tambo and Augathella areas (Day, 1966b). Likewise, the occurrence of the belemnite Peratobelus australis (Phillips) at SB116 indicates the range of this species overlaps that of P. oxys. Several guards found near the top of the Aptian sequence in the Tambo area were tentatively identified with P. australis by Day (1966b). Tatella maranoana (Etheridge Jnr.) also occurs above the Purisiphonia horizon as forms listed by Day (1964a) as Tatella? aptiana Whitehouse are now regarded as conspecific with T. maranoana.

Maccoyella reflecta (Moore) appears to be the most characteristic fossil of strata above the Purisiphonia horizon. The related M. barklyi, which has shorter ears, seems to be confined to the lower parts of the Aptian sequence. This closely parallels the situation reported by Day (1964b) from the Hughenden area, where however, the ranges of the two species may overlap briefly.

The only ammonite observed in these collections is doubtfully identified as Tropaeum australe, a species originally described by Moore (1870, p. 115, Fig. 3) from the "Upper Maranoa". It is represented by a large body chamber fragment with a quadrate whorl section, and external impressions of smaller whorls.

An unusual feature of these collections is the occurrence of Inoceramus at SB114, SB125 and SB129. Aptian records of Inoceramus are quite rare. The species is an erect one with ornament not unlike that of the species compared with I. anglicus Woods and I. neocomiensis d'Orbigny by Brunnschweiller (1960). Albian species are quite distinct.

Pinna sp. ind. represented at SB119 by a single, incomplete specimen with closed valves is the first Pinna the writer has observed in collections from the Surat Basin. The genus has previously been reported from the Australian Lower Cretaceous by Hudleston (1890, Pl. 9, Fig. 16 - Pinna australis from Primrose Springs in South Australia) and by Etheridge Jnr. (1892, Pl. 20, Figs. 16-17 - Pinna sp. ind. from Walsh River, Blackdown Formation).

The single specimen designated "Ostrea" sp. is the first Aptian oyster noted by the writer. Oysters have been reported previously from the Mackunda Formation in the Manuka and Muttaburra areas.

"Nuculana elongata" represented by several well preserved left and right valves from SB129, is conspecific with Leda elongata Etheridge Snr. (1872, Pl. 20, Fig. 5) from the Maryborough Formation.

Two specimens from SB129 are doubtfully referred to the tellinid genus Palaeomoera Stocliczka. The species were reported from GAB1942 in the Minmi Member of the Mitchell area as Gari cf. elliptica Whitehouse, and from GAB1134 in the Doncaster Member of the Hughenden area as Tatella aff. maranoana (Etheridge Jnr.). In outline the species resembles "G" elliptica, but the umbones are centrally placed and the species is proportionately higher than "G".elliptica. Tellina sp. figured by Etheridge Snr. (1872, Pl. 20, Fig. 7) from Maryborough may be conspecific.

Collection SB125 contains several specimens of the crinoid Isocrinus australis (Moore) and the sponge Purisiphonia clarkei Bowerbank in positions of growth. Associated with these are the brachiopods "Rynchonella" rustica Moore (1870, p. 245, Pl. 10, Figs. 7-9) and "Argyope" wollumbillaensis Moore (1870, p. 243, Pl. 10, Figs. 3-5). Brachiopods are not common in Aptian deposits and are even rarer in Albian ones.

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(e) LOWER ALBIAN FOSSILS FROM THE COREENA MEMBER IN THE SURAT BASIN; 1966 COLLECTIONS

The seven collections reported below provide the first record of Albian macrofossils in the Surat Basin. Two of the collections are from the Roma 1:250,000 Sheet area: the remainder are from the Mitchell 1:250,000 Sheet area.

Mitchell 1:250,000 Sheet area (Collector E.N. Milligan)

Locality:	SB100: near tributary of Emu Creek, about 3 miles east of Mt. Abundance (m.r. 668684).
Lithology:	"Belemnite conglomerate" in cross-laminated, glauconitic siltstone
Determinations:	*Dimitobelus diptychus* (McCoy) *Peratobelus selheimi* ? (Tenison Woods) Indet. pelecypod
Age:	Lower Albian

Locality:	SB101: near tributary of Emu Creek, about 2 miles east of Mt. Abundance (m.r. 667685)
Lithology:	Coquina bands in calcareous, siltstone
Determinations:	*Aucellina hughendenensis* (Etheridge) *Barcoona trigonalis* (Moore) *Maccoyella corbiensis* (Moore) *Nuculana* sp. nov. B *Euspira reflecta* (Moore) Indet. belemnite
Age:	Probably Lower Albian

Locality:	SB102: just east of where road crosses Back Creek, about 4 miles north of Amby (m.r. 638708)
Lithology:	Siltstone

Determinations: Dimitobelus diptychus (McCoy)

Age: Lower Albian

Locality: SB109: near headwaters of Paddy Creek about 2 miles south of One Tree Hill (m.r. 671671)

Lithology: Calcareous siltstone

Determinations: Dimitobelus diptychus (McCoy)
Barcoona trigonalis (Moore)
Camptonectes sp.

Age: Lower Albian

Roma 1:250,000 Sheet area (Collector E.N. Milligan)

Locality: SB108: Middle Creek where Mt. Abundance road crosses (m.r. 140688)

Lithology: Calcareous siltstone

Determinations: ? Tatella sp. ind.

Age: Probably Lower Albian

Locality: SB111: Blyth Creek near where the Carnarvon Highway crosses (m.r. 173678)

Lithology: Calcareous siltstone

Determinations: Tatella aptiana ? Whitehouse
Indet. pelecypods
worm burrow
plant fragments

Age: Probably Lower Albian

REMARKS

An early Albian age for these collections is indicated by the presence of the Lower Albian belemnite Dimitobelus diptychus at SB100, SB102, and SB109, and the Lower-Upper Albian pelecypod Aucellina hughendenensis at SB101. This is the first record of Albian (Tambo) macrofossils in the Surat Basin, only Aptian (Roma) fossils having been reported there previously.

The fauna and its mode of preservation are remarkably similar to those reported by Day (1966) from the lower part of the Coreena Member in the Augathella and Tambo areas. Collection SB100 is a "belemnite conglomerate" composed of large numbers of Dimitobelus diptychus together with several guards of the presumably Aptian species Peratobelus selheimi ? Identical "belemnite conglomerates" with the same mixing of Aptian and Albian species were reported by Day (1966) from GAB1933 in the Tambo area, and from GAB2039, GAB2057, and GAB2059 in the Augathella area. Coquinas of the small pelecypod Barcoona trigonalis occur at SB101 and SB109. In the Coreena Member these are strikingly developed, although the species is known to occur in the Doncaster Member of the Tambo area, and in the Mackunda Formation of the Manuka area. Only Aucellina hughendenensis is not known from the Coreena Member in the Augathella and Tambo areas, but this pelecypod species is common in outcrops of that unit near Barcaldine and Aramac.

The correspondence of faunas is closely paralleled by lithological and stratigraphical similarities. The silty sediments with the fauna reported herein are very like those of the Coreena Member. Further they occupy a similar stratigraphic position immediately above the Aptian Doncaster Member. Clearly, these silty sediments outcropping south of Mitchell and Roma are to be correlated with the Coreena Member of the Augathella and Tambo areas.

Dimitobelus diptychus is abundantly represented at SB100 by fairly large clavate forms, together with smaller spindle shaped guards. In reports on Coreena fossils from the Tambo and Augathella areas the latter were compared with Dimitobelus liversidgei. They are now regarded as young individuals of D. diptychus. Several specimens clearly exhibit the double lateral lines and dorso- and ventro-lateral grooves which typify the genus. At SB102 and SB109 D. diptychus is represented by fewer specimens which are less well preserved. Reasons for considering D. diptychus a Lower Albian species are elaborated in the report on Coreena fossils from the Tambo area (Day, 1966). There are several guards designated Peratobelus selheimi ? in the "belemnite conglomerate SB100, but this species is not nearly as abundant as D. diptychus. The guards are large and cylindrical and show the two simple ventro-lateral grooves characteristic of Peratobelus. The alveolus is very deep and is capable of accommodating a large phragmocone. Large phragmocones were described from the "Palmer River" (Blackdown Formation) by Tenison-Woods (1883, p. 150, Pl. 7, Fig. 1) as Belemnites selheimi. However, the writer has observed large phragmocones associated with quite small guards in Geological Survey of Queensland collections from the "Walsh River" "Blackdown Formation". Thus the present guards may represent a different species. As remarked in earlier reports Day (1966) Peratobelus is an Aptian genus and its rare occurrences with the Albian Dimitobelus may be remanie ones.

Aucellina hughendenensis is represented at SB101 by a few left and right valves. The left valves have the narrow umbones, posterior obliquity, and radial ornament characteristic of this Lower-Upper Albian species.

At SB101 there is a single, well preserved left valve identified with the Aptian species Maccoyella corbiensis. This species was reported from GAB1933 in the Coreena Member of the Tambo area, where it was regarded as a derived species. This explanation may be invoked again here, although like Peratobelus selheimi ?, the species may range in the Lower Albian.

The single left valve of Camptonectes sp. from SB109 has strong radial ornament. The form is conspecific with similarly designated pectinids from the Coreena and Allaru Members and the Mackunda Formation.

The pelecypod genus Tatella may be represented at SB108 and SB111. An internal mould of a left valve from the latter locality has the shape of the probable Albian species Tatella aptiana Whitehouse (1925) from the "Lake Eyre Basin". The specimen from SB108 is less complete.

Three left valves of a posteriorly truncate nuculanid identified as Nuculana sp. nov.B, are conspecific with similarly designated forms from the Coreena and Allaru Members and the Mackunda Formation.

The sole gastropod in these collections is the naticid Euspira reflecta which is represented at SB101 by several small specimens. In the Eromanga Basin this species ranges through the entire Aptian-Albian sequence.

In addition collection SB111 contains numerous plant fragments and worm burrows.

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APPENDIX 2

PALYNOLOGY OF SHALLOW HOLES DRILLED IN 1965 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 <u>Dingodinium cerviculum</u>.
* Contains a high proportion of "Gen. et sp. nov A" Eisenack and Cookson.

The Cretaceous, unit K1b/ Dingodinium cerviculum Zone age of the Minmi Member of the Blythesdale Formation is established. The presence of unit K1a 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" Eisenack and Cookson at the same horizon is completely in accord with its occurrence in unit K1a in the Otway and Gippsland Basins in Victoria (Evans, 1966b). A few other acritarchs (Micrhystridium spp.) were detected in the oldest sample of K1a, in BMR 1 (Mitchell), core 4. "Gen. et sp. nov. A" swarms in illitic mudstone at certain horizons in K1a in the Otway Basin. Its relative abundance in BMR 1 (Mitchell) in the Great Artesian Basin coincides with the presence of glauconite (M.C. Galloway, pers. comm.), 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 K1a 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 BMR 5 (Mitchell) yielded a typical unit J6 assemblage. However, cores from presumably higher up the section, in BMR 4 (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 north-west 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).

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APPENDIX 3

PALYNOLOGY OF SOME SHALLOW HOLES DRILLED IN 1966 IN THE MITCHELL AREA, QUEENSLAND

by

D. Burger

Cores from four shallow holes, drilled in the Cretaceous of the Mitchell 1:250,000 Sheet area during 1966 were examined for pollen grains, spores and microplankton. The holes represent a more or less continuous sequence from the lowermost Blythesdale Formation into the Coreena Member of the Wallumbilla Formation and cover the spore units Kla to Kld. A selection of core samples, containing stratigraphically important microfossils from Mitchell No.s 8, 10 and 11 is listed in Table 1 and from Mitchell No. 7 in Table 2.

Mitchell No. 8 penetrated the Coreena Member from 0-162 feet and yielded a Kld microflora.

Mitchell No. 10, which penetrated the Coreena Member from 0-270 feet and the Doncaster Member of the Wallumbilla Formation to 401 feet, contains units Klb-c and Kld. The base of Kld, characterized by the first occurrence of *Crybelosporites striatus*, appears to occur between cores 4 and 5, i.e. within the Coreena Member.

Mitchell No. 11 penetrated the Doncaster Member from 0-45 feet, the Minmi Member of the Blythesdale Formation to 134 feet and the remainder of the Blythesdale Formation to 395 feet. Unit Kla was recognized in cores 5 to 2 and unit Klb-c in core 1 within the Minmi Member. Unit Klb-c was also encountered in the Minmi Member of Mitchell Nos. 1 and 4, so that the contact between units Kla and Klb-c appears to occur in the lower to middle part of that Member.

Microplankton forms identified from the Kingull-Nullawurt interval of Mitchell No. 11 represent the *Dingodinium cerviculum* zone (Evans 1966). The base of this zone seems to lie in the Nullawurt Member (core 4) within spore unit Kla. The top of the zone seems to coincide with the base of spore unit Kld, but there are no indications of the *Odontochitina operculata Muderongia tetracantha* zone in unit Kld of Mitchell Nos. 8 and 10.

Microfloral Assemblages, designated by Dettmann (1963) for the Lower Cretaceous of South-Eastern Australia are also taken into account here for comparative purposes. The Speciosus Assemblage, characterized by *Dictyotosporites speciosus*, is traced in Mitchell Nos. 8, 10 and 11 (Table 1). The base of the Assemblage seems to occur near the base of the Nullawurt Sandstone Member in Mitchell No. 11 (core 4). The underlying Stylosus Assemblage is characterized by *Crybelosporites stylosus*; this type is traced to the top of the Minmi Member, thereby slightly outranging unit Kla. The co-occurrence of C. stylosus and D. speciosus is therefore characteristic for the upper part of unit Kla.

Mitchell No. 7 penetrated marine Cretaceous from 0-135 feet and Hooray Sandstone to 265 feet. The analysed core samples yielded a Lower Cretaceous microflora, equivalent to the Stylosus and the lower part of the Speciosus Assemblages (Table 2). Core 10 contains Cicatricosisporites australiensis with Murospora florida and is therefore of Kla age. The top of Kla cannot be established by the absence of M. florida in the other cores. But as shown above, part of the interval in which the range of both Crybelosporites stylosus and Dictyotosporites speciosus overlap (between core 10 and core 1) may be attributed to unit Kla. The microplankton content of the marine Cretaceous section (between core 7 and core 1) indicates an age equivalent to the Minmi Member. Therefore, as the top of unit Kla lies within the Member, at least core 7 might be attributed to this unit.

Because of the uncertain position of the top of Kla, there are no positive indications of unit Klb-c.

The table in Appendix 2 shows the results of palynological investigation by Evans on cores and cuttings from Mitchell Nos. 1 to 5, drilled during 1965. In agreement with the results shown in Table 1, the pre-Minmi Blythesdale Formation of Mitchell No. 1 appears to yield a Kla microflora, while the Minmi Member of Mitchell Nos. 1 and 4 contains unit Klb-c. The presence of "Gen. et sp. nov. Forma A" Eisenack and Cookson below the Minmi Member of Mitchell No. 11 has also been recorded from Mitchell No. 1 together with the presence of glauconite, indicating that the earliest Cretaceous brackish to marine incursions affected deposition of the sequence Mooga Sandstone Member to Kingull Member (Evans in Exon et al. 1966).

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TABLE 1.

Formation	Blythesdale					Donc.	Coreena		Coreena		
Shallow hole	Mitchell 11					Mitchell 10			Mitchell 8		
Core number	5	4	3	2	1	7	5	4	4	3	1
Core depth	281'6"	212'11"	157'8"	99'6"	48'	392'	150'	83'6"	152'	86'10"	60'
Sample No. (MFP)	4278	4289	4288	4286	4276	4252	4256	4255	4245	4244	4242
Assemblage	Styl.	Speciosus				Speciosus			Speciosus		
Pollen unit		Kla			b-c	Klb-c		Kld	Kld		
Cicatricosisporites australiensis	x	x	x	x	x	x	x	x	x	x	x
Murospora florida	x			x							
Crybelosporites stylosus	x	x		?	x						
Dictyotosporites speciosus		x				x	x		?	x	
Crybelosporites striatus								x	x		x
Muderongia ssp.			x	x							
Dingodinium cerviculum			x	x							
Canningia sp.			x	x							
"Gen. et sp. nov. A" Eis. & Cooks.	x										

TABLE 2.

Formation	Hooray		Minmi + Donc.		
Shallow hole	Mitchell 7				
Core number	12	10	7	6	1
Core depth	261'3"	180'6"	125'	105'	80'
Sample No. (MFP)	4313	4311	4305	4308	4306
Assemblage	Styl.	Speciosus			
Pollen unit	Kla		Kla?	?	?
Cicatricosisporites australiensis	x	x	x	x	x
Murospora florida		x			
Dictyotosporites speciosus		x		x	x
Crybelosporites stylosus	x			x	x
Muderongia tetracantha			x	x	x
Dingodinium cerviculum			x	x	x
Canningia sp.			x	x	

APPENDIX 4

REPORT ON 1966 COLLECTION OF PLANT FOSSILS FROM THE SURAT BASIN

by

Mary E. White

(Taken from Part I of Record 1967/68)

INTRODUCTION

Plant fossils were collected at five localities in the Surat Basin in 1966 by N. Exon and E.N. Milligan.

Two localities in Nullawurt Sandstone contain a Lower Cretaceous assemblage. Specimens collected from rubble lying in the Injune Creek Group (Loc. SB266) contain a very large number of Lower Cretaceous plants in an excellent state of preservation. A locality in Mooga Sandstone contains Lower Cretaceous plant fragments.

1. Locality SB236: Mitchell Sheet. Nullawurt Sandstone Member of Blythesdale Formation. 1 mile west-north-west of Walhallow Homestead. (Military grid reference 651, 738). Collector N.F. Exon.

Specimen No. F22844.

Several leaves up to 1cm. wide and 6cm. long, parallel-sided, with prominent midribs and fine secondary veining at right angles to the midrib, are referred to Taeniopteris spatulata McClell. Leaves of this type have a Jurassic and Lower Cretaceous distribution. None of the leaves is complete, and there is no indication whether they were simple leaves or leaflets of compound leaves of the Stangerites, Angiopteridium or Morrisia type. Classification of such leaves is not wholly satisfactory. Taeniopteris spatulata is used as a form species. With poor specimens any other determination would be unnecessarily complicating.

Age: Jurassic or Lower Cretaceous

2. Locality SB245: Roma Sheet. Nullawurt Sandstone Member. On rise immediately W. of Goldsborough Hs. (Military grid ref. 131, 722). Collector N.F. Exon.

Specimen No. F22845, F22846.

Conifer fronds referred to Elatocladus planus Feist. are illustrated in the record.

Specimen F22846 contains part of a lamina of Hausmannia wilkinsi Walkom showing the dichotomising venation. Hausmannia wilkinsi was described by Walkom in 1928 from Plutoville, Cape York Peninsula, from Lower Cretaceous strata. (Walkom, A.B. 1928 .. Fossil Plants from Plutoville, Cape York Pen.; Proc. Linn. Soc. N.S.W., 53, 2; p. 148).

Age: Lower Cretaceous.

3. Locality SB131: Roma Sheet. Top sandstone of Nullawurt Sandstone Member. In Bungil Creek (148°47'48"E; 26°25'06"S). Collector E.N. Milligan.

Specimen Nos. F22851, F22851A, F22852.

In the specimens numbered F22851 there are indeterminate plant fragments and numerous casts of small spherical seeds of average diameter .25 cm. What appears to be part of a Molluscan shell is present in specimen F22851A. Among the indeterminate plant fragments are a few which might be pinnule fragments of Cycadites. Each is about 1.5 cm long, .25-.3 cm. wide, with keeled appearance. Two ? veins spaced .1 cm. apart form the keely, the sides are flexed forwards. No identification can be made on the fragmentary evidence.

Specimen F22852 is illustrated in the record. A triangular scale of indeterminate affinities (or ? cast of conical seed) is present with a number of the small spherical seeds which occur in profusion throughout the sample.

Age: No age determination can be made.

4. Locality SB132: Roma Sheet. Near top of Mooga Sandstone Member of Blythesdale Formation. Near Dulacca. (149°50'54"E, 26°23'32"S). Collector E.N. Milligan.

Specimen No. F22853.

These specimens contain great quantities of macerated and fragmentary plant material, largely indeterminate. Some oval seeds, max. diam. .7 cm. are present, also two small leaf fragments which are tentatively referred to Phyllopteris lanceolata Walk.

Age: Probably Lower Cretaceous.

5. Locality SB266: Roma Sheet. Derived material lying on Injune Group. Probably from Duricrusted Cretaceous - possibly Doncaster Member. Occurs as silicified argillaceous rubble immediately north of Lyndon Hs. (Military grid ref. 137, 747). Collector N. Exon.

Specimens F22854 - F22861.

The following plants are identified:-

Taeniopteris spatulata McClell.
Taeniopteris sp. (very narrow leaves)
Cladophlebis australis Morr.
Nilssonia schaumbergensis Dunker.
Sphenopteris burrumensis Walk.
Sphenopteris flabellifolia Ten. Woods.
Otozamites feistmanteli Zigno.
Araucarites arberi Walk. Cone Scales
Cycadolepis. Flower bracts.
Phyllopteris lanceolate Walk.
Casts of spherical seeds.

Age: This is a Lower Cretaceous flora containing most of the elements of the Burrum Flora in Queensland.

NOTES ON SPECIES

Taeniopteris spatulata McClell.: Common in Jurassic and Lower Cretaceous

Taeniopteris sp.: Very Narrow Taeniopteroid leaves, averaging .15 cm. wide and up to several cm. long. These may be parts of compound leaves. No close identification can be made.

<u>Cladophlebis</u> <u>australis</u> Morr.: Very abundant fern of Jurassic and Lower Cretaceous.

<u>Nilssonia</u> <u>schaumbergensis</u> Dunker.: A Lower Cretaceous species of Nilssonia. Similar to <u>Pterophyllum</u> <u>fissum</u> common in Lower Cretaceous in Australia (Records 1961/146). Small fronds and basal portions of fronds could almost be referred to <u>P.fissum</u>. Fronds of this type have a Lower Cretaceous distribution. <u>N.schaumbergensis</u> is a prominent member of the Burrum flora in Queensland.

<u>Sphenopteris</u> <u>burrumensis</u> Walk.: A fern described from Burrum Series.

<u>Sphenopteris</u> <u>flabellifolia</u> Ten. Woods.: Described from Burrum Series.

<u>Otozamites</u> <u>feistmanteli</u> Zigno.: Shows callosities at the petioles. Range of such fronds Jurassic and Lower Cretaceous.

<u>Araucarites</u> <u>arberi</u> Walk.: Described from the Burrum Series.

<u>Cycadolepis</u>.: Bennetitalean flower bracts. Lower Cretaceous.

<u>Phyllopteris</u> <u>lanceolata</u> Walk.: Described from the Burrum Series in Queensland. Leaves of this type have a Jurassic/Lower Cretaceous distribution.

APPENDIX 5

UPPER JURASSIC BENTONITE FROM YULEBA CREEK

by

P.G. Duff and E.N. Milligan

(Part II of Record 1967/9)

GEOLOGY

INTRODUCTION

During the Bureau of Mineral Resources regional mapping survey of Roma 1:250,000 Sheet area, clays with an appearance strongly suggestive of bentonite were recognized cropping out in the east bank of Yuleba Creek, 20 miles north of Yuleba. A sample (approximately 8 oz. in weight) was tested by the Petroleum Technology Laboratory. The results were sufficiently encouraging to warrant further collecting and four (5lb.) samples were tested. Although one of these samples was a recollection of the original sample, all the new samples were of an inferior grade. A limited number of cored scout holes were later drilled to obtain fresh material from the same horizons as the more promising outcrop sample.

STRATIGRAPHY

The 'clays' tested come from the Orallo Formation which is of Upper Jurassic age (Day, 1964, p. 5). The top of the formation is characterized by a unit of mudstone and claystone commonly associated with carbonaceous laminae and lignite beds. This unit has a known extent from Bungeworgerai Creek in the west of the Roma Sheet area to the eastern margin of the Roma Sheet area (see Fig. 1). Variation in thickness and detailed lithology of this upper unit is virtually unknown as good outcrop is rare and is exposed only under well developed outcrops of the overlying Mooga Sandstone Member of the Blythesdale Formation. However, small outcrops of claystone and 'clay' have been recognised in the unit throughout its mapped extent.

LOCATION OF SAMPLES

Two samples were collected from 'claystone' interbeds in the coarse grained sandstone of the middle unit of the Orallo Formation (531 from 200 yards upstream from the original sample locality and 474 from near the eastern margin of the Roma Sheet area - see Fig. 1 and inet). The remainder were collected from the upper unit of the Orallo Formation and their relative stratigraphic position is indicated in Table 6.

Scout holes Nos. 2, 3 and 4 were drilled to intersect the section at sample locality 40. These sections could not be positively correlated as the Mooga Sandstone Member is eroded in the scout hole sections and photo-interpretation shows a weak lineament between the scout holes and the outcrop, suggesting a possible fault. The scout hole 2, 3 and 4 sections can however be more confidently correlated with the scout hole 5 section and thus with outcrop sample 441 (and the original sample 441a).

Scout hole No. 5 was drilled 500 yards east-north-east of sample 441, in order to penetrate that section at depth. The section was encountered at a level approximately 25 feet above the outcrop sample. A fault with downthrow to the south is considered responsible for this difference in elevation.

GEOLOGICAL SIGNIFICANCE OF THE SAMPLES

Outcrop samples 474 and 531 were selected at random to test the lateral and vertical extent of apparent 'swelling clays' in the Orallo Formation and therefore have no comparative significance in relation to the other samples.

Outcrop samples 441a and 40 (and scout hole No. 3 sample 21'10" - 22'8" which is believed to be a clay band which is either alluvial or injected into the alluvium) are of higher quality (with respect to A.P.I. standards) than outcrop sample 441 and 'bed-rock' samples from the scout holes. Sample 441a and 40 were collected from the outcrop surface which had been covered for some time by the water in the creek. Sample 441 was collected by 'trenching' into fresh material.

It is possible, then, that water action has selectively concentrated higher quality bentonite on the surface of the outcrop due to the varying swelling properties of interlaminated 'clays'. This possibility is supported by the fact that the interval represented by sample 441 in scout hole No. 5 was logged as interlaminated bentonite and mudstone. This sample tested from scout hole No. 5 would have contained a mixture of these two types.

The samples from the scout holes were selected by general 'bentonitic' appearance. At the well site, clays approaching the appearance of the outcrop material were recognized as occurring only in thin bands interbedded and interlaminated in 'claystone' and 'mudstone'. The 'claystones' were generally firm in texture but varied in appearance, some bearing more suggestive of bentonite than others.

The tests showed that irrespective of appearance, the cored material showed a generally uniform reaction throughout the sequence. The lowest value for plastic viscosity, however, was from a section logged at the well site as 'mudstone'.

ECONOMIC CONSIDERATIONS

1. Quality:

The quality of the deposit is rather uniform throughout 34 feet of section in scout hole No. 5.

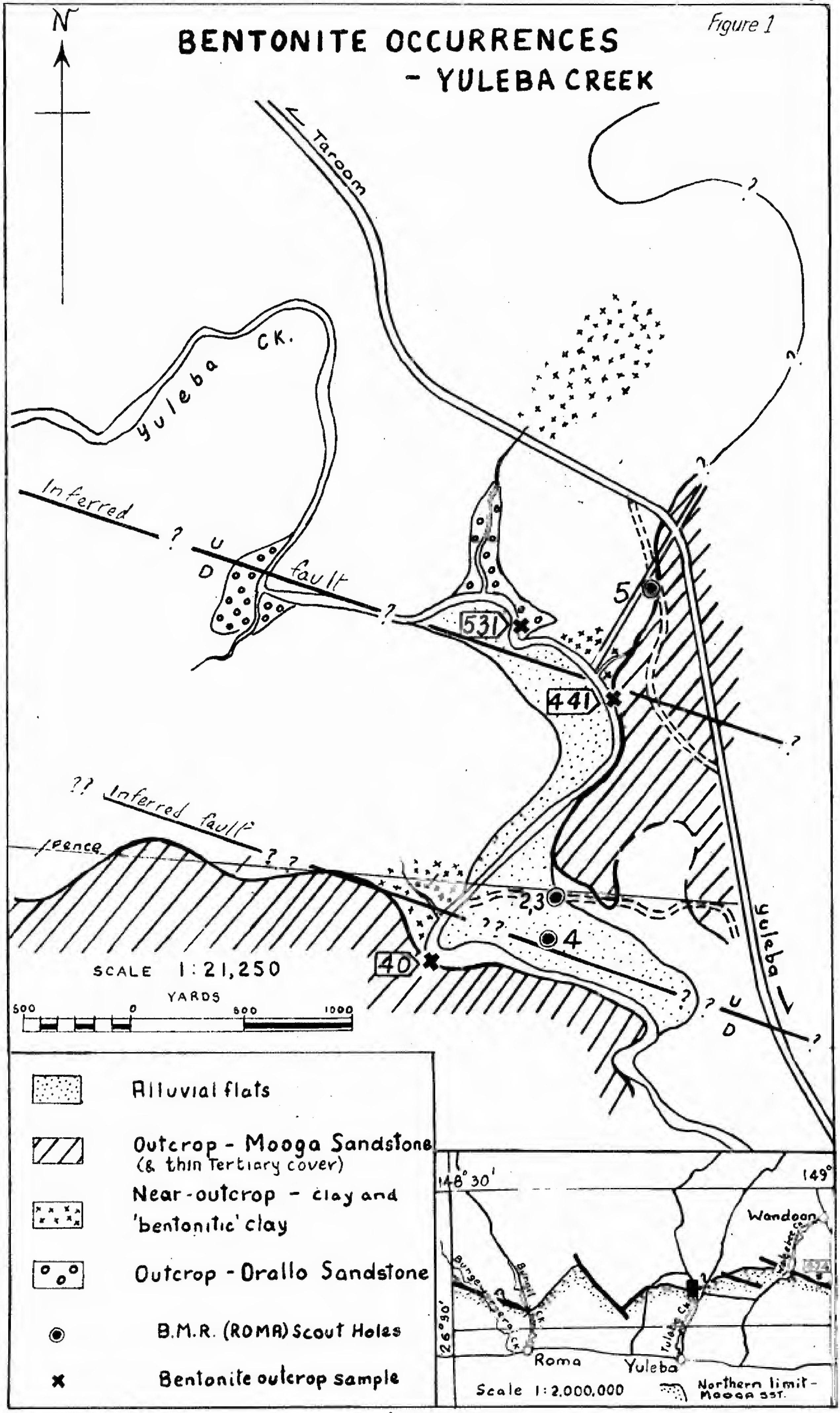
2. Preserved thickness:

There is a marked contrast in preserved thickness between scout hole No. 5 and the remaining scout holes. There is not sufficient evidence available to determine whether this thinning is due primarily to erosion or depositional thinning. In any case the area in the vicinity of scout holes 2, 3 and 4 must be considered non-prospective.

TABLE 6. SUMMARIES OF LITHOLOGIC LOGS AND CORRELATIONS

OUTCROP SAMPLE 441-441a base Mooga	B.M.R. ROMA SCOUT base Mooga	B.M.R.ROMA SCOUT 2,3,& 4.* Alluvial & ?Colluvial clay mud and sand	OUTCROP SAMPLE 40 base Mooga
3" mudstone, sandy, shaly 3' mudstone, carbonaceous; and lignite.	3'3" (mudstone, red-brown and grey-brown, grading down to lignite.		? ?
3' + 'bentonite'*	3'8" (2'5" bentonite' (1'6" claystone, bentonitic (2'11" mudstone & bentonite' interlaminated *(37'-37)		
	2'5" mudstone, grey to brown* *(41'6"-42'2" & 42'8"-43'3")		
	7'3" claystone, ?bentonitic* *(46'1" - 46'9")		
	4'2" claystone, grey		
	1'6" mudstone, dark grey		
	6'4" claystone, green grey, lignitic at base* (58'3" - 58'11")	3' mudstone, very fine grained with carbonaceous lenses*	ca 10' mudstone, bluish grey, grading to dark grey and lignitic
	3'6" claystone, green grey *(63'4" - 64'0")	2'3" 'bentonite' and clay*	2'+ 'bentonite and claystone ? ?
	4'7" mudstone, brown and grey-brown, interlaminated and cross laminated.	7'0" mudstone, brown and grey brown, interlaminated and cross laminated*	
	sandstone	sandstone	

* Sample interval A.P.I. Tested.



To accompany Record 1967/9 G55/A12/12

3. Overburden:

Where the best thickness of the deposit has been investigated (scout hole No. 5) there is 37 feet of overburden, including approximately 20 feet of alluvium, 13 feet of hard Mooga Sandstone Member and 4 feet of Orallo Formation. The overburden is expected to increase in thickness east and south of scout hole No. 5.

4. Dip:

The regional dip of the strata is expected to be in the order of 1 to 2 degrees south.

The deposit cannot be considered to be economic in the area sampled. More drilling is required to test the area north and north-east of scout hole No. 5 where the Mooga Sandstone Member has been eroded and where the topography and soil suggests that the top 'claystone/mudstone' unit of the Orallo Formation is still preserved.

APPENDIX 6

CORE ANALYSIS DETERMINATIONS - BMR ROMA SCOUT BORES

by

P.G. Duff

Core analysis was carried out on suitable cores from the holes drilled in the bentonitic sequence at the top of the Orallo Formation (see Appendix 5).

Cores analysed are listed below:

BMR (Roma S.B. No. 2
Core Nos. 4, 5, 6

BMR (Roma) S.B. No. 3
Core No. 2

BMR (Roma) S.B. No. 4
Core No. 2

BMR (Roma) S.B. No. 5
Core Nos. 1 and 4

The results are tabulated hereafter.

Petroleum Technology Laboratory, Bureau of Mineral Resources, Geology and Geophysics, Canberra

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 nitrogene, 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. BMR (ROMA) SCOUT BORE NO. 2 DATE OF TEST: 17th January, 1967

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				
4	36' 9" 37' 4"	Sandstone	27	N.D.	49	2.00	2.73	N.D.	N.D.	N.D.	N.D.	N.D.	NIL
4	41' 3" 42' 0"	"	27	3	98	2.00	2.75	27	Nil	Nil	"	"	"
5	44' 9" 45' 6"	"	30	224	644	1.90	2.71	N.D.	N.D.	N.D.	"	"	"
5	50' 0" 50' 7"	"	30	32	113	1.91	2.73	20	Nil	Nil	"	"	"
6	57' 2" 58' 0"	"	30	452	1353	1.91	2.74	34	Nil	Nil	"	"	"

REMARKS:-

General File No. 62/399
Well File No.

Petroleum Technology Laboratory, Bureau of Mineral Resources, Geology and Geophysics, Canberra

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 nitrogene, 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. BMR (ROMA) SCOUT BORE NO. 3 DATE OF TEST 17th January, 1967

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				
2	36' 4" 37' 0"	Sandstone	24	14	66	1.99	2.72	22	Nil	Nil	N.D.	N.D.	Nil
			BMR (ROMA) SCOUT BORE NO. 4										
2	36' 8"	Sandstone	25	14	N.D.	2.06	2.74	26	Nil	Nil	N.D.	N.D.	Nil

REMARKS:

General File No. 62/399

Well File No.

Petroleum Technology Laboratory, Bureau of Mineral Resources, Geology and Geophysics, Canberra

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 nitrogene, 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. BMR (ROMA) SCOUT BORE NO. 5 DATE OF TEST 17th January, 1967

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	31' 0" 31' 9"	Sandstone	32	75	104	1.85	2.72	11	Nil	Nil	N.D.	N.D.	Nil
4	69' 3" 69' 9"	"	24	11	26	2.06	2.71	29	Nil	Nil	N.D.	N.D.	Nil

REMARKS:

General File No. 62/399.

Well File No. ________

APPENDIX 7

POROSITY, PERMEABILITY AND DENSITY OF OUTCROP SAMPLES

by

P.G. Duff

Samples were collected at random from various units, with the idea of eventually comparing them with subsurface samples from the same units. All the plugs were oriented parallel to the bedding, or crossbedding, giving maximum porosity and permeability, with the exception of samples 403 and 421 in Table 1 which were oriented normal to the bedding or crossbedding. The sample numbers in Table 1 are field numbers from notebook Roma ENM/1966. The sample numbers in Table 2 are from notebooks Mitchell NFE/1966 and Roma NFE/1966.

TABLE 1. SAMPLES COLLECTED BY E.N. MILLIGAN

Sample No.	Sample Locality Map	Sample Locality Reference	Sample Lithology and Stratigraphic Position	Effective Porosity (% of Bulk Vol.)	Absolute Permeability (md) To Dry Nitrogen	Absolute Permeability (md) To Water	Dry Bulk Density (gm/co)	Apparent Grain Density (gm/cc.)
383	Roma, Qld 1:250,000 S.E.55-12	149°03'06" 26°29'27"	Sst.,v.f.gr. quartzose; Nullawurt Sst.Member. Blythesdale Fm.	30	74	7	1.90	2.70
403	"	148°47'48" 26°25'06"	Sst., f. gr. as above	28	121	51	1.94	2.69
420	"	148°34'20" 26°30'00"	Sst. as above. Top Nullawurt Sst. Member; Blythesdale Fm.	30	542	213	1.85	2.66
421	"	148°48'40" 26°22'15"	Sst. as above; Basal Nullawurt Sst. Member; Blythesdale Fm.	24	435	241	2.04	2.68
421b	"	"	Sst.,labile, Med.gr.; Kingull Member, Blythesdale Fm.	26	113	Nil	2.02	2.75
451	"	149°22'26" 26°22'00"	Sst., med.gr.,quartzose; Topmost Sst; Mooga Sst. Member; Blythesdale Fm.	35	43	N.D.	1.72	2.66
532*a	"	149°00'54" 26°09'26"	Sst., labile. m.gr. calc.; Kingull Member; Blythesdale Fm.	16	25	Nil	2.29	2.74
532*b	"	"	"	9	Nil	Nil	2.60	2.77
534	"	149°00'06" 26°29'26"	Sst.,sublabile, f.gr.; Mooga Sst. Member; Blythesdale Fm.	27	47	Nil	1.92	2.67

Table 1.

Sample No.	Sample Locality	Map Reference	Sample lithology and Stratigraphic Position	Effective Porosity (% of Bulk Vol.)	Absolute Permeability (md) To Dry Nitrogen	Absolute Permeability (md) To Water	Dry Bulk Density (gm/co)	Apparent Grain Density (gm/cc.)
536	Roma, Qld. 1:250,000 S.E. 55-12.	149°18'25" 26°23'18"	Sst., "deep-weathered", sublabile, m.gr.; Minmi Member; Blythesdale Fm.	30	908	444	1.80	2.69
537	"	149°19'02" 26°23'54"	"	32	1031	652	1.81	2.68
540b	"	149°18'25" 26°24'52"	Sst.,m.gr.,calc.; Middle Nullawurt Sst. Member; Blythesdale Fm.	5	Nil	Nil	2.57	2.72
456	"	"	Sst., sublabile,"deep-weathered", m.gr.; Minmi Member; Blythesdale Fm.	28	N.D.	N.D.	1.89	2.63

* Two different samples marked 532, designated by "a" and "b" in the laboratory.

TABLE 2. - SAMPLES COLLECTED BY N.F. EXON

Sample No.	Sampling Locality	Heat Graphic of sample	4-mile sheet	Effective Porosity (% of bulk vol.)	Absolute Permeability (md.)		Dry Bulk Density (gm/cc)	Apparent Grain Density (gm/cc)
					To Nitrogen	To Water		
S-202	26°17'; 148°13'	Nullawurt Sst. Member	Mitchell, Q.	34	860	322	1.78	2.70
S-212-C	26°07'; 148°04'	" " "	" "	33	2,815	1,960	1.82	2.70
S-212-D	"	" " "	" "	38	1,978	40	1.65	2.65
S-212-H	"	Minmi Member	" "	33	Greater than 10,000	10,500	1.77	2.66
S-214-A	26°18'; 148°13'	" "	" "	31	3,811	2,000	1.86	2.70
S-215	26°19'; 148°13'	Nullawurt Sst. Member	" "	35	451	440	1.74	2.69
S-218-A	26°11'; 148°26'	Springbok Sst. Member	" "	31	N.D.	N.D.	1.84	2.65
S-269	26°18'; 148°44'	Westbourne Formation	Roma, Q'ld.	27	306	64	2.00	2.75
S-274-A	26°03'; 148°52'	Birkhead Formation (basal)	" "	25	23	Disintegrated	2.02	2.70
S-274-B	26°03'; 148°52'	" " "	" "	25	297	64	2.09	2.78

APPENDIX 8

SHALLOW STRATIGRAPHIC DRILLING, MITCHELL AND ROMA SHEET AREAS, 1966

by

N.F. Exon

General

The Surat Basin Party supervised the drilling of four holes in the Mitchell Sheet area and six in the Roma Sheet area, from 17th October to 16th November, a period of 24 working days. The rig used was a Mayhew 1000, belonging to the Petroleum Technology section of the B.M.R. 400 feet of drill pipe, a ten-foot core barrel, and equipment for drilling with mud, were available. A Widco portalogger was available, but due to various faults only one hole (BMR Mitchell No. 11) was successfully electrically logged.

Drilling

Seven holes drilled in the Mitchell Sheet area in 1965 (BMR Mitchell Nos. 1-7) are summarized in Appendix 4 of Record 1966/90. The logs of these holes are presented in the body of the present record.

Holes BMR Mitchell Nos. 8-11, and BMR Roma No. 1 were drilled and cored to:

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

(2) Intersect unit boundaries.

(3) Obtain palynological material.

These holes were all moderately successful in obtaining one or more of these aims.

Holes BMR Roma Nos. 2-5 were drilled and cored to obtain material for analysis from the bentonite deposits discovered during the mapping. This drilling was successful. BMR Roma No. 6 was drilled east of the other holes to test for bentonite elsewhere in the area. Drilling results are summarized below:

Hole No.	Grid ref.	Total depth (ft.)	Drilling (ft.)	Coring (ft.)	No. of Cores	Core recovery	
						Actual	%
BMR Mitchell 8	619,686	158	125	33	4	25	79
BMR Mitchell 9	622,695	108	71	37	5	29	78
BMR Mitchell 10	641,703	401	338	63	7	43½	68
BMR Mitchell 11	645,724	400	327	73	9	39½	54
BMR Roma 1	154,703	414	62½	351½	40	318	91
BMR Roma 2	230,724	62	9	53	6	43½	82
BMR Roma 3	230,724	37	18	19	2	19	100
BMR Roma 4	230,724	38	22	16	2	16	100
BMR Roma 5	230,725	72	30½	41½	4	39	94
BMR Roma 6	247,727	302	253	49	5	39	80
TOTAL		1992	1256	736	84	611½	90

It can be argued that continuous coring of holes is the most satisfactory method. However, this is exceedingly slow, and excellent results for many purposes can be obtained by a combination of air drilling and cores every 50 feet or wherever the geologist decides.

Examination

Cores and cuttings were examined either at the well site, or later with a binocular microscope.

Thin sections from six cores in BMR Mitchell No. 11 were also examined. Logs of the Mitchell holes were presented in figures and plates in the body of this record. BMR Roma No. 1 is discussed under the relevant stratigraphic headings within the Blythesdale Formation. The bentonite holes are covered by Duff and Milligan (1967), and in Appendix 5 of this record.

BMR Mitchell Nos. 8, 10 and 11 were examined palynologically and the results are presented in Appendix 3. BMR Mitchell No. 11 was also examined for forams, which were present in the 3 highest cores (Terpstra, 1967).

Discussion

Apart from the bentonite drilling the most important was that of BMR Mitchell No. 11, and the continuously cored BMR Roma No. 1, both of which intersect most of the Blythesdale Formation. As Roma No. 1 was not electrically logged, processing of it for spores and forams has been left until after the 1967 field season, during which the hole will be re-drilled and logged.

The drilling and logging of BMR Mitchell No. 11 has allowed the electrical characteristics of the various members to be tied in with the surface lithologies. Hence it has been possible to carry the surface units into the subsurface. All the members of the Blythesdale Formation in the Roma area have been confidently identified for the first time, in electric logs of oil wells, over a large area in the subsurface.

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Abbreviations for Plate 7 and Fig. 9 and 10

Bd	bed	Lst	limestone
bdd	bedded	lt	light
Bdg	bedding	m	medium
Biot	biotite	mass	massive
Blk	black	Mdst	mudstone
Bnds	bands	mic	micaceous
Brach	brachiopod	micxl	microcrystalline
br (brn)	brown	Min	mineral
c̄	with	mnr	minor
Calc	calcite	Musc	muscovite
calc	calcareous	Pbl	pebble
carb	carbonaceous	Pelcp	pelecypod
Cht	chert	pk	pink
cl	clayey	Plt Rems	plant remains
cln	clean	Pyr (pyr)	pyrite(ic)
Clst	claystone	Qz	quartz
Conc	concretion	Qzt	quartzite
conc	concretionary	qzs	quartzose
czs(c)	coarse	Rk	rock
dissmd	disseminated	Rl	rhyolite
dk	dark	Sd	sand
Fd	feldspar	sft	soft
fe	ferruginous	sh	shaly
fib	fibrous	si	siliceous
f	fine	sl	slightly
Frag	fragment	slt	silty
Gast	gastropod	Sltst	siltstone
Glau	glauconite	Sprs	spores
glau	glauconitic	srt	sorted
gn	green	Sst	sandstone
Grn (d)	grain(ed)	Subl	sublabile
Grnt	garnet	tk	thick
Gvl	gravel	tn	thin
gy	grey	v	very
Gyp	gypsum	vert	vertical
intbdd	interbedded	vf	very fine
intlamd	interlaminated	weath(wthrd)	weathered
intv	interval	wh	white
lab	labile	xbd	cross bedded
Lam	laminae	Xl	crystal
lamd	laminated	xlamd	crosslaminated
li	lithic	yel	yellow

NOTE: Nouns begin with a capital letter and the adjectival equivalents with small letters.


CORRELATION OF OIL WELLS
MITCHELL & ROMA SHEETS
(East-West)
AMOSEAS ALBA No.1
AMOSEAS SCALBY No.1
AMOSEAS STRATHMORE No.1
A.A.O. GLENROY No.1
A.A.O. LORNE No.1
AAO ARBROATH No.1
AAO BINYA No.1
AAO DIRINDA No.1
AAO APPLE GROVE No.1
AAO BARDLOMING No.1
AAO COMBARNGO No.1
AAO LORELLE No.1
UKA CONLOI No.1
Tertiary
Wallumbilla Formation
Coreena Member
Doncaster Member
Minmi Member
Nullawurt Sandstone Member
Kingull Member
Mooga Sandstone
Orallo Formation
Gubberamunda Sandstone
Injune Creek Group
Westbourne Formation
Springbok Sandstone Member
Birkhead Formation
Eurumbah Beds
Hutton Sandstone
Evergreen Formation
Boxvale Sst Member
Precipice Sandstone
Clematis Sandstone
Rewan Formation
Moolayember Formation
Timbury Hills Formation
Reid's Dome Beds
Gumbardo Volcanics
Blackwater Group
"Hooray Sandstone"
Undifferentiated "Hooray Sandstone"
Undifferentiated Birkhead Hutton
Quartz biotite gneiss
Adamellite
Schistose mudstone
Arbroath Fault
NEBINE RIDGE
ARBROATH TROUGH
ROMA SHELF
MIMOSA TROUGH
Elevation (mean sea level)
GENERAL REFERENCE
GL (1410) Ground level (feet)
KB (1165) Kelly bushing (feet)
RT (1113) Rotary table (feet)
483 Depth below well datum (feet)
TD 3325 Total depth (feet)
Dominantly sandstone
Regional unconformity
Note : Horizontal scale 1:1,000,000
Significant hydrocarbon show
LOCALITY MAP
REFERENCE
Kll Wallumbilla Formation
Klb Blythesdale Formation (or equivalent)
Ji Injune Creek Group
(MITCHELL) Mitchell Sheet area
Scale 0 10 20 30 40 Miles
To Accompany Record 1967/63
Plate 5

CORRELATION OF OIL WELLS, ROMA SHEET, N-S.

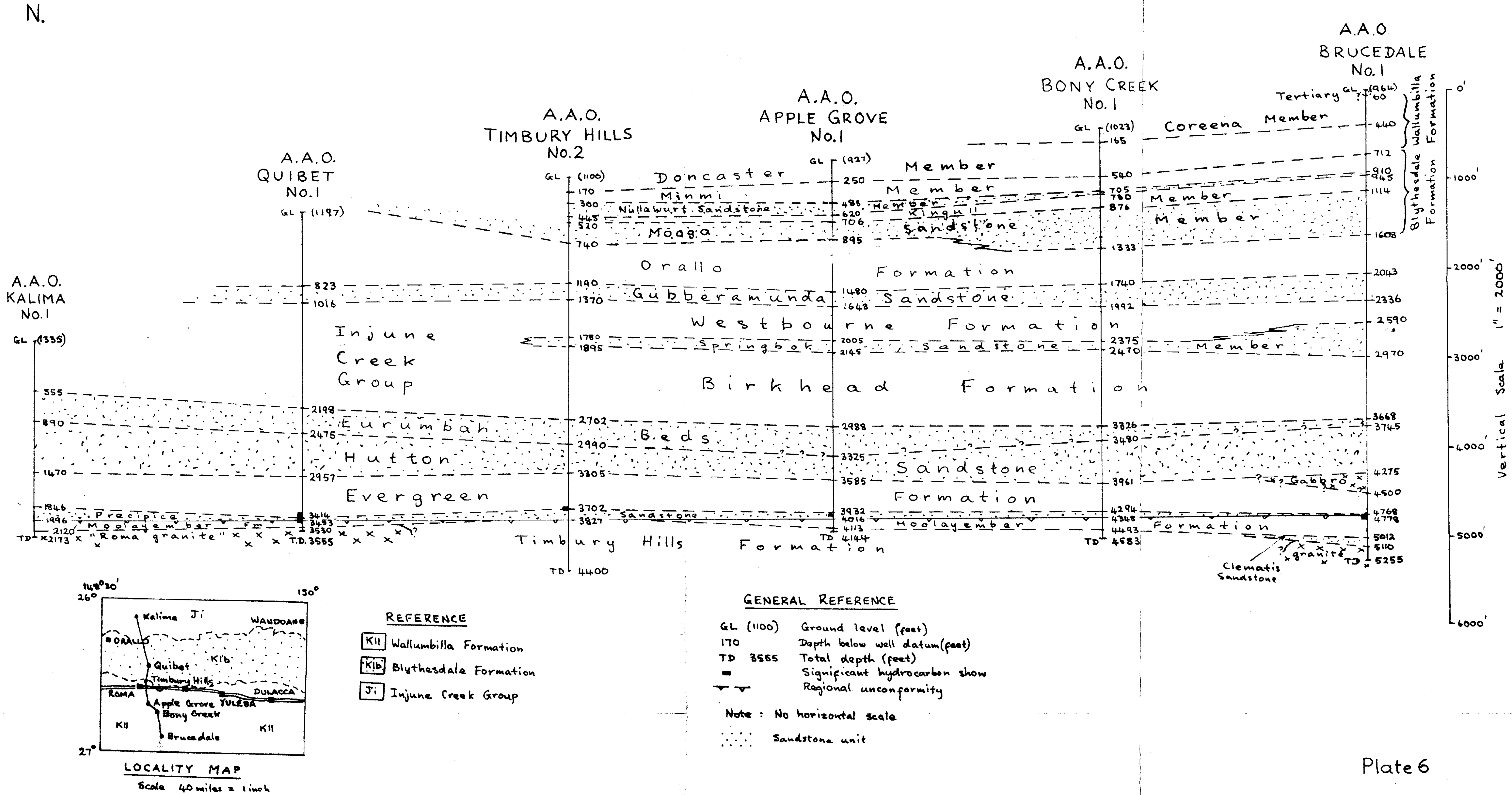


Plate 6

To Accompany Record 1967/63

Plate 7

CORRELATION CHART OF MEASURED SECTIONS & DRILL HOLE B.M.R. MITCHELL No.11.

UPPER JURASSIC AND LOWER CRETACEOUS SEDIMENTS

NORTH-EASTERN MITCHELL SHEET

Sections measured by N.F.Exon using Abney level

To Accompany Record 1967/63

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

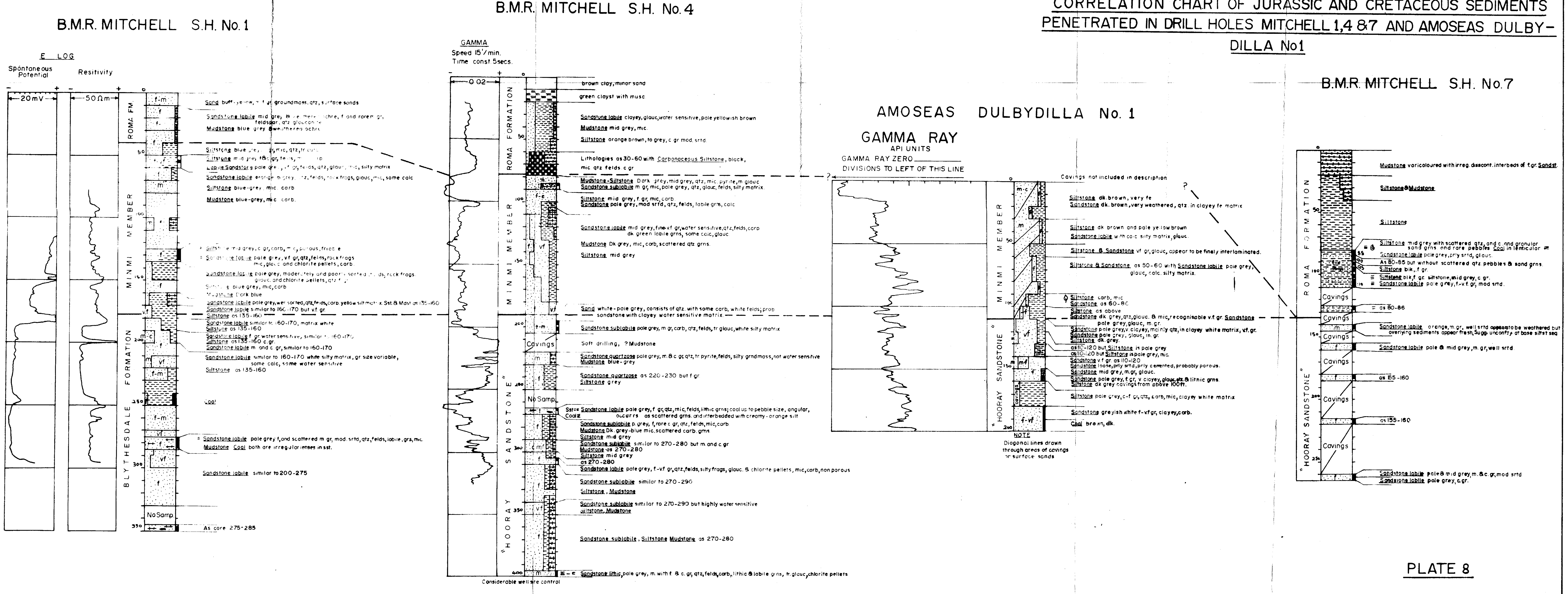


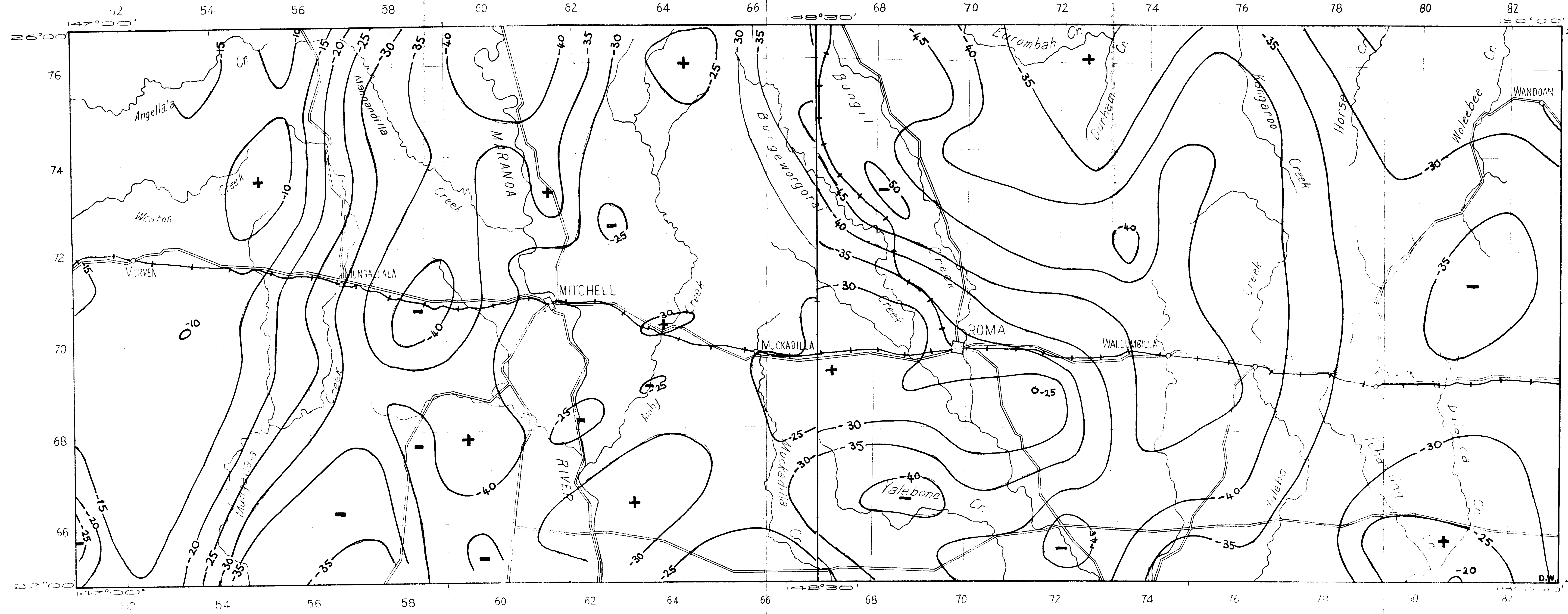
PLATE 8

To accompany Record 1967/63

G55/A11/9

GRAVITY - BOUGUER ANOMALIES

Plate 9



-10 Contour (milligals)
+ 'High' anomaly
– 'Low' anomaly

West of 148°30' average rock density assumed 1·9 g/cm³
East of 148°30' average rock density assumed 2·2 g/cm³

SCALE 1:500,000

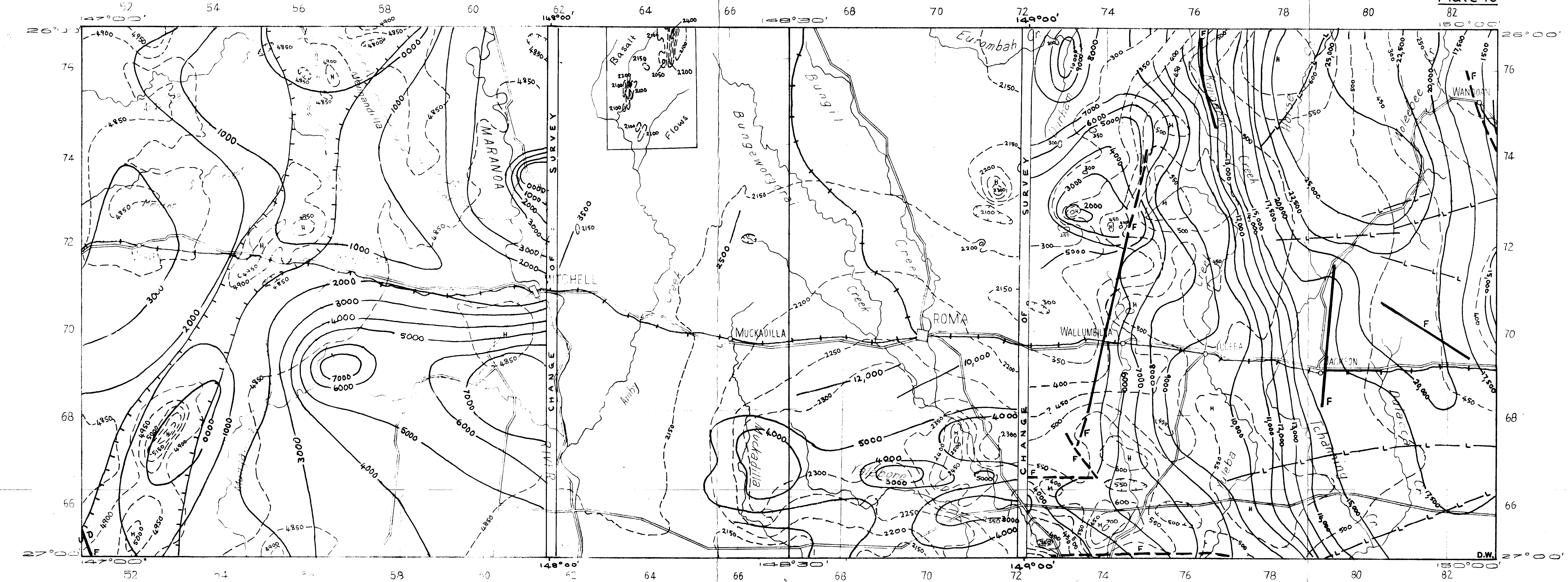
Reductions of BMR maps G55/B2-11 and G55/B2-12

To Accompany Record 1967/63

B

Total Magnetic Intensity and Interpretation

Plate 10



MAGNETIC DATA

— — 4850 — — Magnetic contour (gammas)

Magnetic low

Magnetic high

To Accompany Record 1967/63

INTERPRETATION DATA

—— 7000 —— Depth contour (below sea level; feet)

F —— — — Fault

— L — L — Lineament (possible fault)

Basement contact

SCALE 1:500,000

I	II	III
Mitchell		Roma

I Magellan Petroleum Corporation (1963)

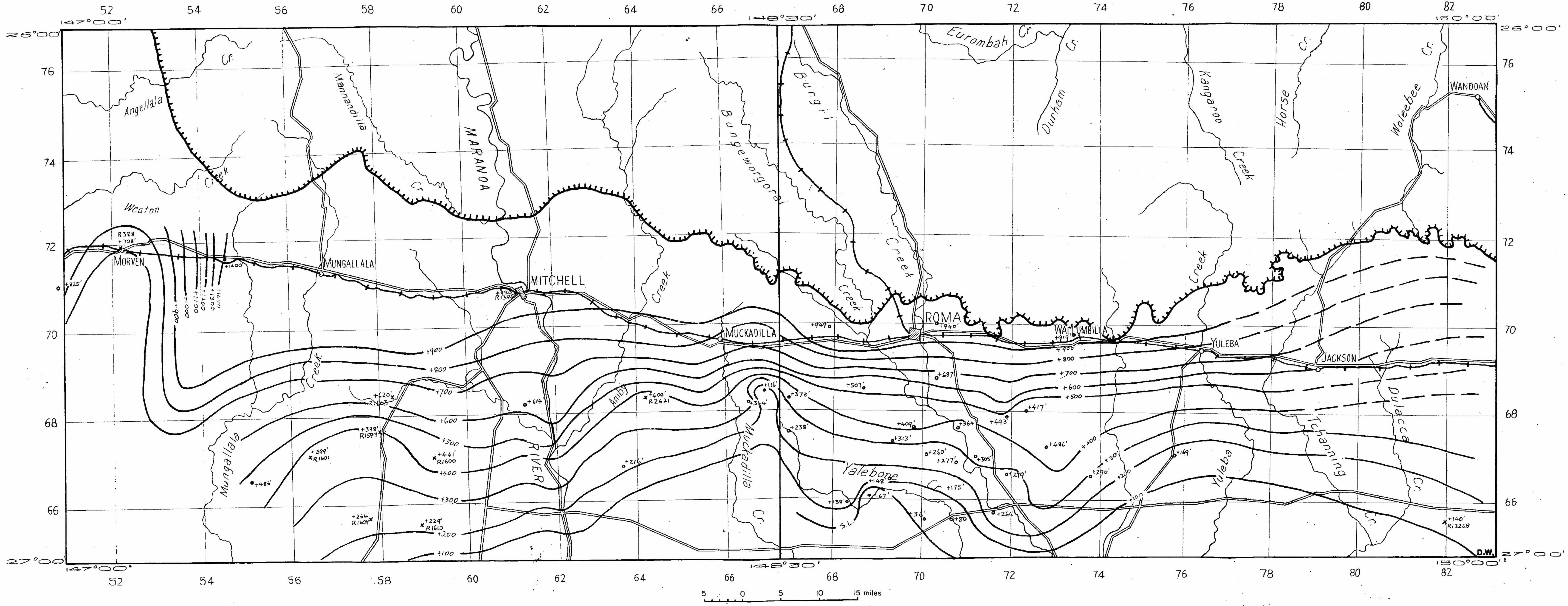
II Bureau of Mineral Resources (1964); Maps G55/B1-26, G55/B1-29

III Aero Service Corporation (1963)

PLATE 11

CONTOURS ON THE BASE OF THE WALLUMBILLA FORMATION

INTERPRETED FROM LOGS OF OIL BORES AND GAMMA RAY LOGS OF WATER BORES



R2621 Registered number of bore

× Water bore

o Oil exploration well

Outcrop margin of Wallumbilla Formation

+600 Elevation on the base of Wallumbilla

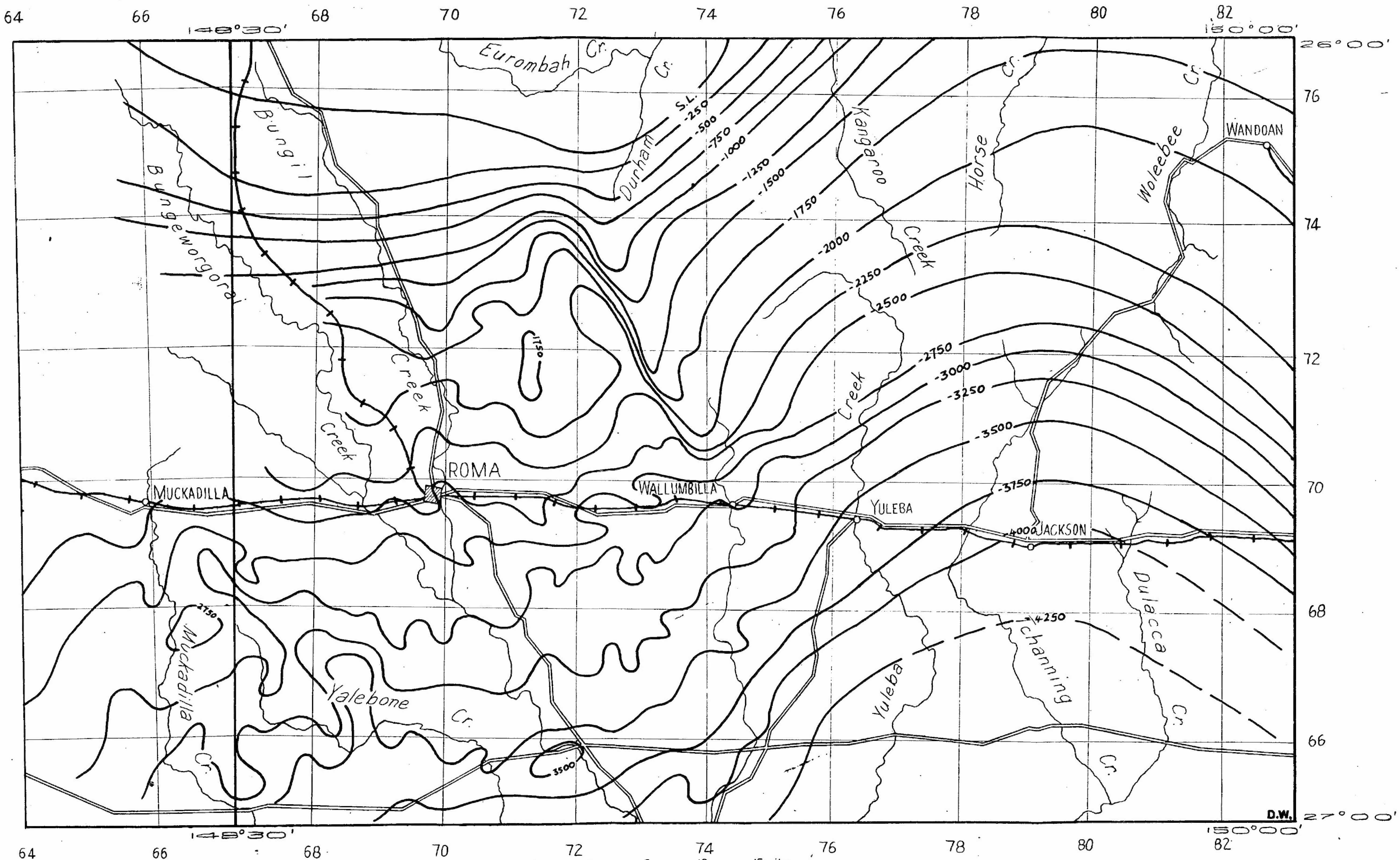
Datum - Mean sea level. Contour interval 100'.

To Accompany Record 1967/63

CONTOURS ON THE TOP OF THE EVERGREEN FORMATION

INTERPRETED FROM OIL WELL LOGS

PLATE 12



5 0 5 10 15 miles

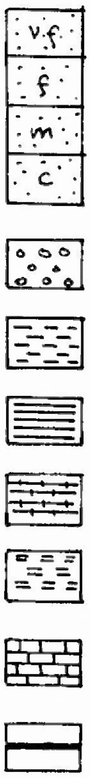
-3000 Elevation on top of Evergreen Formation

Datum - Mean sea level. Contour interval 250'.

To Accompany Record 1967/63

PLATE 14 5

REFERENCE FOR COLUMNAR MEASURED SECTIONS AND SHALLOW DRILL HOLE LOGS



sandstone

		grain size (mm)
v.f.	very fine	0.06 - 0.12
f	fine	0.12 - 0.25
m	medium	0.25 - 1.0
c	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

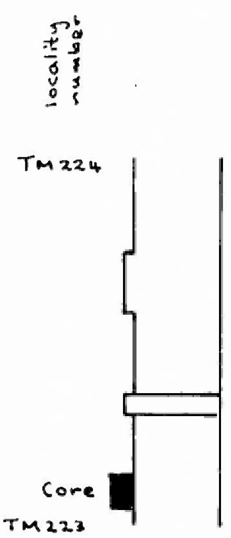
yaps in sections are concealed areas

bedding structure

very thick	> 40"	brackets around symbol indicate poor development
thick	12-40"	
medium	4-12"	
thin	0.4-4"	
laminate	< 0.4"	
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