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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

107590

1966/89

THE GEOLOGY OF THE TAMBO, AUGATHELLA AND BLACKALL 1:250,000 SHEET AREAS, QUEENSLAND.

by

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*(Geological Survey of Queensland)

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SUMMARY

The Tambo, Augathella and Blackall Sheet areas cover parts of three major basins: the Drummond Basin, the Bowen Basin, and the Eromanga Basin. Drummond Basin and Bowen Basin sequences crop out only in the north-eastern part of the Tambo Sheet area.

About 6000 feet of Upper Devonian to Lower Carboniferous sediments and volcanics are exposed in the Drummond Basin sequence, in the strongly folded, northerly trending, Mount Beaufort Anticline. The Silver Hills Volcanics, consisting of flows and pyroclastics, is the lowest exposed formation. The Telemon Formation disconformably overlies the Silver Hills Volcanics, and is conformably overlain by the Mount Hall Conglomerate and the Ducabrook Formation. The Telemon and Ducabrook Formations consist of about 4500 feet of multicoloured sandstone, siltstone and shale, and minor tuff; a thin lens of quartzose Mount Hall Conglomerate separates these formations in the southern part of the anticline.

The Bowen Basin sequence includes 4000 feet of sediments of Carboniferous to Upper Triassic age. The main period of folding and faulting followed the deposition of the Lower Carboniferous Ducabrook Formation, and preceded the deposition of about 1500 feet of glacigene Carboniferous to Lower Permian sediments of the Joe Joe Formation. Later, in the Permian and Triassic, fairly gentle folding continued spasmodically. A period of folding and erosion was followed by Lower Permian deposition of a blanket of sand on the Springsure Shelf. In the Upper Permian the environment changed, and lacustrine mudstones were deposited; some volcanic activity gave rise to bentonitic beds. Coal-measure conditions prevailed for a short time, in some areas, at the close of the Permian.

The Triassic sequence consists of about 2000 feet of fluviatile and freshwater lacustrine sediments. At this time the south-west trending Birkhead Anticline was growing slowly, and had a profound effect on sedimentation; it separates the typical Springsure Shelf sequence from that of the Lake Galilee/Jericho area. The labile sandstones, and multicoloured siltstones and mudstones, of the upper part of the Rewan Formation, intertongue with the sandstones of the Dunda Beds, across the anticline. After an erosional break, the fluviatile quartzose sands of the Clematis Sandstone, which thin greatly over the anticline, blanketed the area; they overlap onto the Upper Permian in the subsurface in the west. Then followed another period of lacustrine deposition, followed by uplift and erosion.

Eromanga Basin sedimentation began in the Lower Jurassic and continued well into the Cretaceous; the sequence is conformable throughout,

and folding was largely confined to warping over basement highs. Freshwater Jurassic sediments, 2500 feet thick, were deposited in cycles, with deposition of fluviatile sands followed by quieter lacustrine periods. Periodic uplift probably accounts for the repeated sedimentary cycles.

Early in the Lower Jurassic, renewed movement on the Birkhead Anticline resulted in its becoming a high area. Streams running down its southern flank deposited fluviatile sandstone, which was much thicker in the low areas. This sandstone overlaps onto the Upper Permian in the subsurface in the west. Later sand deposition continued across the anticline, and overlapped onto the uppermost Triassic, before giving way to lacustrine conditions in the Middle Jurassic. Fluviatile conditions recurred late in the Middle Jurassic, and towards the end of the Jurassic, and continued into the lowermost Cretaceous.

Rolling Downs Group sediments, about 3500 feet thick, were deposited in a great shallow basin, throughout Cretaceous times. The source areas had low relief, and produced only fine grained sediments. Conditions varied from shallow marine, to freshwater lacustrine and, occassionally, fluviatile. Marine interludes were confined to the Lower Cretaceous. Conditions in the great inland sea were generally unfavourable for most marine life, and the faunas are quite restricted.

Cappings of duricrust and Tertiary sandstone, and sand and soil cover, obscure much of the Rolling Downs Group. Tertiary basalt is practically non-existant.

The Drummond Basin sequence is essentially that mapped by Mollan, Exon and Kirkegaard (in press) in the Telemon Anticline, with the absence of the quartzose Raymond Sandstone the only major change.

The Permian and Triassic sequences are almost identical to those in the western part of the Springsure Sheet area (Mollan et al., op.cit.). However, north of the Birkhead Anticline, the Peawaddy Formation is indistinguishable from the underlying Colinlea Sandstone, and the upper part of the Rewan Formation becomes the Dunda Beds of Vine et al. (1965).

The Jurassic sequence is essentially that of Woolley (1941a). His Dooloogarah Sandstone includes the Precipice and Boxvale Sandstones, and part of the Hutton Sandstone. His "Lower Intermediate Series" is the upper part of the Hutton Sandstone plus the Birkhead Formation, and his "Upper Intermediate Series" is the Westbourne Formation.

A new correlation with the Surat Basin (Exon, 1966), equates the interval Birkhead Formation-Adori Sandstone-Westbourne Formation with the

Injune Creek Group (Exon, 1966), and the "Hooray Sandstone" with the interval Gubberamunda Sandstone-Orallo Formation-Blythesdale Formation (after Day, 1964).

In the Cretaceous, the Rolling Downs Group, consisting of the Roma, Tambo and Winton Formations of Whitehouse (1955), has been subdivided and modified as in Vine and Day (1965). Whitehouse's Roma Formation is the Roma Formation plus the lower part of the Coreena Member of the Wilgunya Formation. His Tambo Formation is the remainder of the Wilgunya Formation (consisting of three members), plus the Mackunda Formation. The Winton Formation remains unchanged.

Exploratory drilling for oil and gas in the area, has been unsuccessful to date. However, very few holes have been drilled, and prospects of striking hydrocarbons are still quite fair. Many structural traps have been defined by geophysical work.

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 Augathella, Blackall and Tambo 1:250,000 Sheet areas. The survey continued the project of mapping the Queensland part of the Great Artesian Basin, and the Bowen Basin. Before field work commenced, Exon and Casey prepared a photogeological map of the Tambo Sheet area.

The area mapped forms an inverted "L". The Blackall and Tambo Sheet areas lie between longitudes 144°00'E and 147°00'E, and latitudes 24°00'S and 25°00'S; the Augathella Sheet area, which is south of the Tambo Sheet area, lies between longitudes 145°30'E and 147°00'E, and latitudes 25°00'S and 26°00'S. The three Sheet areas are named after the three major towns of the region; two other townships - Isisford and Yaraka - lie in the Blackall Sheet area.

The pre-Jurassic sequence of the Tambo Sheet area was mapped in 1964 by Exon (BMR) and Kirkegaard (GSQ), as part of the Bowen Basin project, and this work was somewhat modified by Exon in 1965.

Field work on the Jurassic and younger sediments took place from early June to late August, 1965; Exon returned to the area in November to supervise a scout hole drilling programme. The party consisted of N.F. Exon (Party Leader), M.C. Galloway, and E.H.J. Feeken (Draftsman) of the Bureau of Mineral Resources, and D.J. Casey of the Geological Survey of Queensland. R.R. Vine of the BMR and R.W. Day of the Australian National University each spent a fortnight with the party. Marine fossil collections were examined by Day (Appendix I), and plant collections by Mary E. White (Appendix 4).

The rough division of work both in field mapping and text preparation was -

Exon - Devonian to base of marine Cretaceous sequence on Tambo and Augathella Sheet areas.
Galloway- Rolling Downs Group on the Augathella Sheet area.
Casey - Blackall Sheet area; Cretaceous and Jurassic of the Tambo Sheet area.
Kirkegaard - Permian and Triassic sequences of the Tambo Sheet area.

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

The whole of the Augathella, Blackall and Tambo 1:250,000 Sheet areas were mapped. Over the greater part of the region only Mesozoic sediments crop out but, in the north-east corner of the Tambo Sheet area, rocks of Upper

Palaeozoic age were mapped.

The area, which contains abundant black soil downs, supports a large pastoral industry and is well served with access roads. Good roads link it with Longreach, Ilfracombe, Barcaldine, Jericho and Alpha to the north, and Charleville and Morven, to the south; the main access roads are shown in Fig. I. Late in 1965, the only sealed roads were the Landsborough Highway between Augathella and Barcaldine, and the Mitchell Highway between Augathella and Charleville. Unsealed roads are impassable after heavy rain. The Mitchell Highway joins the Warrego Highway, which links the area with Brisbane, at Charleville, and the Landsborough Highway joins the Warrego Highway at Morven.

There are regular air services from Blackall to Brisbane. The Blackall-Yaraka branch railway joins the Rockhampton-Longreach railway at Jericho. Charleville is linked by air and rail with Brisbane.

The vegetation is closely related to the underlying rock types, which give rise to various soil types. Average annual rainfall is about 20 inches, and is unreliable. The sandy soils, largely confined to the eastern half of the Tambo Sheet, generally support either open eucalypt forest and poor grass, or scrub consisting largely of wattle, lancewood and boodgeroo. The clayey soils, found largely in the same general area, support brigalow-belah-wilga-bottle tree-sandalwood scrub. The widespread black soil downs are well grassed and treeless.

R.A.A.F. airphotos, at an approximate scale of 1:46,000, flown in 1951-54 provide a complete coverage of the area. Planimetric maps of the Blackall and Tambo Sheet areas at a scale of 1:250,000 are available from the Department of National Development, Canberra, and were used as bases. The geological map of the Augathella Sheet area was based on early prints, from the Royal Australian Survey Corps, of a future Augathella Sheet area 1:250,000 map. Maps of the Augathella Sheet area, at a scale of 4 miles to 1 inch, produced by the Royal Australian Survey Corps are also available. Other planimetric maps at a scale of 4 miles to 1 inch, covering the whole area, are available from the Department of Public Lands, Brisbane.

Water supplies are obtained by bores from the aquifers of the Great Artesian Basin; most bores are pumped as production from flowing bores in this area is now restricted. Small local supplies are obtained from spear pumps in the sandy beds of major water courses.

Five shallow scout holes were drilled on the Tambo Sheet area in 1964 (Mollan, Exon and Forbes, 1965b) and four in 1965: details of the 1965 drilling operations are recorded in Appendix 5; graphic logs of the holes are presented in Figs. 3, 4, 5 and 10. The cores and cuttings are stored at the Bureau of Mineral Resources Core and Cuttings Laboratory, Fyshwick, A.C.T.

Fossil collections are stored with the Bureau of Mineral Resources Museum, Canberra. Collections are prefixed "GAB", but are shown on the maps simply with the prefix "G". An earlier collection of fossils from this area (Reynolds, 1960) are prefixed "T".

A correlation of four oil wells and one deep water bore in the area, is presented in Plate 5. The formation picks, shown in this plate, are made by comparison of surface geology with lithological logs of the holes, and electric and gamma ray logs, where these are available.

Percentages of minerals in thin section, referred to in the text, are estimates only.

Localities given in brackets, thus (4600, 0035), refer to the 10,000 yard military grid covering the area (see Plates 7, 8 and 9).

Nomenclature

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

"Siltstone" is used as a grainsize term (1/16mm to 1/56mm). 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.

The Wentworth Scale has been followed for grain size terminology (Pettijohn, 1957; also see Plate 10). Bedding terminology follows that proposed by McKee and Weir (1943).

Palynology

Evans palynological divisions of the Permian (Evans, 1964b) and Mesozoic (Evans, 1966) are adopted in the text.

PHYSIOGRAPHY

Drainage in the area is to the Barcoo, Bulloo, Warrego, Nogoa and Belyando River systems. The Barcoo joins Coopers Creek and flows to the Lake Eyre internal drainage basin; the Bulloo flows to the Lake Bulloo internal drainage basin; the Warrego flows to the Darling River and thence to the Southern Ocean; the Nogoa flows to the Fitzroy River and thence to the Pacific Ocean. The Belyando joins the Burdekin and flows to the east coast. Part of the watershed known as the Great Dividing Range separates the catchments of the Warrego and Barcoo river systems from those of the Belyando and Nogoa river systems. The river systems, the divides and the physiographic regions are shown in Fig. I.

The area has been divided into five physiographic units. These are discussed below.

Rolling country with some strike ridges and cuestas

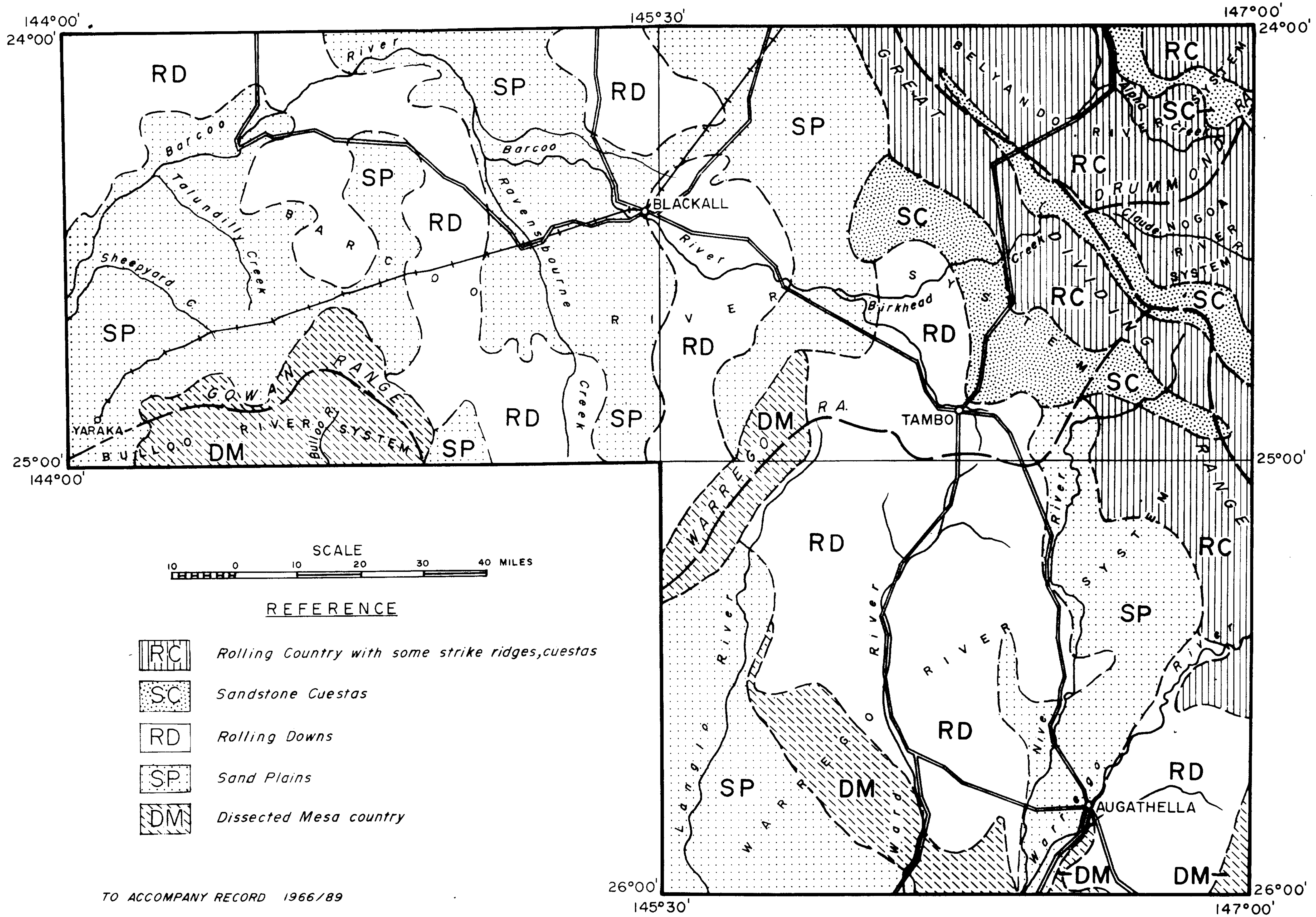
This unit is confined to the eastern parts of the Tambo and Augathella Sheet areas. It consists of the less resistant, generally finer grained pre-Cretaceous rocks. More resistant parts of this sequence form the Sandstone Cuesta unit (see 2), and the two topographic forms alternate south-westwards (across strike), from the north-east corner of the Tambo Sheet. Rocks in this unit include Devonian/Carboniferous sediments and volcanics, Upper Permian and Triassic sediments, the upper part of the Lower Jurassic sandstone sequence, the Middle Jurassic silty sequence, and part of the Upper Jurassic Cretaceous sandstone sequence. The cuestas generally dip to the south-west.

Sandstone cuestas

Sandstone cuestas alternate with the rolling country (see 1). The following stratigraphic units all form cuestas: the Permian Colinlea Sandstone, the Lower Jurassic Precipice and Boxvale Sandstones, the resistant part of the Upper Jurassic/Cretaceous Adori Sandstone, and the "Hooray Sandstone" (in the area north-east of Tambo). The outcrop of the non-resistant Westbourne Formation is included in this physiographic unit, because it occupies a narrow zone between two cuesta-forming sandstone. The cuestas form ranges with cliffs to the north-east, and a gradual incline to the south-west.

Fig.1

TOPOGRAPHY AND DRAINAGE



REFERENCE

RC	*Rolling Country with some strike ridges, cuestas*
SC	*Sandstone Cuestas*
RD	*Rolling Downs*
SP	*Sand Plains*
DM	*Dissected Mesa country*

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Dissected mesa country

This region is comprised of tableland areas, flanked by irregular mesas and buttes dissected from a former more extensive tableland. The areas have a resistant duricrust cap overlain by thin Tertiary sediments and Quaternary sand cover. In the western parts of the Augathella Sheet area, this country blends imperceptibly southwards into a sand plain.

Rolling Downs

This country undulates gently and is typified by khaki clay soils. It is very fertile and is used for sheep grazing and, in the Tambo-Augathella area, for experimental farming. It forms grasslands which are almost treeless; a few stunted trees grow along watercourses and on low stony rises. The rolling downs grade into sand plains as the thickness and extent of unconsolidated sandy sediments increase. This increase is accompanied by a change from open grassland to lightly timbered areas.

Sand plains

These are outwash plains formed by redistribution of sand derived from the sandy Jurassic units. The country is almost flat and commonly slopes gently upward to the areas from which the sand was derived. It supports very poor grass and is lightly timbered.

PREVIOUS INVESTIGATIONS

Geological

Isolated observations on the geology of the area mapped were made by various geologists, e.g. Jack (1895a) and Ball (1926). A report by Jensen (1922), on the geology of the Tambo district, included a geological map of part of the Tambo and Augathella Sheet areas. He investigated a reported oil seep in the Enniskillen Range area and interpreted the regional structure from water bore data. This report was incorporated in a broad regional investigation of the Roma, Springsure, Tambo and Taroom areas (Jensen, 1926a). Notes on the geology of the Blackall district, as suggested by water bore information, were also included in this survey. Woolley mapped the Permian to Triassic units (1941b), and Jurassic to Lower Cretaceous units (1941a), of part of the Tambo Sheet area. Various modifications of the sequence and subdivisions in this unpublished work are made herein but, overall, his mapping in this limited area was very good (for comparison of his 1941a terminology with present terminology see Table 3). Whitehouse (1954) was the first to attempt to map the Great Artesian Basin as a whole and to co-ordinate recorded observation and stratigraphic nomenclature. The most complete accounts of the geology of the whole basin, with comprehensive bibliographies, were compiled by Whitehouse (1954), and Hill and Denmead (eds., 1960). Microfossils and macrofossils were identified from localities in the

Tambo area (Crespin 1945, 1960; Dickins, 1963).

Geophysical

Extensive geophysical surveys have been carried out in the area mapped, by private companies (generally subsidised by the Commonwealth Government), and by the Bureau of Mineral Resources. Geophysical information has been incorporated in structural form-line maps based on water bore data (Figs. 11, 12, 13).

Exploratory drilling for oil and gas

Six wells have been drilled in the search for petroleum in this area. Their positions are shown on Plates 7, 8 and 9 and a general summary of each is given in Table 1. The earliest well drilled, SPL Birkhead No.1, was not subsidised, but all others have been. Completion reports of the subsidised wells are available at the Bureau of Mineral Resources, and the Geological Survey of Queensland, six months after completion. No significant petroleum shows have yet been seen in the area.

DESCRIPTION OF ROCK UNITS

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

Rocks were deposited in three basins of different ages. Each basin was folded before deposition commenced in the next, and each basin overlies the previous one.

The 6000 feet thick Devonian and Carboniferous Drummond Basin sequence consists of extrusive volcanics, and lacustrine and fluviatile sediments. Volcanism diminished with time. The 4000 feet thick Permian and Triassic Bowen Basin sequence consists of shallow water lacustrine and fluviatile sediments.

The Jurassic and Cretaceous Eromanga Basin sequence, which is only gently warped, consists of about 2500 feet of fluviatile and lacustrine sediments, overlain by about 3500 feet of fine grained shallow water marine and lacustrine sediments, the upper half of this sequence being entirely freshwater.

Post-Cretaceous silicification is widespread, and there are Tertiary valley-fill deposits in some areas.

TABLE 1 - OIL DRILLING

Name of Well	Year Drilled	Subsidized	Total Depth (feet)	Hydrocarbon shows	Status	Sheet area
SPL Birkhead No.1	1957	No	5185	Gas show at 3600 feet. D.S.T. negative	Abandoned	Tambo
Amoseas Westbourne No.1	1964	Yes	4867	None	Abandoned	Augathella
Amoseas Boree No.1	1964	Yes	8781	None	Abandoned	Tambo
Phillips Carlow No.1	1966	Yes	12028	None	Abandoned	Blackall
Phillips Bury No.1	1966	Yes	9004	None	Abandoned	Augathella
Amoseas Balfour No.1	1966	Yes	5560	None	Abandoned	Augathella

TABLE 2 - SUMMARY OF ROCK UNITS

ERA	PERIOD	ROCK UNIT AND MAP SYMBOL	LITHOLOGY	THICKNESS (feet)	RELATIONSHIPS	PALAEONTOLOGY	ENVIRONMENT OF DEPOSITION
CAINOZOIC	Quaternary	Qa	Alluvial sand, gravel, clay.	Less than 30			Fluviatile.
		Qs	Sand, soil.	Less than 50			
	Undifferentiated	Cz	Poorly bedded clayey sandstone, siltstone, claystone.	Less than 50	Weathering products of underlying formations, consolidated in situ. Often apparently conformable on underlying units.		
		Czd	Duricrust (silcrete, laterite).	Less than 30	Alteration products of underlying formations.		
	Tertiary	T	Well bedded clayey sandstone, conglomerate, siltstone.	Less than 100	Unconformable on underlying units.	Wood fragments.	Fluviatile.
		Tb	Olivine basalt flows	15			Terrestrial.
MESOZOIC	Lower-Upper? Cretaceous	Winton Formation Kw	Labile sandstone, siltstone, mudstone, in part calcareous; minor coal, peat, intraformational conglomerate.	1550 +	Conformably overlies Klm	Plant fragments, fossil wood, K2 spores.	Lacustrine.
	Lower Cretaceous	Mackunda Formation Klm	Labile to sublabile sandstone, siltstone, mudstone, in part calcareous; minor limestone, coquinite.	350-500	Conformably overlies Klw.	Marine fauna, K2 spores.	Shallow marine and freshwater lacustrine.
		Wilgunya Formation Klw	Mudstone, siltstone, labile sandstone, calcareous in part; minor limestone, coquinite.	1000-2000	Conformably overlies Klr.	Molluscan marine fauna, K1-K2 spores.	Shallow marine, freshwater lacustrine and fluviatile.
		Allaru Member Kla	Grey to buff siltstone and mudstone, in part calcareous; minor limestone.	500-900	Conformably within Klw.	Molluscan marine fauna, K2 spores.	Shallow marine.
		Toolebuc Member Klo	Pale grey, very fine-grained concretionary limestone, calcareous shale.	15-25	Conformably within Klw.	Restricted, largely pelecypod marine fauna; fossil wood, K2 spores.	Shallow marine.
		Coreena Member Klc	Grey to buff mudstone, siltstone and very fine-grained labile sandstone. Some calcareous beds, coquinite, intraformational conglomerate.	85-300	Conformably within Klw.	Molluscan marine fauna, fossil wood, Klb-d spores.	Shallow marine and lacustrine.
		Roma Formation Klr	Grey mudstone and siltstone; glauconitic sandstone lenses near base.	500-700 (lower sandstone part 0-150)	Conformably overlies J-Kh.	Molluscan marine fauna, fossil wood, Klb-c spores.	Shallow marine.
	Jurassic-Cretaceous	"Hooray Sandstone" J-Kh	Crossbedded white clayey sublabile to labile sandstone, some pebbly; conglomerate, siltstone. Contains lower fine-grained part, upper pebbly part.	150-400 (lower part 0-230 upper part 0-200)	Conformably overlies Juw, but has unconformity within it.	Plant fragments.	Fluviatile.

ERA	PERIOD	ROCK UNIT AND MAP SYMBOL	LITHOLOGY	THICKNESS (feet)	RELATIONSHIPS	PALAEONTOLOGY	ENVIRONMENT OF DEPOSITION
MESOZOIC	Middle-Upper Jurassic	Westbourne Formation Juw	Grey carbonaceous siltstone and mudstone; very fine-grained, buff quartz-rich sandstone.	40-400 (thins NW of Birkhead Anticline)	Conformably overlies Ja. Part of Injune Creek Group.	Plant fragments, J5-J6? acritarchs and spores.	Lacustrine, deltaic.
		Adori Sandstone Ja	Crossbedded, white clayey sublabile to labile sandstone, pebbly in part; siltstone.	100-230	Conformably overlies Jmb; contact shows local scouring. Part of Injune Creek Group.	Triassic/Jurassic plants (White, 1966), J5 spores.	Fluviatile, minor lacustrine.
	Middle Jurassic	Birkhead Formation Jmb	Grey or green sublabile to labile sandstone, calcareous in part; carbonaceous siltstone and mudstone; minor coal.	500±	Conformably overlies Jlh. Part of Injune Creek Group.	Plant fragments, J4 spores.	Lacustrine.
	Lower Jurassic	Hutton Sandstone Jlh	Crossbedded, buff, clayey, quartzose to labile sandstone, siltstone, mudstone.	400-500	Overlaps Jlb and Jlp NW of Birkhead Anticline, where it overlies R̄m. Part of "Hutton-Precipice Equivalent", in subsurface.	Plant fragments, fossil wood, J2-3 spores.	Fluviatile, lacustrine.
		Boxvale Sandstone Member of the Evergreen Formation Jlb	Crossbedded, white quartzose sandstone, pebbly in part; siltstone.	0-250	Conformably overlies Jlp. Pinches out NW of Birkhead Anticline. Part of "Hutton-Precipice Equivalent", in subsurface.	Plant fragments, J2 spores.	Fluviatile, lacustrine.
		Precipice Sandstone Jlp	Crossbedded, white quartzose sandstone, pebbly in part; siltstone.	0-400	Unconformably overlies R̄m; completely overlaps R̄m in subsurface. Pinches out NW of Birkhead Anticline. Part of "Hutton-Precipice Equivalent", in subsurface.	Plant fragments, J1 spores.	Fluviatile, lacustrine.
	Middle-Upper Triassic	Moolayember Formation R̄m	Siltstone, mudstone; buff, green or grey, quartzose to labile sandstone, calcareous in part.	1000± (0-650 in subsurface)	Conformably overlies R̄e.	Upper Triassic/Lower Jurassic plants (White, 1966), spores.	Lacustrine, fluviatile.
		Clematis Sandstone R̄e	Crossbedded, white quartzose to sublabile sandstone; minor conglomerate, siltstone, mudstone.	50-350	Overlies R̄ld and R̄lr with apparent conformity. Regionally unconformable e.g., overlies Upper Permian in Phillips Carlow No.1.	Plant fragments.	Fluviatile.
	Lower Triassic	Dunda Beds R̄ld	Crossbedded, buff to yellowish brown, quartzose to labile sandstone; minor siltstone, mudstone.	150-200 (absent SE of Birkhead Anticline)	Facies equivalent north of Birkhead Anticline of upper part of R̄lr.	Plant fragments.	Fluviatile.
		Rewan Formation R̄lr	Buff, brown or green, sublabile to labile sandstone, grey, green and red siltstone and mudstone; minor calcareous siltstone and limestone.	200 north of Birkhead Anticline; 400 south of Birkhead Anticline	Conformably overlies Puw. Thins to W in subsurface.	Fossil wood, R̄2a acritarchs and spores.	Lacustrine, fluviatile.
PALAEOZOIC	Upper Permian	Blackwater Group Puw	Labile sandstone, minor calcareous; carbonaceous siltstone, mudstone; minor coal.	200-250	Unrecognizable to W in subsurface. Conformably overlies Puc.	<u>Glossopteris</u> flora, fossil wood, P3d acritarchs and spores, P4 spores.	Terrestrial, lacustrine, minor paludal.
		Black Alley Shale Puc	Grey carbonaceous mudstone and white claystone; bentonitic clays, bentonite.	150	Unrecognizable to W in subsurface. Conformably overlies Pup.	Upper Permian acritarchs and spores (Evans, 1962).	Lacustrine; contemporaneous volcanism.

ERA	PERIOD	ROCK UNIT AND MAP SYMBOL	LITHOLOGY	THICKNESS (feet)	RELATIONSHIPS	PALAEONTOLOGY	ENVIRONMENT OF DEPOSITION
P A L A E O Z O I C	Upper Permian	Peawaddy Formation Pup	Quartzose to sublabile sandstone carbonaceous siltstone, mudstone.	100-200 (absent NW of Birkhead Anticline)	Apparently conformably overlies Plo. Grades laterally into Plo NW of Birkhead Anticline.	Fish scales, Upper Permian acritarchs and spores.	Lacustrine, fluviatile.
	Lower Permian	Colinlea Sandstone Plo	Crossbedded, quartzose to sublabile sandstone, conglomerate, minor siltstone.	450±	Disconformably overlies Plj. Unrecognizable to W in subsurface.	*Glossopteris* flora, Lower Permian spores.	Fluviatile.
		Reid's Dome Beds Plj	Siltstone, sandstone.	50-	Disconformably overlies C-Pj. Pinches out to W.	*Glossopteris* flora.	Lacustrine.
	Carboniferous-Permian	Joe Joe Formation C-Pj	Siltstone, sandstone (in part calcareous), shale, conglomerate; minor tuff, limestone.	1500-	Unconformably overlies Clu. Thins to W, and over basement highs, in subsurface.	Plant remains, animal tracks. Elsewhere Carboniferous plants (Mollan, Exon and Kirkegaard, in press).	Glacigene, fluviatile and lacustrine.
	Lower Carboniferous	Ducabrook Formation Clu	Lithic sandstone, siltstone, shale; in part tuffaceous.	3500±	Conformably overlies Clh, where present. Disconformably overlies Dut elsewhere.	Elsewhere Lower Carboniferous fish (SQD, 1952) and plants (White, 1962).	Fluviatile and lacustrine; contemporaneous vulcanism.
		Mount Hall Conglomerate Clh	Crossbedded quartzose sandstone and conglomerate.	150-	Apparently conformably overlies Dut.	Probable Lower Carboniferous plants elsewhere (Mollan, et al., op. cit.).	Fluviatile.
	Upper Devonian	Telemon Formation Dut	Quartzose to sublabile sandstone, siltstone and shale, in part tuffaceous; minor limestone.	1000	Apparently conformably overlies Ds.	Algae. Probable Upper Devonian plants elsewhere (White, 1962).	Lacustrine and fluviatile; minor contemporaneous vulcanism.
		Silver Hills Volcanics Ds	Basaltic, trachytic, rhyolitic flows, lithic tuff and agglomerate.	1500+			Terrestrial vulcanism.

DEVONIAN

Silver Hills Volcanics

The name Silver Hills Volcanics was proposed by Veevers, Mollan, Olgers and Kirkegaard (1964b, p.7) for "the dominantly acid volcanic complex which lies west of the Anakie Inlier" in the Emerald Sheet area. They stated that: "The Silver Hills Volcanics are named after Silver Hills Homestead, 13 miles west-north-west of Anakie. The type area lies 1 mile west-south-west of the homestead in a gap through which Spring Creek traverses the range formed by the volcanics".

The unit crops out in the Clermont, Emerald, Springsure, Jericho and Tambo 1:250,000 Sheet areas, generally in anticlinal cores. It crops out in the Mount Beaufort Anticline, the southern end of which is in the extreme north-east of the Tambo Sheet area. Scrub and sparse tree cover is typical of the unit, the lower part of which forms rounded hills, and the upper tuffaceous part, prominent cuestas.

Only the upper part of the formation, approximately 1500 feet thick, is exposed in the Mount Beaufort Anticline in the Tambo Sheet area; the total thickness in the anticline is considerably greater.

In the Tambo Sheet area, the lower half of the exposed formation consists of basaltic and trachytic flows, in places porphyritic, commonly flow banded, some with zeolitic amygdales. The upper part of this lower sequence also contains rhyolites, some of which are spherulitic and contain pink zeolitic spherulites. In the south this sequence is apparently directly overlain by the Telemon Formation.

Farther north, in the eastern flank of the anticline, this lower sequence is overlain by a thick competent pyroclastic sequence. This consists largely of poorly bedded, thick bedded, red and green lithic tuff, agglomerate and variably welded pyroclastic flows. Some grey 'cherty' ash beds and banded flows are also present.

Two flows from the lower sequence, an augite andesite and a toscanite, which were examined in thin section contain haematite. Two blocky ash flows, from the pyroclastic sequence, also examined in thin section, contain red, green and white fragments of pumice, rhyolite, welded tuff, other fine grained acid volcanics, and some embayed and angular quartz fragments, set in a glassy groundmass. One rock is only incipiently welded, and the devitrified groundmass is only slightly altered. The other is moderately welded, and glass has broken down to palagonite, and the clasts are recrystallized and sometimes corroded.

The volcanic cycle commenced with extrusion of basaltic and trachytic lava; the flows became more acid as volcanism progressed. Spherulitic textures indicate some subaqueous deposition. Later, localised explosive acid volcanism gave rise to a suite of acidic pyroclastic rocks; these are crudely bedded and show no sign of reworking. In the south this may have been a period of non-deposition. Lack of marine fossils suggest freshwater and terrestrial deposition.

The Silver Hills Volcanics are overlain by the Upper Devonian Telemon Formation, probably disconformably; in the Clermont Sheet area they lie on the Middle Devonian Retreat Granite (Veevers, Randal, Mollan and Paten, 1964a). They are probably of Upper Devonian age.

Telemon Formation

The Telemon Formation (Hill, 1957) was originally named the 'Telemon Series' by Shell (SQD, 1952) after Telemon Pastoral Holding - the type area on the Springsure Sheet. The unit crops out in the Clermont, Emerald, Springsure and Tambo Sheet areas. In the north-eastern part of the Tambo Sheet area it forms low strike ridges on the eastern flank and southern nose of the Mount Beaufort Anticline. On the western flank it is downfaulted and obscured. Scrub and occassional trees grow on the formation.

Shell (op.cit.) subdivided the formation into a "lower conglomerate group" and an "upper multicoloured group". Mollan, Exon and Kirkegaard (in press) estimated thicknesses of 2000 feet for the "conglomerate group" and 5000 feet for the "multicoloured group" in the Nogoa Anticline (50 miles east of the Mount Beaufort Anticline), and 50 feet and 3000 feet, respectively in the Telemon Anticline (35 miles east). Only the "multicoloured group", estimated to be 1000 feet thick, is present in the Mount Beaufort Anticline.

In the anticline the main rock types exposed are fine grained labile to quartzose green, brown, buff and grey <u>sandstone</u>, <u>siltstone</u> and <u>shale</u>, which are calcareous in places. The sandstone varies from friable to tough. Both <u>sandstone</u> and <u>siltstone</u> are thin to medium bedded, in places flaggy and/or with low-angle crossbedding. Some beds contain clay clasts and carbonaceous fragments. The <u>shale</u> is laminated to thin bedded.

Other rock types are red <u>tuffaceous sandstone</u>, fine grained thin bedded <u>limestone</u>, minor <u>algal limestone</u> and very minor pale grey, 'cherty' beds which are probably altered <u>tuff</u>.

Three sandstone specimens examined in <u>thin section</u>, consist essentially of angular quartz grains, quartz aggregates and very fine grained volcanic fragments. They vary from very labile to almost quartzose. Some contain minor feldspar, quartzite, muscovite and iron oxides and very minor biotite, zircon, tourmaline and ?rutile. One specimen contains abundant calcareous cement.

The Telemon Formation overlies the Silver Hills Volcanics with no obvious angular break; the contact has not been seen. In other areas (e.g. Mollan et al., op.cit.) they are probably disconformable.

The unit thins, and the basal conglomerate lenses out, westwards, across the Springsure (Mollan et al., op. cit.) and Tambo Sheet areas, indicating a source area to the east, probably dominated by the Silver Hills Volcanics. The coarse grained sediments of the lower part of the "multicoloured group" in the east are not present in the Mount Beaufort Anticline. Here the unit may represent only the upper part of the "multicoloured group" in the east. Alternatively, the absence of coarse grained sediments may be merely a function of distance from the source area.

The lack of marine fossils suggests that the formation was deposited in a non-marine basin. Algal colonies probably lived in brackish lakes in which thin limestone beds were deposited. Tuffs and tuffaceous sediments indicate intermittent explosive volcanism; no flows have been seen.

In the Emerald Sheet area the unit contains the plant Leptophloeum australe, of probable Upper Devonian age (White, 1962). In this area it overlies the Silver Hills Volcanics, of probable Upper Devonian age, and is overlain by Lower Carboniferous sediments. Hence its age is considered to be Upper Devonian.

Comparison with Devonian sequences in nearby areas

The Devonian sequence in the Mount Beaufort Anticline is considered to be very similar to those in the Nogoa and Telemon Anticline to the east. Veevers et al. (1964b) mapped the Mount Beaufort Anticline during a regional survey. The present authors would interpret the complex interfingering of sediments and volcanics in the anticline somewhat differently, after mapping in the Springsure (Mollan, Exon and Kirkegaard, in press) and Tambo Sheet areas. Veevers et al. (1964b, figs. 11 and 12) confine the Silver Hills Volcanics to Mount Beaufort itself, where they consist largely of "coarsely banded trachyte and spherulitic chalcedonic rhyolite" with minor "finely banded rhyolite and rhyolitic agglomerate". In the overlying Telemon Formation they include an upper sedimentary part and a lower part comprising andesite flows and lenses of tuff, sandstone, minor conglomerate and limestone. In the northern half of the anticline the lower part of the sequence consists of volcanics and sediments in roughly equal proportions; the sediments pinch out southwards and in the extreme south of the anticline, the sequence is entirely volcanic, consisting of tuffs, agglomerates and flows.

Mollan, Exon and Kirkegaard (in press) found alternating thick volcanic sequences and thick sedimentary sequences in the Silver Hill Volcanics in the Springsure Sheet area to the east. In the west flank of the Nogoa Anticline the uppermost 1000 feet of section, overlain by the Telemon Formation, consists of "interbedded amygdaloidal lavas, including basalt with porphyritic plagioclase, trachyte and andesite, some fluidal crystal tuff and porous quartz sandstone". The overlying Telemon Formation consists of sediments of both volcanic and non-volcanic provenance.

Thus the lower part of the sequence called Telemon Formation by Veevers et al., in the Mount Beaufort Anticline, and the sequence called Silver Hills Volcanics by Mollan et al., in the Springsure Sheet area, are strikingly similar. The uppermost thick volcanic sequence chosen by Mollan et al., as the top of the Silver Hills Volcanics in the Springsure area, is also appropriate in the Mount Beaufort Anticline. So the lower part of the Telemon Formation of Veevers et al. (1964b) is here assigned to the Silver Hills Volcanics; the sediments above this sequence, and below the Mount Hall Conglomerate, comprise the Telemon Formation.

The sequence at Mount Beaufort itself may be part of the Silver Hills Volcanics or part of the underlying Dunstable Formation.

LOWER CARBONIFEROUS

Mount Hall Conglomerate

The Mount Hall Conglomerate (Hill, 1957) was originally named by Shell (SQD, 1952) in the Springsure Sheet area, after Mount Hall in the Telemon Anticline, which is the type area. It crops out in structurally high areas in the Springsure, Emerald and Tambo Sheet area.

In the Tambo Sheet area it is represented by a steeply dipping lens forming a prominent strike ridge 1000 yards long, on the southern nose plunge of the Mount Beaufort Anticline. The western end of this east-west trending lens has been truncated by a large fault. The formation consists largely of medium to very thick bedded, crossbedded, white, fine grained to pebbly quartzose sandstone, with some clay matrix. Thick to very thick bedded lenticular conglomerate beds containing pebbles of quartz and lesser chert, acid volcanics and silicified sandstone, are common.

The contact with the underlying Telemon Formation was not seen; elsewhere (e.g. Mollan, Exon and Kirkegaard, in press) it is disconformable.

The Mount Hall Conglomerate is everywhere extremely lenticular. It was probably deposited from streams as coalescing piedmont fans and in places later reworked after slight epeirogenic movements.

The maximum thickness of this lens is 150 feet, compared with about 1000 feet in the type area (Mollan et al., op. cit.).

No fossils were found in this area, but probable Lower Carboniferous plants occur in the Springsure Sheet area (op. cit.). As the unit disconformably overlies the Upper Devonian sequence, and is overlain by the Lower Carboniferous Ducabrook Formation, it is regarded as Lower Carboniferous in age.

Ducabrook Formation

The Ducabrook Formation (Hill, 1957) was originally named the "Ducabrook Series" by Shell (SQD, 1952) after Ducabrook Pastoral Holding in the Emerald Sheet area, which is the type area.

It crops out extensively in the Springsure and Emerald Sheet areas, and also in the Clermont, Jericho and Tambo Sheet areas. In the Tambo Sheet area it crops out in the Mount Beaufort Anticline, in the extreme north-east. A large north-north-west trending fault separates the outcrop area into two parts. West of the fault the formation dips to the west and south-west; east of the fault it dips to the south-east. The formation forms low strike ridges, with some scrub and tree cover.

The formation consists of a thinly interbedded sequence of green, red or buff sandstone, siltstone and shale, in part calcareous, with primary and secondary volcanic material. The sandstone is generally fine-grained, but occasionally coarser, and varies from lithic sublabile to lithic. It is often tuffaceous and contains abundant green, red or black volcanic fragments, quartz and feldspar, often set in a fine matrix or calcite cement. There are some tuff beds but no flows have been seen. Immediately west of the outcrop of Mount Hall Conglomerate, in the Belyando River, there are round fibrous calcareous nodules (to one foot in diameter) in green siltstone.

The sediments are generally thin to medium bedded, often flaggy; some are poorly (and more thickly) bedded. Some low angle cross-bedding occurs, but this is an unusual feature.

Three fine-grained rocks were examined in thin section. Two are somewhat tuffaceous lithic sandstone with very fine-grained volcanic fragments, angular and fractured quartz and quartz aggregates, some oligoclase and orthoclase. One of these is red in colour with abundant iron-stained matrix, calcite cement and minor iron ore, zircon and chlorite. The second is buff and free of matrix, with muscovite, biotite, iron ore and minor green tourmaline and zircon. The third rock is a fine-grained red, thinly bedded lithic tuff with exceedingly angular clasts. It contains abundant volcanic fragments including pumice, angular and often splintery quartz, fresh subhedral plagioclase, orthoclase, and lesser quartz-feldspar rock fragments and quartz aggregates. Minor constituents are brown biotite and iron ore. 25 percent of this rock is limonitic recrystallized glass and matrix, in convolute layers.

Where there is no faulting, the Ducabrook Formation overlies the Mount Hall Conglomerate where present, or the Telemon Formation. In the Springsure and Emerald Sheet areas, the quartzose to sublabile flaggy sandstones of the Raymond Sandstone conformably overlie the Mount Hall Conglomerate and are, in turn, conformably overlain by the multicoloured sediments of the Ducabrook Formation. In the Mount Beaufort Anticline, quartzose sandstone lithologies typical of the Raymond Sandstone do not appear in the south, and were not mapped in the north (Veevers et al., 1964b). There may be a disconformity above the Mount Hall Conglomerate, or more probably, the lower part of the Ducabrook Formation in this area, is a facies equivalent of the Raymond Sandstone. Where the Mount Hall Conglomerate is not present, the Ducabrook Formation disconformably overlies the lithologically similar Telemon Formation. In this case, the contact can only be mapped by tracing beds around from the lens of Mount Hall Conglomerate.

The Ducabrook Formation was deposited in a shallow, probably non-marine basin. Periods of non-deposition and desiccation followed be renewed inundation are represented by mudclasts in sandstone beds. The rapid alternation of red and green siltstone and sandstone, and the presence in adjacent areas (see Mollan, Exon and Kirkegaard, in press) of probable algae, oolites, fish and small pelecypods indicate a wide variety of short-lived environments. There was some contemporaneous explosive volcanic activity.

No fossils were found in the formation in this area. Elsewhere the Ducabrook Formation contains Lower Carboniferous fossil fish remains (Jack & Etheridge, 1892, and SQD, 1952). The plant fossil Lepidodendron veltheimianum of probable Lower Carboniferous age was found in the Emerald Sheet area (White, 1962). In the Springsure Sheet area small pelecypods, probably freshwater forms, are abundant in some beds. The age of the formation is Lower Carboniferous.

CARBONIFEROUS-PERMIAN

Joe Joe Formation

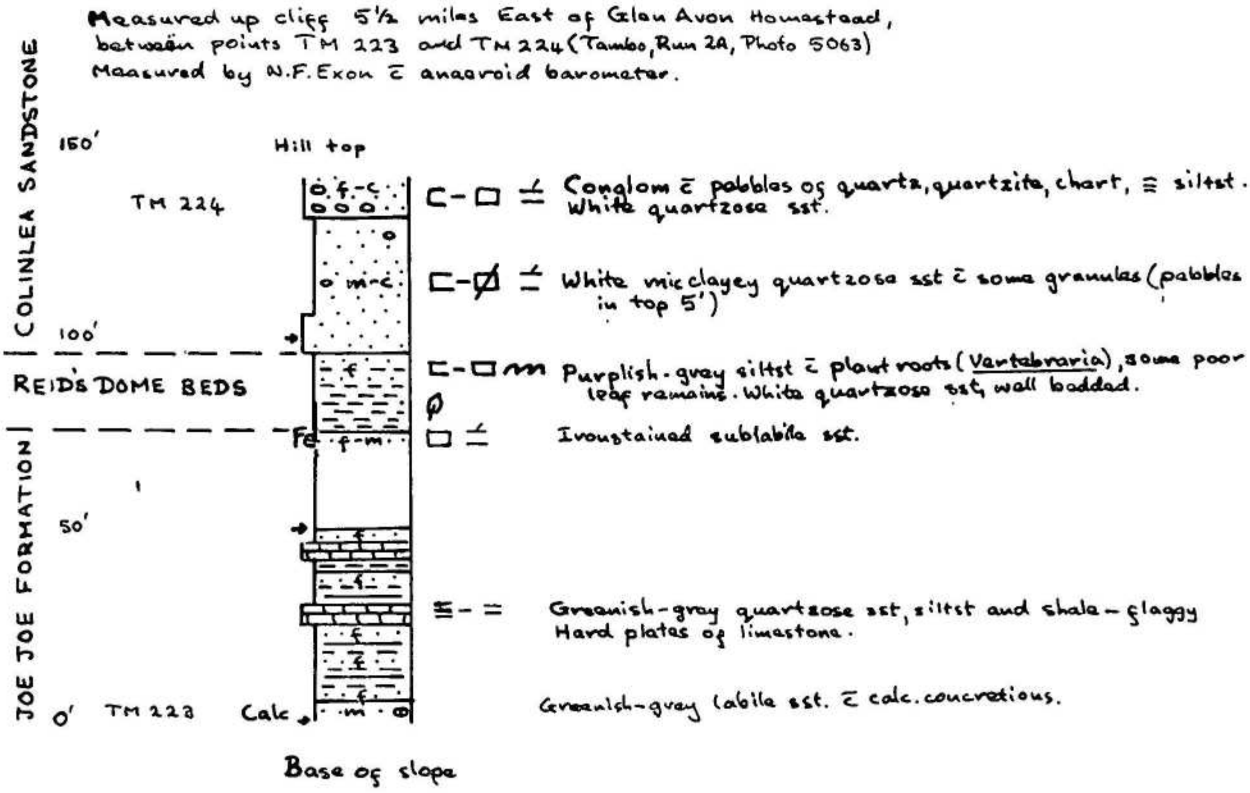
The Joe Joe Formation (Mollan, Exon and Kirkegaard, in prep.) was originally named the "Joe Joe Creek Series" by Shell (SQD, 1952) and amended to "Joe Joe Creek Formation" by Hill (1957). The name is derived from Joe Joe Creek in the north-west of the Springsure Sheet area; the type area is

Fig. 2

MEASURED SECTION S11

JOE JOE FORMATION, REID'S DOME BEDS, COLINLEA SANDSTONE.

Measured up cliff 5½ miles East of Glen Avon Homestead, between points TM 223 and TM 224 (Tambo, Run 2A, Photo 5063)
Measured by N.F. Exon c̄ aneroid barometer.



Bureau of Mineral Resources Geology and Geophysics May 1966 To accompany Record 1966/89 G55/A2/4 in the vicinity of the creek.

The formation crops out in the Springsure, Tambo and Jericho Sheet areas. In the Tambo Sheet area it crops out over approximately 100 square miles in the north-east, around Spider and Native Companion Creeks. The upper part of the formation is reasonably well exposed, whereas much of the lower part is concealed. The lower conglomeratic part forms grassy rounded hills with dendritic drainage and widespread gravel deposits; the upper fine-grained part forms low cuestas with sparse tree cover.

The lower part of the Joe Joe Formation which is up to 500 feet thick, consists essentially of polymictic conglomerate, greenish sublabile to labile sandstone, and lesser siltstone.

Fine to medium grained sandstone is the dominant rock type. This is grey-green, green, or brown and lithic to lithic sublabile, containing clasts of fine-grained sediments, volcanics, feldspar and quartz. It is poorly thick bedded and in many places contains calcareous concretions and has a calcareous matrix. Coarse grained, granular and pebbly sandstones are fairly common. One specimen of brown lithic sandstone, examined in thin section, has clasts of recrystallized sediments, quartz, fine-grained acid volcanics, quartzite and feldspar set in calcite cement, with minor chlorite and limonite.

The conglomerate, which is tillitic in part, contains angular to subrounded pebbles and cobbles, some few of which are faceted, in a sandy or silty matrix. The clasts are generally of local derivation and include volcanics from the Silver Hills Volcanics and Ducabrook Formation, sandstone, large angular siltstone blocks, shale, quartzite and lesser chert, limestone and quartz.

Angular erratic blocks, some of tremendous size, occur associated with conglomerates low in the formation. The largest are derived from the Silver Hills Volcanics. South of the Mount Beaufort Anticline, approximately 2 miles south of the outcrop of Mount Hall Conglomerate, there is a line of pyroclastic flow boulders which consist of red cobbles with blurred margins in a fine dark red groundmass. The cobbles are acid flows, porphyritic in feldspar and biotite; the stony groundmass contains small feldspar phenocrysts. Nearby, to the east, there are fine-grained porphyritic volcanic boulders. Ten miles west of the anticline, 3 miles north of Avonmore Homestead, another set of erratics consists of angular acid volcanic cobbles with pink feldspar phenocrysts, set in a pink to grey groundmass, which is porphyritic in feldspar and ?hornblende.

Green siltstone lenses are a minor component of the lower part of the Joe Joe Formation.

The upper part of the formation consists essentially of well bedded greenish quartz-rich siltstone and sublabile to labile sandstone. The siltstone is generally laminated to thin bedded, in minor part medium bedded, and grades to shale. In places it is platy; this platy siltstone is, in many places, calcareous and associated with platy limestone. Thick calcareous lenses and large knobbly concretions (of possible algal origin) also occur. Laminated siltstones grade into varve-like siltstones which are probably, in part at least, true varves. The siltstone, in places, is ripple marked and cross-bedded and shows current striations caused by debris dragging on the bottom, and some mudcracks. In places it contains arthropod tracks identical with those in the Springsure Sheet area (Mollan, Exon and Kirkegaard, in press). The sandstone is very fine to medium grained, and in part calcareous with some calcareous concretions. It is green, grey-green or brownish in colour, and better bedded than the sandstone of the lower part of the formation; it contains siltstone clasts in some beds. Bedding is thin to thick, and there is some cross-bedding. Fine, hard, thin-bedded pink and white, in part calcareous, tuffaceous feldspathic sandstone and tuff are minor constituents. They shows small-scale cross-bedding at some localities. Plant stems and strap-like leaves are common in tuff beds and siltstone, and are coalified in some siltstone beds.

The upper part shows subdivisions roughly comparable to those noted on the western part of the Springsure Sheet area (Mollan, Exon and Kirkegaard, in press, section S3). Thicknesses cited below have been estimated using dip information to the west of Garden Gully Homestead.

200 feet	Greenish-brown to buff, poorly bedded, fine to medium-grained, in places calcareous, sublabile to labile sandstone.
500 feet	Siltstone, shale, lesser limestone - laminated to thin bedded, in places varve-like or platy, green or grey. Some ripple marks, fine cross bedding, current striae, large nodules. Some arthropod tracks. Some greenish sublabile sandstone, minor hard pink tuff. Plant fragments abundant at some levels.
200 feet	Thin to thick bedded, fine grained greenish quartzose to sublabile sandstone, siltstone, hard pink and white tuff. Common plant remains.

The Joe Joe Formation unconformably overlies the Ducabrook Formation. On the airphotos, bedding trends in the Ducabrook Formation disappear under the amorphous pattern of the Joe Joe conglomerates.

Following uplift, and some erosion of the Ducabrook Formation, exposing the Devonian sequence of Mount Beaufort Anticline, there was extensive glaciation during which the Joe Joe Formation was deposited. Glaciers moving down the slopes of the anticlinal mountain range, with associated streams, deposited the tillite, and fluvio-glacial sandstone and conglomerate of the lower part of the formation. Enormous boulders were deposited in some areas, perhaps dropped from floating ice, or perhaps as eskers or morainic deposits. Following this burst of high-energy deposition, more placid conditions prevailed while siltstone and shale, including some varved sediments, were deposited in shallow lakes fed by glacial melt streams. Current features including ripple marks, cross-bedding, and drag striae, are common in these sediments. Thin calcareous beds also formed in these lakes. The marginal deposits dried out and cracked from time to time; during later sand deposition these deposits were torn up or undercut, and siltstone and shale fragments were included in the sandstone. Plant life was widespread around the margins of the lakes, and various animals crawled on the lake bottoms. Tuff beds, which commonly preserve plant remains, show that there was contemporaneous volcanic activity.

The formation averages 1500 feet thick in this area, with the lower part 500 feet thick and the upper part 1000 feet.

Plant remains found in this area, although widespread, are of little use for dating. They consist entirely of equisitalean stems and strap-like leaves. In the Springsure Sheet area plant remains include Cardiopteris polymorpha, a Carboniferous form (Mollan et al., op. cit.). Spores from the unit indicate that it is partly Permian (Evans, 1966b) in Jericho No.1 well, 50 miles west of the outcrop area. However, in Birkhead No.1 well, 40 miles to the south-west, no Permian spores were found. In general, younger Joe Joe sediments are preserved farther west. This may be related to depth of erosion before deposition of the Colinlea Sandstone. In this area the formation is considered to be Carboniferous to Lower Permian.

PERMIAN

Reid's Dome Beds

This unit is named from AOE No.1 (Reid's Dome) well, in the Denison Trough in the Springsure Sheet area, where it includes the "undivided fresh-water beds" and the "lower shales and mudstones" (see Mollan, Exon and Kirkegaard, in press). It was also penetrated in AOE No. 2 (Reid's Dome) and AOE No.3 (Consuelo). In these wells it consists of siltstone, carbonaceous siltstone, shale and coal.

It crops out in the Nogoa Anticline, and on the Springsure Shelf in the western part of the Springsure Sheet area, as a thin Glossopteris-bearing siltstone and sandstone unit. The outcrop extends five miles into the north-east part of the Tambo Sheet area, where it wedges out. It forms the uppermost part of the slope at the foot of the scarp of the Colinlea Sandstone.

The Reid's Dome Beds in this area (see Fig.2) are thin to medium bedded, sometimes ripple marked, purplish-grey siltstone and white quartzose sandstone. The sandstone is fine grained, medium to thick bedded and is not cross bedded. Plant roots (Vertebraria) and poorly preserved leaf fragments are common.

In this area, the unit overlies the Joe Joe Formation, probably disconformably. Dips in both these units, and in the disconformably overlying Colinlea Sandstone, are very low and no discordance was detected. The uppermost sandstone of the Joe Joe Formation is ferruginized, suggesting a period of non-deposition, weathering and probably erosion (Fig. 2), before deposition of the Reid's Dome Beds. The sporadic occurrence of the unit suggests that it was deposited in shallow depressions in the Joe Joe Formation. Perhaps some of the unit was eroded prior to deposition of the Colinlea Sandstone. Its exact relationship to the thick subsurface sequence is unknown, although it is a time equivalent of part at least, of this sequence.

The unit is 40 feet thick in the section measured, compared with 120 feet in the western part of the Springsure Sheet area, and thousands of feet in the Denison Trough. The presence of several Glossopteris species (Mollan et al., op.cit.) indicates a Permian age. Because it is below the Colinlea Sandstone it must be Lower Permian.

Colinlea Sandstone

Shell (SQD, 1952), used the term "Colinlea Series" for beds between the Joe Joe Formation and the Mantuan Productus Bed. Hill (1957) published the name "Colinlea Formation" for the same unit. Mollan, Exon, Kirkegaard and Dickins (1964), applied the name Peawaddy Formation to the upper part of the "Colinlea Formation" including the Mantuan Productus Bed. They defined the Peawaddy Formation from exposures in the Reid's Dome - Consuelo Anticline area. They proposed the name Colinlea Sandstone for the lower part of the "Colinlea Formation", which consists dominantly of quartzose sandstone. This usage is followed here. The type area of the Colinlea

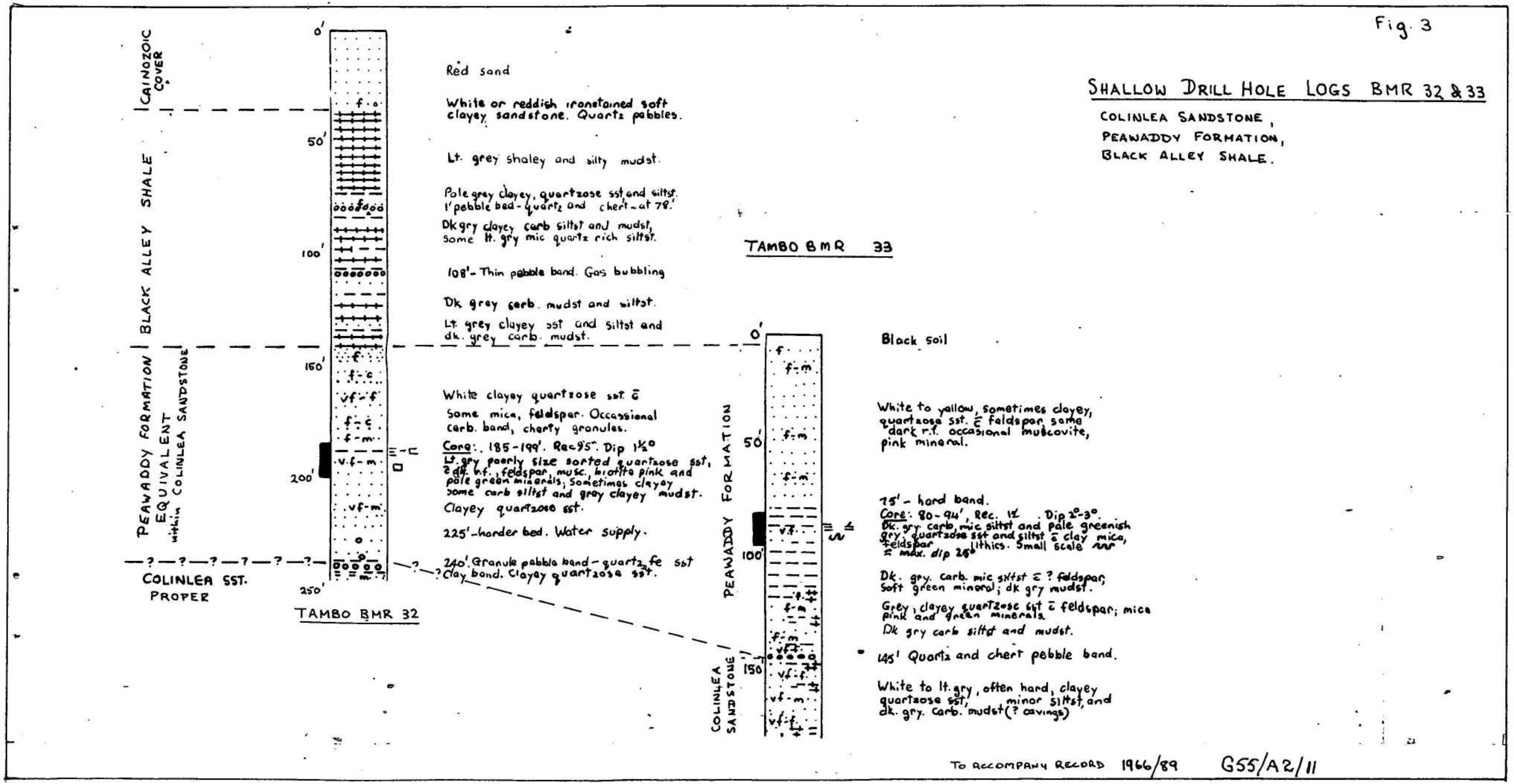


Fig. 3
SHALLOW DRILL HOLE LOGS BMR 32 & 33
COLINLEA SANDSTONE,
PEAWADDY FORMATION,
BLACK ALLEY SHALE.
CAINOZOIC COVER
BLACK ALLEY SHALE
PEAWADDY FORMATION EQUIVALENT within COLINLEA SANDSTONE
COLINLEA SST. PROPER
0'
50'
100'
150'
200'
250'
Red sand
White or reddish ironstained soft clayey sandstone. Quartz pebbles.
Lt. grey shaley and silty mudst.
Pale grey clayey, quartzose sst and siltst. 1' pebble bed - quartz and chert - at 78'.
Dk grey clayey carb siltst and mudst, some lt. gry mic quartz rich siltst.
108' - Thin pebble band. Gas bubbling
Dk grey carb. mudst and siltst.
Lt. grey clayey sst and siltst and dk. grey carb. mudst.
White clayey quartzose sst. c̄
Some mica, feldspar. Occassional carb. band, cherty granules.
Core: 185-199'. Rec 9.5". Dip 1½°
Lt. gry poorly size sorted quartzose sst, c̄ dk. r.f., feldspar, musc., biotite pink and pale green minerals, Sometimes clayey some carb siltst and grey clayey mudst.
Clayey quartzose sst.
225' - harder bed. Water supply.
240'. Granule pebble band - quartz, fe sst Clay band. Clayey quartzose sst.
TAMBO BMR 32
TAMBO BMR 33
PEAWADDY FORMATION
COLINLEA SANDSTONE
0'
50'
100'
150
Black soil
White to yellow, sometimes clayey, quartzose sst. c̄ feldspar some dark r.f. occasional muscovite, pink mineral.
75' - hard band.
Core: 80-94', Rec. 1' . Dip 2°-3°.
Dk. gry carb, mic siltst and pale greenish grey quartzose sst and siltst c̄ clay mica, feldspar lithics. Small scale c̄ max. dip 25°
Dk. gry. carb. mic siltst c̄ ? feldspar, soft green mineral; dk gry mudst.
Grey, clayey quartzose sst c̄ feldspar; mica pink and green minerals.
Dk gry carb siltst and mudst.
145' Quartz and chert pebble band.
White to lt. gry, often hard, clayey quartzose sst, minor siltst, and dk. gry. carb. mudst (? cavings)
TO ACCOMPANY RECORD 1966/89
G55/A2/11

Sandstone (Mollan, Exon and Kirkegaard, in press) is "along the Central Western Highway immediately north of Vandyke Homestead and lies within a land division known as Colinlea Holding".

The Colinlea Sandstone crops out on the Springsure Shelf in the western two-thirds of the Springsure Sheet area, and in the Tambo and Jericho Sheet areas. In the Tambo Sheet area it forms a west-north-west trending belt in the north-east. In the east it is deeply incised and cliff-forming, whereas farther west it has only low relief. Dip slopes and bedding trends are usually discernible in the airphotos; there is dense cover, consisting of small trees, on the sandy soils of the formation.

The Colinlea Sandstone consists mainly of white, medium to coarse grained, medium to thickly bedded, typically cross bedded, quartzose to sublabile sandstone with some feldspar and muscovite, and minor clay matrix. It also includes thinly bedded, fine-grained, quartzose to sublabile sandstone and siltstone, which in places contain plant fragments. Thickly bedded pebbly quartzose sandstone and conglomerate are very common. The pebbles are dominantly quartz with fewer chert, porphyritic acid volcanics, quartzite and sedimentary pebbles. There is a general increase in the proportion of acid volcanic pebbles stratigraphically up the formation. The amounts of muscovite and of clay matrix (possibly representing an increase in feldspar), also increase upwards.

North-east of Glen Avon Homestead, where the contact was observed, the base of the Colinlea Sandstone is a six inch thick conglomerate bed, composed mainly of subangular quartz pebbles, but also containing angular sandstone pebbles of similar lithology to the immediately underlying sandstone of the Joe Joe Formation. The base of the Colinlea Sandstone, near the Glen Avon/Alpha road, has pebbly bands in which most of the pebbles are porphyritic volcanics, and lithic clastic sediments; a few tabular pebbles of phyllite and schist were noted.

Torbanite crops out within the unit in a small creek two miles north of Glen Avon Homestead. The extent of this torbanite and the associated coal was proved by drilling by the Queensland Department of Mines (Connah, 1964). Estimated reserves are 150 to 180 million gallons of distillate.

The Colinlea Sandstone gradually becomes more labile westwards; on the Jericho Sheet it is labile to sublabile and has low relief, whereas on the eastern margin of the Tambo Sheet it is largely quartzose and cliff-forming. Yet the bedding features and overall appearance of outcrops remain practically unchanged.

The sandstone disconformably overlies the Reid's Dome Beds in the east of this area. The pebbly cross bedded sandstone of the Colinlea Sandstone contrasts with the siltstone and fine-grained sandstone (which is not cross-bedded) of the Reid's Dome Beds. In the northern end of the Nogoa Anticline (Mollan, Exon and Kirkegaard, in press), the sandstone lies unconformably on the Reid's Dome Beds. Elsewhere in the area, the Colinlea Sandstone disconformably overlies the Joe Joe Formation and the basal beds of the Colinlea Sandstone often include clasts from the Joe Joe Formation. In the Springsure Sheet area (see Mollan et al., op.cit.), the Colinlea Sandstone overlaps the Joe Joe Formation along the southern part of the Nogoa Anticline axis. Here the Colinlea Sandstone rests unconformably, in turn, on all older formations down to the Dunstable Formation. In the Tambo Sheet area the upper part of the Colinlea Sandstone, north of the Birkhead Anticline, is a time equivalent of the Peawaddy Formation south of the anticline (see Peawaddy Formation).

The Colinlea Sandstone was deposited as fluviatile and deltaic sands in shallow fresh water, on a gently subsiding shelf area. Isolated cross-bedding readings suggest deposition by south or south-east flowing streams, but these readings are too few to be reliable. Acritarchs are found in the sandstone at the top of the equivalent of the Peawaddy Formation in SPL Birkhead No.1 (see Peawaddy Formation), suggesting marine conditions at this level. The competent pebbles were probably largely derived from the pre-existing conglomerates of the Joe Joe Formation and Mount Hall Conglomerate. Some pebbles of sedimentary rocks are from the Joe Joe Formation, and some, derived by scouring, from within the Colinlea Sandstone.

The thickness of the sandstone in this area, computed from dip information, is about 450 feet; it probably decreases slightly westwards. This compares closely with the thickness in the western part of the Springsure Sheet area. Plant fossils collected from the unit in the Springsure Sheet area (Mollan et al., op. cit.) are of Lower Permian age, and from the Jericho Sheet area (Vine, Jauncey, Casey and Galloway, 1965) are Upper Permian. Spores from shallow drill hole BMR No.6 (Springsure), are of Lower Permian age (Evans, in prep., b). The unit may range from Lower to Upper Permian throughout its extent; alternatively, it may include Upper Permian only in the west. It is probable that, north of the Birkhead Anticline, the upper part of the Colinlea Sandstone is equivalent to the Upper Permian Peawaddy Formation. Thus, in this area, the authors believe the age of the formation to be Lower to Upper Permian.

Peawaddy Formation

The Peawaddy Formation (Mollan, Kirkegaard, Exon and Dickins, 1964) is named from Peawaddy Creek in the Springsure Sheet area. Its type section is in Peawaddy Creek, 3½ miles west-north-west of Consuelo Homestead. It is the upper part of the "Catherine Sandstone" (Hill, 1957) in the Denison Trough, and the upper part of the "Colinlea Formation" (Hill, 1957), including the Mantuan Productus Bed, on the Springsure Sheet. It consists of about 450 feet of lithic sandstone and siltstone, above the Catherine Sandstone in the Denison Trough, and above the Colinlea Sandstone on the Springsure Shelf (Mollan, et al., 1964).

It crops out in the north-east of the Tambo Sheet area as a narrow west-north-west trending belt. It becomes unrecognizable north-west of the Birkhead Anticline, probably being replaced by sediments assigned to the Colinlea Sandstone. The unit forms a sparsely timbered sandy area, with low relief, between the Colinlea Sandstone and the black soil plains of the overlying Black Alley Shale.

Outcrop is poor, and consists mainly of white to buff, fine to medium grained, medium bedded, soft quartzose to feldspathic sublabile sandstone, with clay matrix and some muscovite, and minor lithic fragments. A few very clayey sandstones are probably altered feldspathic sandstones. The unit also includes some laminated, finely cross-bedded grey siltstone, in places with carbonized plant fragments. The lack of resistance of the unit is, in places, due to the presence of the fine-grained carbonaceous sandstone.

The logs of two shallow drill holes (Fig. 3) provide additional lithological information about this unit. In Tambo BMR No.33, drilled through the formation halfway across the belt of outcrop in the Tambo Sheet area, the Peawaddy interval is 150 feet thick. The upper half of the unit is quartzose sandstone (in places clayey), and the lower half is interlaminated, cross-bedded, dark grey carbonaceous micaceous siltstone and mudstone, and grey quartzose sandstone and siltstone. This lower half is typical of the Peawaddy Formation in the Springsure Sheet area.

In Tambo BMR No.32, near Durrandella Homestead beyond the north-western outcrop limit of the Peawaddy Formation, the equivalent of the Peawaddy Formation within the Colinlea Sandstone, which is 100 feet thick, is mainly quartzose sandstone with minor carbonaceous siltstone. This is probably the western limit of sediments typical of the Peawaddy Formation. Just south of here, in outcrop, the equivalent of the Peawaddy Formation is less resistant than the underlying Colinlea Sandstone and contains feldspathic beds, and no conglomerate, but is otherwise indistinguishable.

The Peawaddy Formation conformably overlies the Colinlea Sandstone in this area. It is more quartzose here than in the type area, and westwards the quartz content increases still further. Near the Birkhead Anticline, the distinctive siltstone of the formation is not present, and the sandstones of Peawaddy age are indistinguishable from those of the Colinlea Sandstone. This facies change near the anticlinal axis necessitates extending the upper stratigraphic limit of the Colinlea Sandstone to the base of the Black Alley Shale. The lateral boundary between the Peawaddy Formation and the Colinlea Sandstone is gradational, and is, somewhat arbitrarily, placed under the alluvium of Alpha Creek.

In the east, the base of the Peawaddy Formation is taken immediately above the uppermost conglomerate bed of the Colinlea Sandstone.

In this area, the formation was deposited in a low-energy fresh water environment, the lower silty part, at least, in standing water. The abundant carbonaceous material was preserved in a reducing environment of deposition, probably beneath several hundred feet of water. The water was shallower later, and fine to medium grained sandstone was deposited in marginal fluviatile/lacustrine conditions. The generally marine conditions, applying in the type area, apparently extended as far west as Mantuan Downs Homestead on the Springsure Sheet (Mollan, Exon & Kirkegaard, in press), but not as far as this area. An acritach swarm in the top sandstones of the equivalent of the Peawaddy Formation in SPL Birkhead No.1, suggests some marine influence at the close of Peawaddy times in this area.

The unit thins westwards, across the Tambo Sheet area, from an estimated 200 feet in the east, to 150 feet in BMR No.33; the equivalent sequence in BMR No.32 is 100 feet thick. This compares with an estimated thickness of 440 feet near Tanderra Homestead, 40 miles east of the Tambo/ Springsure Sheet boundary (Mollan, et al., 1964).

A few fish scales were found in sandstone in a small creek one mile east-north-east of Alpha Homestead (4713, 9860), but no shelly fossils were found on this survey. Shell fragments were reported near Alpha Homestead by Woolley (1941b), and equated with the Mantuan Productus Bed fauna. In SPL Birkhead No.1, an acritarch swarm is found just below the top (3240 feet) of the equivalent of the Peawaddy Formation, within the upper Colinlea Sandstone. This contains the same species as the swarm found in the Denison Trough immediately above the Mantuan Productus Bed (Evans, pers.comm.). The age of the formation is Upper Permian (Mollan, et al., 1964).

Black Alley Shale

The Black Alley Shale (Mollan, Exon and Kirkegaard, in press) is named after Black Alley Peak, immediately south-west of Reid's Dome in the Springsure Sheet area. This unit is the lower part of the Bandanna Formation (Hill, 1957).

The type section is in a small tributary of Carnarvon Creek, three miles south-east of Black Alley Peak. In the type area, the formation consists of dark grey to greenish shale and mudstone, with interbeds of greasy bentonitic clay, bentonite and a few thin ferruginous layers.

The Black Alley Shale crops out in the Denison Trough in the Springsure and Eddystone Sheet areas, and across the Springsure Shelf into the Tambo Sheet area.

In the north-eastern part of the Tambo Sheet area it occurs in a narrow sinuous belt, trending in a general north-west direction. It forms a belt of well-grassed treeless black soil; this unit is known only from a few outcrops in deeply entrenched creeks and gullies. In the airphotos it is completely devoid of bedding trends, a characteristic which distinguishes it from the otherwise similar overlying Blackwater Group.

The dominant rock types are grey <u>mudstone</u> (weathering to brown) and light coloured <u>claystone</u>. These were the only sediments seen in shallow drill hole Tambo BMR No.32. The only good outcrop seen (4669, 0107), in a gully in the extreme north of the Sheet, consists of buff, thin to medium bedded <u>siltstone</u>, and weathered mudstone and claystone. The siltstone is chaotically and tightly folded, and faulted on a small scale. This outcrop is on the trend of several possible faults, which are shown to the south-west in Fig. 9, and this may explain the deformation of the outcrop. Alternatively, it may be due to the presence of swelling clays in the sequence. It is believed that there is <u>bentonitic clay</u> and probably <u>bentonite</u> in this sequence, as in the type area; the distinctive mosaic-cracking pattern of the mudstone and black soil is identical to that illustrated in Thompson and Duff (1965), in the bentonitic parts of the same sequence in the Reid's Dome area.

In SPL Birkhead No.1 well, the authors have picked the interval 2930 feet to 3240 feet as the Black Alley Shale. In the lithological log of the hole, filed at the Bureau of Mineral Resources, lithologies described include grey <u>ash</u>, dense igneous sediments, "greenish unctuous shale", grey and tan arenaceous limestone, carbonaceous shale, very fine-grained dark grey, well cemented, slightly calcareous, very tight sand, grading into sandy shale, and dark grey shale and sandy shale. The cuttings in this section are very sparse, and the authors believe that the majority of the section is mudstone and claystone. Core 3 (interval 2971 feet to 2972½ feet) is interpreted, by the authors, from the core description and a thin section description, as a fine to coarse-grained, in part lignitic, tuffaceous lithic sandstone.

The description of "greenish unctuous shale" probably describes the typical greenish bentonitic clay of the type area. The remainder of the sequence is similar to the outcrop sequence in the Tambo Sheet area, but in addition, tuffs, limestone, and sandstone are present.

The Black Alley Shale conformably overlies the Peawaddy Formation in the south-east, and the Peawaddy equivalent within the Colinlea Sandstone in the north-west. The transition, from quartzose to sublabile sandstone in the lower units, to mudstone in the upper unit, is very sharp. On the ground, this is the sharp break between tree covered sandy soil or sandstone, and well grassed black soil.

The formation was probably deposited slowly in a gently subsiding basin. Elsewhere, marine conditions were present in the lowermost part of the sequence, but here there is no evidence of these. Contemporaneous volcanism is evidenced by the presence of tuffs; some soft clay beds are probably weathered volcanic material.

The thickness of the unit is estimated at 150 feet, compared with 325 feet in the type section. The thickness varies across the Springsure Sheet (Mollan, Exon and Kirkegaard, in press), from 400 feet maximum in the east, to 200 feet in the west, and the unit continues to thin gradually across the Tambo Sheet.

In this area no macrofossils have been found in the sequence, but lack of outcrop may be the cause of this. Fossil wood scree, at the junction between this unit and the Blackwater Group, could possibly be from the uppermost Black Alley Shale. In the Springsure and Eddystone Sheet areas (Mollan, Exon and Kirkegaard, in press, and Mollan, Forbes, Jensen, Exon and Gregory, in prep.) the formation contains acritarchs, plants, logs, and a few fish scales. In these areas an acritarch swarm was present just above the base of the unit. In SPL Birkhead No.1, a similar acritarch swarm is in the top of the underlying sandstone, about ten feet below the base of the formation. Cuttings from 2900, 3050 and 3150 feet, within the unit in SPL Birkhead No.1 well, contain a spore assemblage of Upper Permian age (Evans, 1962). The age of the formation is Upper Permian.

Blackwater Group

The type area of the Blackwater Group is near Blackwater in the Duaringa Sheet area, where it is divided into three formations. The name was introduced by geologists of the Bureau of Mineral Resources and Utah Development Company, and subsequently published by Malone, Olgers and Kirkegaard (in press), replacing "Upper Bowen Coal Measures". The Blackwater Group is represented in the Eddystone, Springsure and Tambo 1:250,000 Sheet areas by the stratigraphic interval formerly regarded as the upper part of the Bandanna Formation (Hill, 1957), between the top of the Black Alley Shale and the base of the Rewan Formation.

In the Tambo Sheet area, it occurs as a narrow sinuous belt of outcrop overlying the Black Alley Shale. It is a poorly exposed unit, which forms a grassed clayey brown or black soil slope, rising above the Black Alley Shale. Calcareous beds crop out, and form trends which are visible on the airphotos.

The unit crops out largely as brown to grey, thin to medium bedded, in part calcareous, labile to sublabile sandstone and siltstone. The sandstone contains concretions, lenses, and thin interbeds of calcareous feldspathic sandstone and sandy limestone, generally containing *Glossopteris* fragments. Silicified wood "float", with fragments to two feet in length, is common near the sandstone. The top part of the formation consists mainly of grey carbonaceous siltstone and mudstone. Coal seams, characteristic of the Blackwater Group in the Denison Trough, were not seen.

One unusual rock type, from a locality four miles east of Alpha Homestead (4768, 9968), was examined in thin section. In outcrop it is a coarse grey, calcareous sandstone, with quartz and quartzite grains and granules, containing clay clasts and worm markings, and associated with fossil wood "float". In thin section it is seen to contain abundant, equidimensional, angular to subrounded grains of quartz, about 15 percent of metamorphic quartzite, some plagioclase (perthitic in part), minor volcanic grains and biotite, and very minor muscovite, set in calcite cement and minor iron-stained matrix.

Shallow drill hole BMR Tambo No.1 penetrated carbonaceous siltstone, mudstone and minor sandstone, representing the uppermost 100 feet of the Blackwater Group (see Fig. 4). Sandstone recovered in Core 2 is medium-grained, green, lithic, medium-bedded and cross-bedded, and contains mudstone clasts and coaly laminae. No coal seams were logged in this hole.

The abbreviated Blackwater sequence (picked by the authors to be from 2860 to 2930 feet) in SPL Birkhead No.1 well, 35 miles south-west of Tambo No.1, is described in the lithological log as containing very fine-grained, dark grey, very micaceous, non-calcareous sandstone, dark grey very lignitic shale, and very fine-grained, very lignitic sandstone. The electric log suggests the presence of several coal seams.

The Blackwater Group overlies the Black Alley Shale, apparently conformably. It is distinguished from that formation by the presence of abundant siltstone and sandstone.

The Blackwater Group was deposited in a shallow freshwater basin, in which the water level fluctuated. At times, parts of the depositional area were above water level and trees flourished. Later, subsidence and deposition of sand led to the incorporation of fossil wood and clay clasts in sandstone beds. Conditions were swampy, and coal measures were deposited, in some areas, from time to time. Marine incursions are suggested by the presence of acritarchs at at least one level.

The group thins westwards from an estimated maximum of 250 feet in outcrop, to 70 feet in SPL Birkhead No.1, and may pinch out completely farther west.

The group contains Glossopteris remains and wood, in this area. In the Springsure area (Mollan, Exon and Kirkegaard, in press) it contains an Upper Permian suite of plants. In BMR Tambo No.1, Evans (Appendix 2) found that Core 2 contains a P4 spore assemblage; core 3 contains a P3d assemblage which includes a high percentage of acritarchs; cuttings from 2900 feet in SPL Birkhead No.1 contain Permian spores (Evans, 1962). The age of the group is Upper Permian.

TRIASSIC

Rewan Formation

The term "Rewan Series" was first used by Shell (SQD, 1952) and published as Rewan Formation by Isbell (1955). The formation is named after Rewan Homestead, south-east of Reid's Dome, in the Springsure Sheet area. The type area is in the vicinity of the homestead, and the type section is in a creek several miles north of the homestead. Green and red mudstone, and green and khaki lithic sandstone, are typical of the unit.

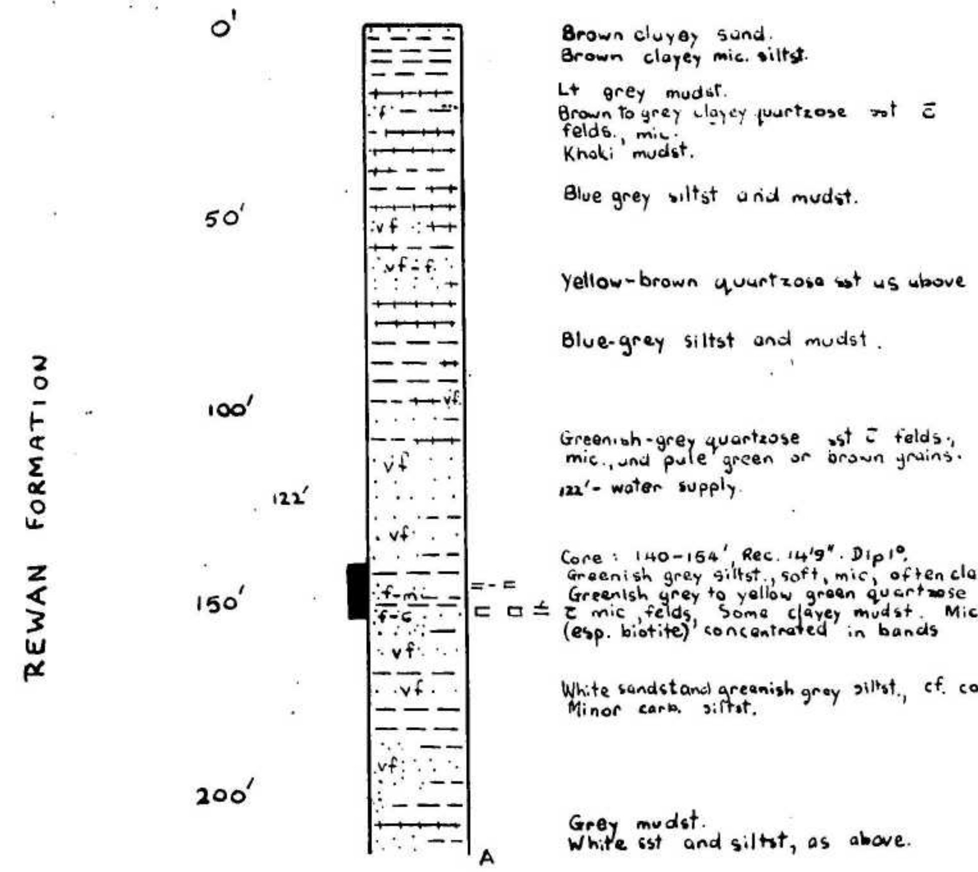
The formation is preserved over much of the southern half of the Bowen Basin, including the Springsure and Eddystone Sheet areas. It crops out, in the north-east of the Tambo Sheet area, as a sinuous north-west trending belt. This lightly timbered unit is generally poorly exposed; resistant beds form small cuestas and mesas. In places the basal part of the unit forms scarps above the plains of the less resistant underlying Blackwater Group.

In this area the formation consists of sandstone, siltstone, and mudstone, with sandstone the most widely outcropping lithology. This contrasts with the type area where mudstone is the dominant exposed lithology. However, west of the type area on the Springsure Shelf, sandstone is the most widespread exposed lithology. In stratigraphic drill holes in the Tambo Sheet area (Fig. 4), sandstone and siltstone were encountered in equal proportions, and there is lesser mudstone.

The sandstone is white or greenish-grey when fresh, and weathers to brown or greenish-brown. It is dominantly lithic, but grades through lithic

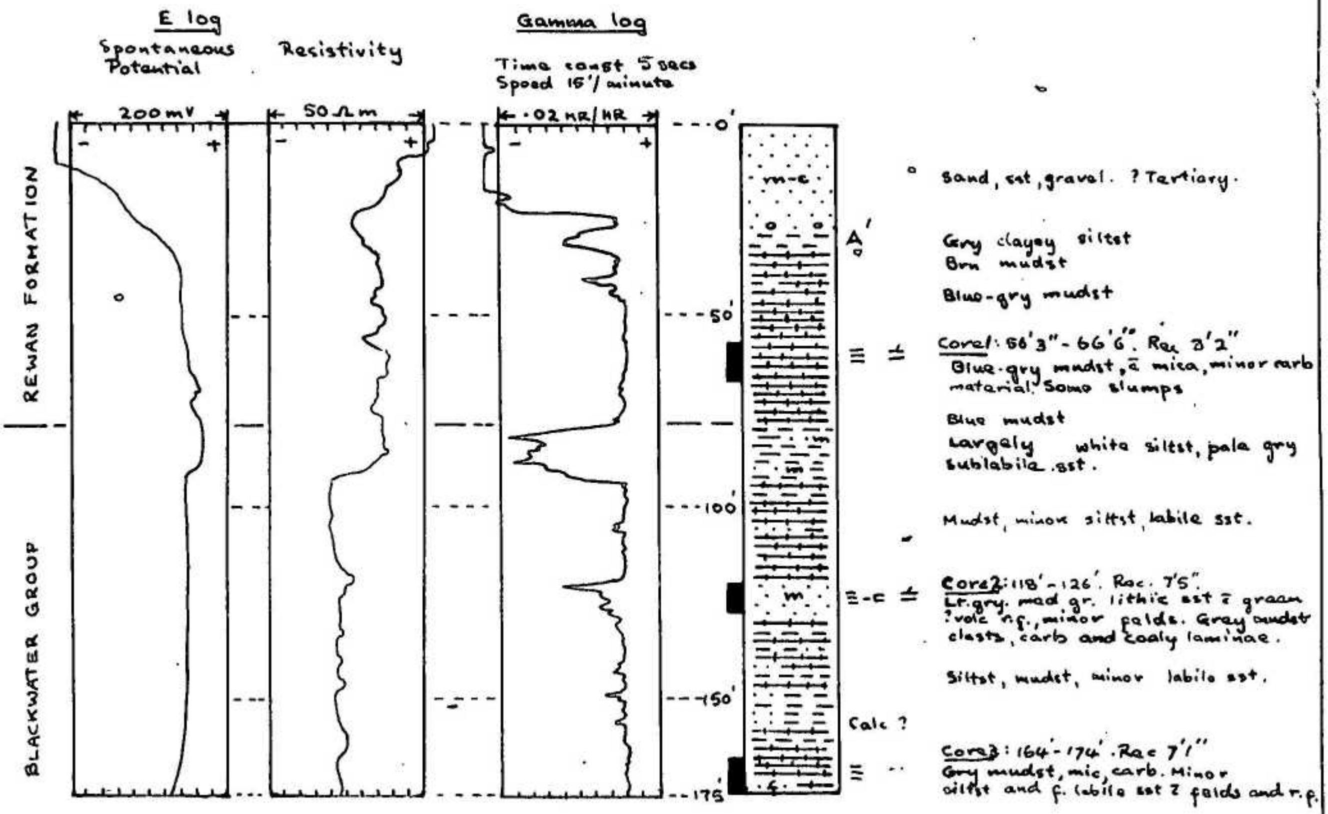
Fig. 4

TAMBO BMR 34



A ≑ A'

BMR TAMBO 1



SHALLOW DRILL HOLE LOGS BMR 34 & TAMBO 1

REWAN FORMATION, BLACKWATER GROUP

TO ACCOMPANY RECORD 1966/89 G55/A2/12

sublabile to quartzose; some beds contain considerable feldspar. Beds are generally medium to very thick, and planar and scour cross-bedding is common. Grainsize ranges from very fine to very coarse, and green or white clay clasts are common in some beds, either scattered throughout the bed or concentrated in layers. Muscovite and biotite are abundant in some beds.

The siltstone is well bedded, laminated to thin bedded, and may contain low-angle cross-bedding and ripple marks; oscillation ripple marks (Photographs, Plate 2) are well preserved in siltstone six miles west of Durrandella Homestead (4660, 0035). In outcrop, the siltstone is grey, green or rarely red; in bore holes, where it is fresh, it is frequently blue-green or blue grey. Calcareous siltstone beds are associated with platy limestone in places. Thin bands of tough ferruginous siltstone occur throughout the unit. Interbedded green and red mudstone is commonly associated with multi-coloured siltstone. This mudstone, which is mottled in places, is fairly widespread in the upper part of the sequence, and outcrops up to 15 feet thick have been noted. Grey mudstone is also common. Siltstone and mudstone beds are apparently more abundant in the east. Carbonaceous material is characteristically absent from the unit.

Two shallow drill holes, Tambo BMR No.34 and BMR Tambo No.1 (Fig. 4), near Alpha Homestead, penetrate 260 feet of the lower part of the unit. The rock types in these holes are laminated grey, green and blue siltstone and mudstone, and thin to medium-bedded, green and white, very fine-grained quartzose sandstone.

At the base of the formation, four miles east of Alpha Homestead (4765, 9965), fossil logs, up to 30 feet in length, lie near outcropping siltstone and sandstone. The siltstone is calcareous, tough and massive, and grades into very fine-grained labile sandstone. Fine to medium-grained calcareous, grey to brown, labile sandstone contains exceedingly abundant green clay clasts, and some carbonaceous plant remains. This sandstone contains vitreous quartz and is probably of tuffaceous origin. It is strikingly similar to sediments in the Brumby Sandstone, which is in the same stratigraphic position farther east (A.R. Jensen, pers. comm.); no similar sandstone was found at other levels in this area.

Three labile sandstone specimens from the formation were examined in thin section. All are well bedded and cross-bedded; they vary from fine to medium-grained, and are greenish-brown or grey. Two are lithic, and one contains considerable mica and feldspar. The majority of clasts are angular quartz and quartz aggregates (20 to 35 percent; average 30 percent), siltstone and shale (2 to 35 percent; average 15 percent), acid volcanics (0 to 50 percent; average 30 percent). Other common constituents are biotite (up to 10 percent) and minor muscovite and iron oxide; minor zeolite, tourmaline and chlorite was seen in some specimens. Micas are aligned in the bedding planes.

In this area the Rewan Formation overlies the Blackwater Group with apparent conformity. The base of the lowest green siltstone bed was generally taken as the boundary in outcrop. In BMR Tambo No.1, blue-grey mudstone overlies white siltstone and grey sublabile sandstone at the contact; carbonaceous material is much more abundant below the contact. Here, Core 1, at 60 feet, yielded a Triassic spore assemblage, and Core 2, at 120 feet, yielded a Permian assemblage (Evans, Appendix 2) of spore division P3d or P4. This suggests that there may be a time break between deposition of the Blackwater Group and of the Rewan Formation.

The Rewan Formation is overlain by the Clematis Sandstone south of the Birkhead Anticline. Near the anticlinal axis, the sandstone of the upper part of the Rewan Formation grades laterally into the less lithic sandstone of the Dunda Beds (see Dunda Beds). North of the anticline, the lower part of the Rewan Formation is overlain, possibly disconformably, by the Dunda Beds.

The conditions of deposition are markedly different from the overwhelmingly red-bed conditions of the type area. In this area, the formation was deposited in a non-marine environment with fluctuating water level. The finer sediments are probably lacustrine deposits whereas the sandstones are, in part at least, fluviatile. Overall, the unit becomes coarser grained and more fluviatile, upwards. Following deposition of the lower, dominantly fine-grained, part of the Rewan Formation, slight differences in sediment composition and facies suggest intermittent separation of two depositional areas, by a north-east trending rise corresponding to the axial part of the Birkhead Anticline. The Dunda Beds, north and west of the rise, were deposited contemporaneously with the upper part of the Rewan Formation, south and east of the rise.

The abundance of mudclasts, and the presence of fossil wood, suggest rapid changes of environment from time to time. The lack of carbonaceous material suggests that oxidising conditions predominated; changes from oxidising to reducing conditions are indicated by the change from red to green mudstone. The colouration of these mudstones is probably attributable to hydrated iron oxides - possibly derived from lateritic soils. A possible marine interval is suggested by acritarchs in Tambo BMR No.34. Scattered cross-bedding measurements, in the east, suggest that the sands of the Rewan Formation were deposited by streams flowing to the north-west.

PLATE 2

(a)

(b) Oscillation ripple marks in a thin siltstone bed in the lower part of the Rewan Formation. (Tambo Sheet area, grid reference 46600035).

The estimated thickness of the Rewan Formation is 400 feet south-east of the Birkhead Anticline, and 200 feet north-west of the anticline (where only the lower part of the Rewan Formation is present); it is 1600 feet thick in the type section, and about 400 feet thick near Mantuan Downs Homestead on the Springsure Shelf (Mollan, Exon and Kirkegaard, in press).

Fossil wood is found low in the sequence; no other macrofossils were seen. In Tambo BMR No.34, spores of Triassic division $\overline{\mathrm{R}}$2a (see Appendix 2) were found in cuttings, from the interval 70 to 80 feet; a few acritarchs were also present. This horizon is equivalent to the acritarch-rich $\overline{\mathrm{R}}$2a assemblage in core 1 (1212 feet) in Alliance Jericho No. 1 well (Evans, pers. comm.), which is fifty miles to the west. The Rewan Formation is of Triassic age; the lowermost Triassic may be absent in this area.

Dunda Beds

The name Dunda Beds was proposed by Vine, Jauncey, Casey and Galloway (1965), for "a dominantly sandstone sequence, which rests conformably on the Rewan Formation on the north-eastern margin of the Eromanga Basin, and is probably a facies variant of the upper part of the Rewan Formation in the Denison Trough". The name is derived from Dunda Creek, a tributary of the Belyando River.

The type section is in an unnamed tributary of Dunda Creek in the Galilee Sheet area, latitutde $22^{\circ}27'$S, longitude $146^{\circ}19'$E. The rock types in the type section are quartzose to sublabile sandstones. The unit generally, was described by Vine et al., as consisting of "lithic to quartzose sandstone, with subordinate thick intervals of mudstone and siltstone".

The unit crops out in the Buchanan, Galilee, Jericho and Tambo Sheet areas. In the Tambo Sheet area it occupies a meridional belt west of Durrandella Homestead, north of the Birkhead Anticline. The unit forms very gently dipping cuestas, and is lightly timbered.

The dominant rock type is very fine to medium-grained, brown and yellowish-brown, clayey labile to quartzose <u>sandstone</u>; there is also some <u>siltstone</u>. The <u>sandstone</u> is largely medium to very thick-bedded, and strongly scour and planar cross-bedded. Near the top of the unit, west of Durrandella Homestead, there is perhaps 50 feet of fine to medium-grained, buff micaceous sublabile sandstone, which has thin to medium, well-developed bedding, and some low-angle cross-bedding. A thin section of a thinly bedded lithic sandstone from this sequence, contains 55 percent subangular quartz, 2 percent mudstone fragments, 5 percent muscovite, 2 percent feldspar and

10 percent interstitial iron oxide. In general, the exposed sandstone of the Dunda Beds is weathered and in some places iron stained; it contains considerable quartz, clayey rock fragments and feldspar, and some black rock fragments and muscovite. White or yellow clay clasts are very abundant. Siltstone is only rarely seen in outcrop; in Tambo BMR No.36 (Fig. 5) there is 25 feet of grey and reddish-brown, in part carbonaceous and micaceous siltstone, at the top of the unit, below the white unweathered Clematis Sandstone. This may correspond to the thinly bedded sandstone farther north. Below the siltstone in Tambo BMR No.36 is 70 feet of yellowish, ironstained, weathered quartzose sandstone (see Fig. 5); the sediments of the unit were weathered before deep burial.

Two thin sections of typical sandstones from the Dunda Beds were examined. These are fine to medium grained lithic sandstones, and consist essentially of subangular quartz and quartz aggregates (40 and 45 percent), feldspar (15 and 5 percent), fine-grained acid volcanics (20 and 25 percent), and shale and siltstone fragments (5 and 10 percent), set in a clay matrix (10 and 20 percent). Minor constituents are biotite and iron oxide (both as rounded grains and interstitial masses).

The Dunda Beds is a fluviatile sequence, with possible lacustrine intervals, derived from a quartz-poor source. Cross-bedding directions vary widely, and more readings would be needed to confidently infer the dominant stream flow direction. North of this Sheet area (Vine et al., op. cit.), the sediment is derived mainly from the east-possibly from the volcanics and sediments of the Drummond Basin sequence. The same probably applies here, as the sediments are very similar.

The Dunda Beds were probably uplifted, deeply weathered, and eroded to some extent, before deposition of the overlying Clematis Sandstone.

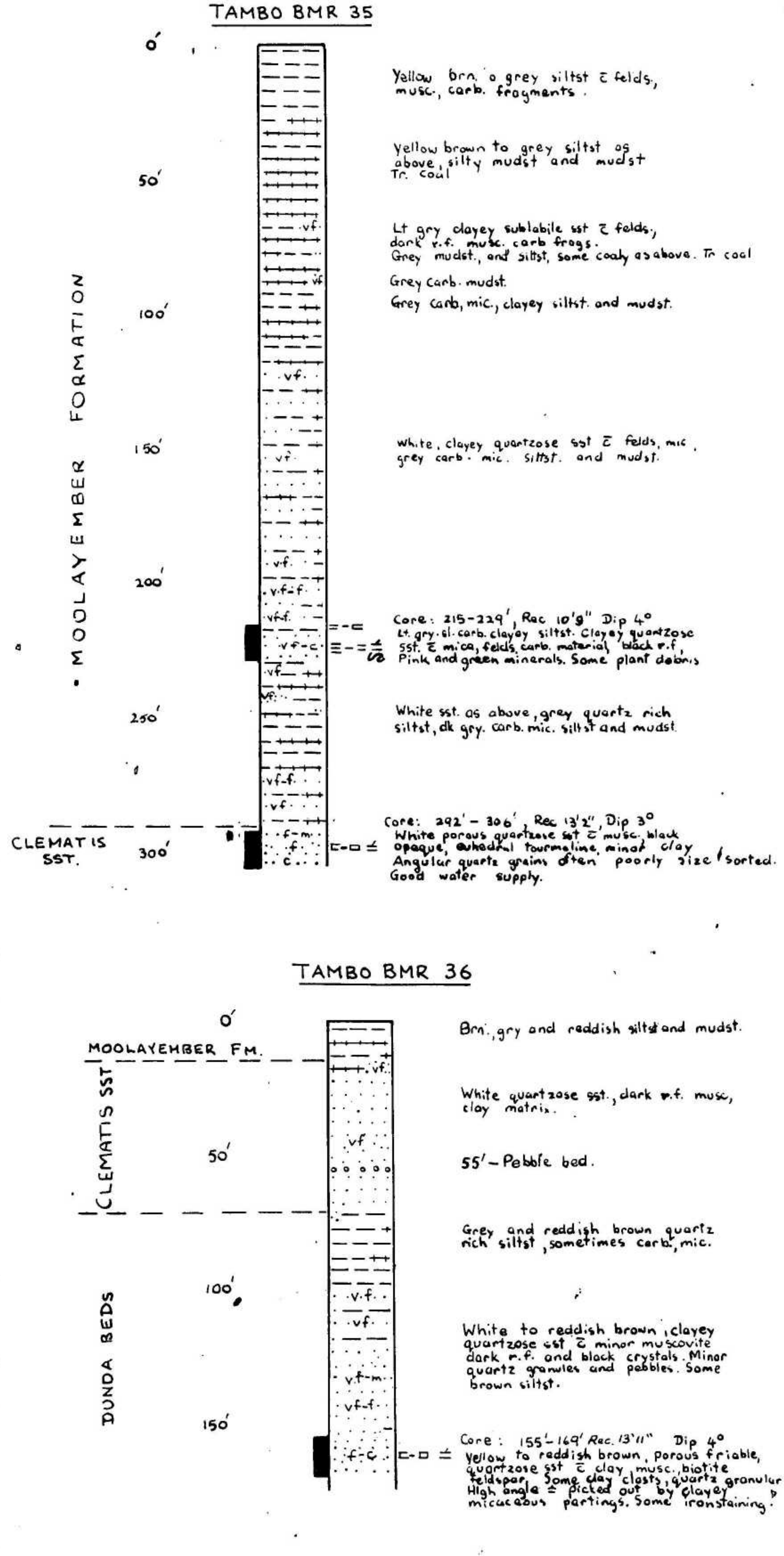
In this area the thickness is a maximum in the north - probably of the order of 200 feet. The unit thins to about 100 feet in the axial region of the Birkhead Anticline. This compares with an estimated 200 to 300 feet in the northern part of the Jericho Sheet area (Vine et al.).

No fossils were collected in the unit. Vine et al. found a suite of plants, which White (1965) identified as of Triassic to Lower Jurassic age. By correlation with the upper part of the Rewan Formation, and because it is overlain by the Middle Triassic Clematis Sandstone, the Dunda Beds is Lower Triassic in age.

Relationship to the Rewan Formation

The Dunda Beds is a facies equivalent of the upper part of the Rewan Formation, and overlies the lower part of the Rewan Formation with regional

Fig. 5



SHALLOW DRILL HOLE LOGS BMR 35 & 36

MOOLAYEMBER FORMATION,

CLEMATIS SANDSTONE,

DUNDA BEDS.

conformity (see Rewan Formation). In thin section and hand specimen, the sandstone of the Dunda Beds is more quartzose, more feldspathic, and contains less sedimentary and volcanic rock fragments, than the sandstone of the Rewan Formation. In the field, it is characteristically yellowish, compared to the greenish or brown Rewan sandstone, and overall, is thicker bedded and more strongly cross-bedded. On the Alpha/Tambo road 7 miles south of Alpha Homestead (4606, 9878) the contact between the basal Dunda Beds and the Rewan Formation is visible. Here, four feet of red and green mudstone is overlain by six inches of ferruginized micaceous siltstone; above this sequence is the fine to coarse, thickly-bedded, cross-bedded clayey labile sandstone of the Dunda Beds. The contact is strongly scoured and the basal sandstone contains large greenish clay clasts, probably derived from the underlying sequence. Thus the contact is, locally at least, disconformable.

Clematis Sandstone

The Clematis Sandstone was named, and the name published, by Jensen (1926a); the name is derived from Clematis Creek, which crosses the boundary between the Baralaba and Taroom Sheet areas. Synonyms of Clematis Sandstone are the "Carnarvon Red Member" of Reid (1930), the "Carnarvon Sandstone" of Reeves (1947), and the "Carnarvon Series" of Shell (SQD, 1952). The type section of the formation is in the headwaters of Clematis Creek in the Baralaba Sheet area (Olgers, Webb, Smit and Coxhead, 1964).

The Clematis Sandstone crops out in much of the southern part of the Bowen Basin. In the north-eastern part of the Tambo Sheet area, it occupies a sinuous north-west trending belt, of densely timbered low ridges and dip slopes, which are separated by low, sandy, lightly timbered areas. In the east, where dips are extremely low, flat, lightly timbered sandy benches are developed.

The dominant rock types are white to buff, very fine to coarse-grained, thinly to very thickly bedded, cross-bedded quartzose to sublabile sandstone and fine conglomerate. The sandstone may be micaceous, feldspathic, lithic or clayey and is strongly cross-bedded. Some ripple marks and clay clasts were found. Quartz pebble beds and conglomerate are fairly common. At some levels there are quartz-rich siltstone and mudstone beds. The unit contains thin tough ferruginous bands; one thicker band contains concretions up to 12 inches across. The unit is an aquifer of moderate importance.

Thin sections of two white fine-grained clayey sandstones, from the north of the area, were examined. They contain 55 and 35 percent quartz, 25 and 20 percent siltstone and mudstone clasts, 20 and 35 percent clay matrix, and minor muscovite and biotite. One contains minor limonite, feldspar and tourmaline.

Two shallow drill holes (Fig. 5) provide sections of this unit. Tambo BMR No.35, 2 miles north of Skye Homestead, intersects the sharp contact between the overlying thinly bedded grey siltstone and fine clayey sandstone of the Moolayember Formation and the coarse grained, thickly bedded, white quartzose sandstone of the Clematis Sandstone. Tambo BMR No.36 penetrates 55 feet of uniform fine-grained quartzose sandstone of the Clematis Sandstone, overlying the uppermost siltstone of the Dunda Beds, and underlying 15 feet of siltstone of the Moolayember Formation.

The Clematis Sandstone overlies the Dunda Beds in the north, and the Rewan Formation in the south, with apparent conformity in the outcrop area. In the subsurface (see Plate 5), the Clematis Sandstone is shown to be unconformable with the underlying units, and overlaps progressively older units westwards. There is a sharp change from the yellow, brown or greenish labile and sublabile sandstone of the underlying units, to the clean white quartzose sandstone of the Clematis Sandstone. Near Merrijig Creek, the base of the Clematis Sandstone consists of a 4 inch thick kaolinitic clay bed. The deep weathering of the Dunda Beds, in particular, suggests that there was a period of non-deposition before the incoming of the Clematis sandstones.

The Clematis Sandstone is a fluviatile deposit, derived from a quartz-rich source - probably a pre-existing sandstone. The cross-bedding dips in many different directions north of the Birkhead Anticline, implying current flow to the west, north and east. In the south of the area, cross-bedding directions are quite consistent, generally being to the north-west.

The thickness of the unit, computed from dip information, is generally about 350 feet in outcrop. It thins drastically over the Birkhead Anticline; only 55 feet is present in Tambo BMR 36. In the subsurface, it thins gradually westwards across the Tambo Sheet area. These thicknesses compare with estimated thicknesses of 500 feet in Reid's Dome, 200 feet on the Springsure Shelf (Mollan, Exon and Kirkegaard, in press), and 350 feet in the southern part of the Jericho Sheet area (Vine, Jauncey, Casey and Galloway, 1965).

No fossils were found in this area. Plants collected elsewhere (Mollan et al.; Vine et al.) have a Triassic to Lower Jurassic age. Spores indicate a probable Middle Triassic age for the unit (Evans, pers. comm.).

Moolayember Formation

The term "Moolayember Shale" was published by Reeves (1947), and the unit was subsequently referred to as Moolayember Formation (Phillips, in Hill and Denmead, 1960).

The type section is near the Carnarvon Highway, in the valley of Bullaroo Creek, a tributary of Moolayember Creek, in the Taroom Sheet area (Mollan, Forbes, Jensen, Exon and Gregory, in prep). In the type section, where the unit is 1000 feet thick, the predominant exposed rock type is thinly to thickly bedded, sublabile sandstone which is, in part, calcareous. Mudstone and siltstone are rarely exposed but they probably predominate in the unexposed parts of this section.

The formation crops out in much of the southern part of the Bowen Basin. In the Tambo Sheet area, it crops out in a north-west trending belt some ten miles wide, north of the scarp of the Precipice Sandstone. Relief is low and outcrop poor; there is sparse brigalow-wilga vegetation. Soil cover is especially extensive in the north. A few quartzose sandstone beds form low cuestas, but bedding trends are usually not discernible on the air photos.

Siltstone and sandstone are the dominant outcropping lithologies. The siltstone is generally poorly exposed and khaki-brown or buff. In fresh exposures, such as on the slopes of hills below Tertiary sediments or the Precipice Sandstone, it is, in general, green or grey. Purple siltstone, weathering to ash-grey, is more abundant in the upper part of the section. The siltstone is laminated to medium bedded, and may be cross-bedded or ripple marked. It varies from quartz-rich to labile, and mica, carbonaceous material, and plant fragments are common constituents.

Commonly the sandstone is brown to greenish, fine to medium-grained, lithic sublabile to lithic, and may contain abundant feldspar. In many places it is calcareous or argillaceous and may contain muscovite, biotite and, sometimes, clay clasts. It is medium to thick bedded and often cross-bedded. Concretions, lenses and beds of tough brown, grey or green when fresh, calcareous, in places carbonaceous sandstone grading to sandy limestone, are present; some thin beds of fine-grained tough grey limestone are also present. Resistant beds of buff, very fine-grained quartzose to sublabile sandstone occur throughout the unit, particularly in the north-west. These are thin to medium-bedded, and are rarely ripple marked. Poorly preserved plant remains are widespread.

Green, grey or purple mudstone crops out in a few places, and red claystone was seen at one locality.

Two miles east of Marston Homestead, there is a particularly good outcrop, in which about 150 feet of dominantly fine-grained sediment, is exposed beneath Tertiary sandstone. Here, green, grey and purple mudstone predominate; buff, ripple-marked, thin to medium-bedded, cross-bedded siltstone and very fine-grained sandstone is abundant; grey to green, medium-grained, medium-bedded, lithic sandstone, with black and green rock fragments and some feldspar, contains some large calcareous lenses.

A thin section of a greenish grey cross-bedded, medium to thickly bedded medium-grained, calcareous lithic sandstone, shows it to contain 50 percent calcite, 15 percent quartz and quartzite, 30 percent shaleyclasts and a little feldspar, magnetite and mica. A thin section of a buff, thinly to thickly bedded, fine-grained lithic sublabile sandstone, from the base of the unit, contains 50 percent quartz, 15 percent shaly fragments, 15 percent carbonaceous material, 7 percent muscovite, 5 percent feldspar, and 10 percent matrix.

One shallow drill hole, Tambo BMR No.35 (Fig. 5) intersects the lower part of the unit - a monotonous sequence of siltstone, mudstone and fine quartzose sandstone, with traces of coal. The contact with the underlying fine to coarse-grained, white, water-bearing quartzose sandstone of the Clematis Sandstone, is very sharp in this hole.

The Moolayember Formation conformably overlies the Clematis Sandstone, and the contact is transitional in places. On the crest of the Birkhead Anticline, near Tambo BMR No.36, this is particularly well illustrated. The clean, white, fine-grained, thin to medium-bedded, quartzose Clematis Sandstone is overlain by a sequence consisting of similar sandstone interbedded with very clayey siltstone, and labile carbonaceous micaceous siltstone containing varicoloured particles and strap-like leaves of <u>Calamites</u>. The low-angle crossbeds, ripple marks, and generally fine grainsize suggest deposition in a shallow freshwater basin - probably in a chain of lakes and swamps which varied in shape, size and depth, from time to time. Periods of desiccation are indicated by clay clasts in sandstone and siltstone beds, and high-angle crossbeds indicate periods of fluviatile deposition in some areas. At one locality, in a fine-grained sandstone, the current direction suggested by symmetrical ripple marks, is at right angles to that indicated by high-angle crossbeds. It is believed that this was caused by secondary reworking of the surface of the sand, probably by wave action, in very shallow water, after deposition. A few cross-bedding direction readings suggest deposition by south and south-west flowing currents, south of the Birkhead Anticline. Derivation was largely from pre-existing sediments. The sediments were uplifted, warped, weathered, and partially eroded, before deposition of the Precipice Sandstone Pre-Jurassic weathering may account for the leached labile sandstone, and pink and ash-grey siltstone, seen at the top of the unit in places.

In the east of the area, the unit is more than 1000 feet thick; soil cover makes it impossible to estimate the thickness in the north-west. Erosion, before deposition of the Precipice Sandstone, has made the thickness very variable; the formation is not present to the west in Amoseas Boree No.1 well (see Plate 5). The thickness is 1000 feet in the type section (Mollan et al., op. cit.) and less than 1000 feet in the Jericho Sheet area (Vine, Jauncey, Casey and Galloway, 1965).

Some poorly preserved plant remains were seen in this area, but none were positively identified. Just east of the Tambo Sheet boundary, plant fossils ranging from Upper Triassic to Lower Jurassic in age were found. Spores from the unit belong to Evans' palynological division TR3, of Middle to Upper Triassic age (Evans, pers.comm.), and this is the age of the unit as a whole.

LOWER JURASSIC

In the Tambo Sheet area the Lower Jurassic sequence consists of three conformable sandstone units - the Precipice Sandstone, the Boxvale Sandstone Member of the Evergreen Formation, and the Hutton Sandstone - which form a north-west trending belt.

The quartzose sediments of the Precipice Sandstone and the Boxvale Sandstone are almost identical. Both units consist of a lower thickly bedded, cross-bedded, fine to coarse-grained sandstone sequence, and an upper thinly bedded, well bedded, fine-grained sandstone and siltstone sequence. The two units together form the prominent, north-west trending, Great Dividing Range, with a relief of around 500 feet, and cliffs on the north-east side. Both thin to the north-west, and pinch out in the north. The lower part of each unit forms a scarp, and the upper part generally a slope.

The two major benches, one in each unit, were traced across the area, in the airphotos, from the Springsure and Eddystone Sheet areas, where the two units are clearly defined. Various measured sections (Plate 6), which show the two-fold division of both units, add control for this extrapolation. The identification of these units was confirmed by spores from drill hole BMR Tambo No.1, in the middle of the outcrop area. Core 1 (at 87'2"), in the upper part of the Boxvale Sandstone as mapped, contains spores of Evans' division J2, which are not found far below the base of the Boxvale Sandstone in the Surat Basin. Core 3 (at 210'), in the upper part of the Precipice Sandstone, contains spores of division J1, which are found in the Precipice Sandstone, and the lower part of the Evergreen Formation, in the Surat Basin. It is not known whether there is a break in deposition between the two units, which might correspond to the lower part of the Evergreen Formation.

The Hutton Sandstone is largely composed of thickly bedded, poorly bedded, sublabile sandstone, with siltstone quite abundant towards the top. This formation is easily weathered, and poorly outcropping.

In the subsurface, in the Eromanga Basin, these three units are seldom distinguishable, one from another, and are generally referred to as "Hutton-Precipice Equivalent".

Precipice Sandstone

The name Precipice Sandstone was first used by Whitehouse (1952, p.90) for the basal formation of his "Bundamba Series". Later (Whitehouse, 1954), he stated "the type area may be taken to be the sandstone cliffs in the gorge of Precipice Creek, a tributary of the Dawson River".

The type section (Mollan, Forbes, Jensen, Exon and Gregory, in prep.), was measured in a tributary of the Dawson River, two miles east-south-east of Fairview Homestead, in the Taroom Sheet area; it is 75 feet thick and consists essentially of fine to coarse-grained quartzose sandstone, with some pebble beds.

The Precipice Sandstone crops out extensively in the Surat Basin. In the eastern half of the Tambo Sheet area, it is a cliff-forming unit, and generally forms the lower of two major cuesta scarps in the Great Dividing Range; the cuestas dip to the south-west. It is covered with sandy soil, which supports open eucalypt forest and poor grass.

The unit consists of quartzose sandstone and siltstone. The sediments in various measured sections are described in Plate 6. In general, the formation can be divided into a lower sandy, scarp-forming part, and an upper silty part which forms a slope below the scarp of the Boxvale Sandstone. In the extreme north the upper part forms a more conspicuous scarp than the lower part.

The lower part consists almost entirely of sandstone, with very minor siltstone. The sandstone is white, quartzose, and often clayey; minor constituents are feldspar, muscovite and dark rock fragments. It is generally medium to very thickly bedded, is strongly scour and planar cross-bedded, and frequently contains clay clasts. It varies from fine to very coarse-grained, and quartz granules are abundant in some beds. Some sandstone beds contain angular to rounded resistant pebbles of quartz, quartzite, rhyolite and indurated siltstone, and fewer unresistant siltstone and claystone pebbles.

The upper part consists, essentially, of very fine to fine-grained quartzose sandstone and siltstone. The sandstone varies from very clean to clayey. These sediments are laminated to medium-bedded, commonly ripple marked, and occasionally contain low-angle cross-bedding. The siltstone is generally weathered white. Some beds of fine to coarse, strongly cross-bedded, thickly bedded quartzose sandstone, identical to those of the lower part of the formation, are also present in the upper part.

The Precipice Sandstone unconformably overlies the Moolayember Formation. Folding which has imposed dips up to 15° on the Moolayember Formation, north of Brumby Creek, is not reflected in the Precipice Sandstone. The contact is generally obscured by scree on Cainozoic sediments. In Section S8 (Plate 6), the change from the weathered and leached siltstone and mudstone of the uppermost Moolayember Formation, to the clean white sandstone of the Precipice Sandstone, is shown to be very sharp. It is obvious that there was uplift, weathering and erosion of the older sediments before deposition of the Precipice Sandstone.

The north-east trending Birkhead Anticline was a topographically (as well as structurally) high area, during deposition of the Precipice and Boxvale Sandstones. South-east of the anticline, both units were largely deposited by streams which flowed south-east down its flanks. Towards the close of Precipice times, lacustrine conditions became widespread. The sands deposited were thicker and coarser in the low area to the south-east of the anticline. North-west of the anticline there were some sediments deposited at this time, but these did not extend far from the anticline. Cross-bedding directions in this north-western area are very variable. The Precipice Sandstone was derived from the pre-existing sedimentary rocks, including the Moolayember Formation.

The unit thins to the north-west (see Plate 6), and apparently pinches out near Burnt Yard Creek, in the extreme north of the area. In Planet Warrong No.1, in the central north of the Eddystone Sheet area there is 500 feet of Precipice Sandstone (Mollan et al., op. cit.); approximately seventy miles to the west-north-west (Section S9), it is 400 feet thick; near the Birkhead Anticline (Section S7) it is 150 feet thick. The lower part is much thicker than the upper in the south-east but, in the north-west, they are approximately the same thickness.

Plant remains were not sufficiently well-preserved for identification. Core 3 (at 210 feet), in BMR Tambo No.2 yielded spores of Evans' division J1 (see Appendix 2), of Lower Jurassic age (Evans, in prep., a). The unit is Lower Jurassic.

Boxvale Sandstone Member of the Evergreen Formation

The name Boxvale Sandstone (from Boxvale Station) was first used by Reeves (1947), for a member of the "Bundamba Series" in the Roma district. It is regarded by Mollan, Forbes, Jensen, Exon and Gregory (in prep.), as a member of the Evergreen Formation.

The type section (Mollan et al., op.cit.) was measured in a tributary of the Dawson River, two miles east-south-east of Fairview Homestead, in the Taroom Sheet area; it is 65 feet thick and consists, essentially, of fine-grained quartzose sandstone.

The Boxvale Sandstone crops out in the Taroom, Eddystone, Springsure and Tambo Sheet areas. In the eastern part of the Tambo Sheet area it is a cliff-forming unit, and forms the upper of two major cuesta scarps in the Great Dividing Range; the cuestas dip to the south-west. The unit has a sandy soil cover, which supports open eucalypt forest and poor grass.

The member consists of quartzose <u>sandstone</u> and <u>siltstone</u>. The sediments cropping out in measured sections, are described in Plate 6. The member can be divided into a lower sandy part and an upper silty part, the lower one usually being slightly thicker.

The <u>lower part</u> consists of white, fine to coarse-grained, quartzose sandstone, which is usually very clean and friable. It generally forms a steep scarp. The sandstone contains some feldspar, muscovite and dark rock fragments and, in places, granules and pebbles. The pebbles are generally quartz, quartzite and less abundant chert and siltstone. The sandstone is generally medium to thickly bedded, strongly scour and planar cross-bedded, and in places contains clay clasts. Wood impressions and remains, and some plant roots, were seen in places.

The <u>upper part</u> consists of very fine to fine-grained, buff and white quartzose sandstone grading into siltstone. It generally forms a slope but in the north forms a scarp. It is thinly to thickly bedded and generally better bedded than the lower part. Cross-bedding is generally low-angled. The sandstone is lithologically similar to that of the lower part. The siltstone is purplish-grey or grey when fresh, but weathers to white. In BMR Tambo No.2, there is some black carbonaceous mudstone. These sediments are frequently ripple-marked and, in places, contain abundant worm casts and plant impressions. The siltstone is very carbonaceous in some outcrops, with abundant plant remains.

In the type area, the Evergreen Formation consists of a lower shaly part overlain by the Boxvale Sandstone Member which is, in turn, overlain by the Westgrove Ironstone Member. Immediately west of the Maranoa Anticline, in the Eddystone Sheet area, the shaly part of the Evergreen Formation pinches out (Mollan, Forbes, Jensen, Exon and Gregory, in prep.). The Westgrove Ironstone Member persists westwards to within 20 miles of the Tambo Sheet, on the Springsure Sheet (Mollan, Exon and Kirkegaard, in press), where it also pinches out. Thus, in this area, the Evergreen Formation is entirely represented by the Boxvale Sandstone.

The Boxvale Sandstone conformably overlies the Precipice Sandstone; it is not known whether there is a depositional break between the two units. The basal Boxvale Sandstone is generally much coarser than the thinly bedded upper part of the Precipice Sandstone. On the Tambo/Springsure road, it is ironstained, and the scarp of the Boxvale Sandstone is much browner than the immediately underlying scarp of the Precipice Sandstone (Section S9).

The depositional history of the Boxvale Sandstone is identical to that of the Precipice Sandstone (see Precipice Sandstone). The lower part was deposited by south-east flowing streams; the upper part was largely deposited in lakes.

The member thins to the north-west, from about 250 feet in the south-east (Section S9), to about 150 feet near the Birkhead Anticline (BMR Tambo No.2); it pinches out eight miles south of Frost Creek in the north of the area. It is about 250 feet thick in the central northern part of Eddystone Sheet area (Mollan, et al., in prep.).

Plant remains are common, but none have been identified. Spores from Core 1 (87'2") in BMR Tambo No.2, near the top of the member, belong to Evans' spore division J2 (see Appendix 2) of Lower Jurassic age (Evans, in prep., a). The member is Lower Jurassic.

Hutton Sandstone

The name Hutton Sandstone was first used by Reeves (1947, p.1346), for the top member of the "Bundamba Series".

He stated that "the Hutton Sandstone forms the sandy soils that cover extensive areas on Westgrove Station" (25 miles north-west of Injune, in the Eddystone Sheet). Due to lack of outcrop near Westgrove Station, the type section (Mollan, Forbes, Jensen, Exon and Gregory, in prep.) was measured near Hutton Creek, twelve miles east-north-east of Injune, in the Taroom Sheet area; it consists of 400 feet of fine to medium-grained, thickly bedded, cross-bedded, quartzose

PLATE 1

Large white claystone clasts in pebbly quartzose sandstone of the Hutton Sandstone (Tambo Sheet area grid reference 443,965).

to sublabile sandstone.

The Hutton Sandstone occurs in the Taroom, Eddystone, Springsure and Tambo Sheet areas. In the eastern half of the Tambo Sheet area, the poorly outcropping Hutton Sandstone forms a north-west trending belt of sandy low relief country, about 5 miles wide, on the western slopes of the Great Dividing Range. The sandy soil supports grass and some open forest.

The Hutton Sandstone is dominantly <u>sandstone</u>, with considerable <u>siltstone</u> and <u>mudstone</u> near the top. The <u>sandstone</u> varies from quartzose to labile, but is dominantly sublabile. It becomes more labile upwards. It is white or buff, when not ironstained. Commonly it is clayey, with feldspar and dark rock fragments, and lesser muscovite. Minor accessories are biotite, and an unidentified pink translucent mineral. The grain size is very variable, and gritty beds occur in places; small quartz pebbles are scattered through some beds. The sandstone is generally poorly thickly bedded, and shows highly variable scour and planar cross-bedding; near the top of the unit the bedding is more distinct, and thin bedding is more common. A few calcareous sandstone beds occur high in the unit.

The <u>siltstone</u>, which grades to <u>mudstone</u>, is grey to purplish, and commonly contains abundant carbonaceous material. It is normally laminated to thinly bedded. Claystone stringers occur at some levels. Two miles east-north-east of Shady Downs Homestead (see photograph, Plate 1), fine to coarse-grained quartzose sandstone overlies a white silty claystone bed. One pebbly bed contains two very large claystone fragments derived from the underlying claystone bed. This indicates contemporaneous erosion.

Beds with abundant worm casts, clay clasts, wood impressions and fragments, and carbonaceous leaf and root remains, in various combinations, are more common in the upper part of the Hutton Sandstone. These occur largely in siltstone beds, but wood and clay clasts are common in sandstone throughout the formation. Botryoidal bog iron oxides, and minor bog manganese oxides, are confined to the upper part of the unit, as are minor coaly and calcareous beds. The formation is a good aquifer, and is extensively used as such, in the Great Artesian Basin.

Secondary ferruginization of sandstone, and siltstone, is common in the formation, and ironstone concretions are found in places.

The Hutton Sandstone overlies the Boxvale Sandstone with apparent conformity, south-east of the Birkhead Anticline. However, north-west of the anticline, it overlaps first the Boxvale Sandstone, and then the Precipice Sandstone; in the extreme north it rests on the Upper Triassic Moolayember

Formation.

The contact between the silty upper part of the Boxvale Sandstone, and the coarser Hutton Sandstone, south-east of the Birkhead Anticline, is scoured. There may be a significant depositional break between the two units. A good exposure of the contact is near BMR Tambo No.2, beside the Alpha/Tambo road. Here, the upper Boxvale Sandstone is largely laminated to thinly bedded, ripple marked, white siltstone with some low-angle cross-bedding; it also contains some thicker bedded quartzose sandstone. The overlying fine to medium-grained, quartzose Hutton Sandstone is poorly thickly bedded, and contains high-angle cross-bedding. It is clayey and contains feldspar, rock fragments, muscovite, and siltstone clasts. The contact is irregular, and locally unconformable. Immediately above the contact there are granules and small pebbles of quartz, quartzite and chert, and some siliceous wood, in the sandstone; siltstone clasts are very abundant in the basal beds.

The contact with the overlying Birkhead Formation is transitional. There are labile sandstones, siltstones and mudstones both above and below the contact. The lowermost thick calcareous sandstone bed is taken as the base of the Birkhead Formation; this normally corresponds to the edge of the black soil country, which was used as a marker in some areas.

During deposition of the Hutton Sandstone, conditions changed gradually from fluviatile to lacustrine. There was a corresponding change in source material, and the sands became more labile with time. Towards the close of Hutton times, very quiet lacustrine conditions allowed bog iron oxides, and minor amounts of manganese oxides, to accumulate. Cross-bedding readings are very variable, suggesting that fluviatile deposition was on flat plains from meandering streams.

The Hutton Sandstone probably thins to the north-west, from about 500 feet to about 400 feet. These thickness estimates have little control, as outcrop is so poor, and dips could not be measured. However, a thickness comparable with the 450 to 500 feet, estimated in the central north of the Eddystone Sheet area (Mollan et al., op.cit.), seems reasonable.

Only plant remains were found in this area, and none of these were identified. Palynological evidence (de Jersey and Paten, 1964) indicates that the formation is largely of Lower Jurassic age, but probably extends into the Middle Jurassic. It is underlain by Lower Jurassic, and overlain by Middle Jurassic, sediments.

POST LOWER JURASSIC

The post Lower Jurassic sequence in this area commences with the Middle Jurassic Birkhead Formation, which consists essentially of about 500 feet of labile sandstone, siltstone and mudstone, and transitionally overlies the Hutton Sandstone. This lacustrine sequence is overlain, with regional conformity, by about 200 feet of fluviatile, sublabile to labile sandstone of the Adori Sandstone which, in turn, is conformably overlain by the 350 feet thick Upper Jurassic Westbourne Formation. The Westbourne Formation consists of very fine grained quartzose sandstone, siltstone and shale, deposited in a fluviatile environment. These three formations together make up the Injune Creek Group.

The overlying unit is the "Hooray Sandstone",* which consists of a lower, thinly bedded, fine-grained sandstone part, deposited conformably on the Westbourne Formation in quiet conditions, and an upper, coarse-grained to conglomeratic fluviatile part, which strongly scours the lower part. The thicknesses of the unit and of the two parts vary greatly. It's age ranges from Upper Jurassic to Lower Cretaceous.

Definitions and descriptions of the various units, and a table showing the correlation, were presented in a paper by Exon (1966). The paper "presents new data relating to the Jurassic/Cretaceous sequence in parts of the Eromanga and Surat Basins, revises existing stratigraphic nomenclature, and correlates the stratigraphy of the two basins". Definitions and descriptions of the two new stratigraphic names, Birkhead Formation and Westbourne Formation, and the two previously published names, Adori Sandstone and "Hooray Sandstone" (Hill and Denmead, 1960) were presented.

The subdivisions of the sequence in the Tambo area are essentially those of Woolley (1941a). In unpublished completion reports on Westbourne No.1 and Boree No.1 wells, American Overseas Petroleum Limited (Gerrard, 1964a,b) used Woolley's nomenclature as modified by Hill and Denmead (1960), and suggested the formal name Westbourne Formation for Woolley's "Upper Intermediate Series", in the belief that this unit was the lateral equivalent of the Orallo Formation (Day, 1964) of the Roma area. Subsequently, in correspondence with the Bureau of Mineral Resources, Amoseas suggested that the Westbourne Formation was stratigraphically below the Gubberamunda Sandstone in the Roma area, on the basis of gamma ray logging. They requested

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* The "Hooray Sandstone" is probably not a valid formation, and hence the name appears within inverted commas.

a palynological investigation, which supported their views.

Mapping by joint Bureau of Mineral Resources - Geological Survey of Queensland field parties, aided by shallow stratigraphic drilling, confirmed and expanded this correlation. The stratigraphic succession, correlation of Surat and Eromanga Basin stratigraphy, and a comparison of new and old stratigraphic nomenclature are set out in Table 3 (after Table 1 in Exon, 1966).

The mapping and correlation led to better understanding of the importance of the northerly trending Nebine Ridge, which separates the Eromanga and Surat Basins, in the history of the areas flanking the ridge. West of the ridge, which is expressed at the surface by the Maranoa Anticline (some 25 miles east of this area), arenites greatly predominate, and the upper part of the sequence is much thinner than in the Surat Basin.

The Birkhead and Westbourne Formations are traceable well into the Surat Basin; together they make up the "Injune Creek Beds" near Injune. Accordingly the "Injune Creek Beds" were raised to group status as the Injune Creek Group (Exon, 1966). The group continues into the Eromanga Basin, where the Adori Sandstone separates the Birkhead and Westbourne Formations.

Injune Creek Group

The term, "Injune Creek Coal Beds" was first used by Jensen (1921) for sediments of Jurassic age in the Roma-Injune area. The unit was included in the "Lower Walloon", Walloon apparently being used by Jensen as a time equivalent for the Jurassic 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" Walloons. Reeves (1947) used "Lower Walloon Series" for the 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. (A full discussion of the history of the "Injune Creek Beds" is given in Mollan, Forbes, Jensen, Exon and Gregory (in prep.)).

Woolley (1941a) mapped an area north-east of Tambo and divided the Middle and Upper Jurassic sequence as below:-

Hooray Sandstone
"Upper Intermediate Series"
Adori Sandstone
"Lower Intermediate Series"

Surface mapping of the Tambo and Augathella Sheet areas and the

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

RECENT USAGE EROMANGA BASIN e.g. L.O.L. Saltern Creek No. 1 Mott & Associates (1964)	WOOLLEY (1941) EROMANGA BASIN	NEW NOMENCLATURE AND CORRELATION: EROMANGA BASIN (Tambo area)	NEW NOMENCLATURE AND CORRELATION: SURAT BASIN (Roma area)		RECENT USAGE SURAT BASIN e.g. A.A.O. Blyth Creek No.1 (Minad, 1964)	
Transition Beds	Hooray Sandstone	"Hooray Sandstone"	Blythesdale Formation*		Transition Member Mooga Member	Blythesdale Formation
			Orallo Formation*		Fossil Wood Member	
Mooga Sandstone			Gubberamunda Sandstone*		Gubberamunda Member	
Fossil Wood Beds	Upper Intermediate Series	Westbourne Formation+	Westbourne Formation	Injune Creek Group	Injune Creek Beds	
Gubberamunda Sandstone	Adori Sandstone	Adori Sandstone	Springbok Sst. Lens			
Walloon Coal Measures	Lower Intermediate Series	Birkhead Formation	Birkhead Formation			
Hutton Sandstone		Hutton Sandstone	Hutton Sandstone		Hutton Sandstone	

* After Day (1964)
\+ After Gerrard (1964b)

Mitchell Sheet area (Exon, Casey and Galloway, 1966), combined with palynological work (Evans, 1966), and gamma ray logging, has proved the correlation shown in Table 3.

In the unpublished completion report of Amoseas Boree No.1, Gerrard (1964b) defined the Westbourne Formation and correlated it with the "Upper Intermediate Series". This name was published by Exon (1966). Exon also proposed a new name, the Birkhead Formation, for the "Lower Intermediate Series", and the Injune Creek Beds were renamed the Injune Creek Group.

Birkhead Formation

The Birkhead Formation is a sequence of brown and grey, fine-grained, calcareous, labile sandstone and siltstone, with a probable maximum thickness of 600 feet in the area mapped. It was defined as a result of the 1965 mapping (Exon, 1966) as a calcareous unit between the non-calcareous Adori and Hutton Sandstones. The unit is the equivalent of the Lower Intermediate Series of Woolley (1941a) and of the lower part of Jensen's Injune Creek Beds (1921). Birkhead Creek, near Birkhead Homestead on the Tambo Sheet area is the origin of the name. The type area is Birkhead Creek where it parallels the Alpha/Tambo road (between Latitude 24°23'E, Longitude 146°22'E, and Latitude 24°33'S, Longitude 146°22'E).

Lack of suitable outcrop prevented a type section being measured in the area; the interval 1880-2244 feet in Amoseas Westbourne No.1 was taken as the type section. This well was drilled 40 miles south-west of the type area. The type section (interpreted as Walloon Formation in the completion report) is a shale and siltstone sequence composed of dark grey and brown shale, calcareous, grey and brown quartzose siltstone and minor coal and fine-grained sandstone. At the surface fine-grained, grey or green, calcareous labile sandstones and siltstones which often crop out as concretions are the dominant lithologies. Some carbonaceous mudstone and coal also occur, but generally the finer lithologies are the more easily weathered and are rarely exposed. Logs of the various oil wells in the area give a more accurate idea of the proportions of the different rock types than can be obtained from surface mapping.

The Birkhead Formation crops out south-eastwards from this area, well into the Surat Basin. It is widespread in the subsurface in the Eromanga and Surat Basins. The formation crops out, in this area, in a north-westerly trending belt about 5 miles wide, from Mount Playfair Homestead in the south-east corner of the Tambo area until it disappears beneath sand cover near Valparaiso Homestead in the north. It forms gently undulating plains with a rather sparse tree cover. Best exposures of the unit occur along the Alpha/Tambo road near Green Hills Homestead; these consist of large calcareous concretions on the surface and some good exposures in road cuttings.

The Birkhead Formation conformably overlies the Hutton Sandstone and is overlain by the Adori Sandstone; the contact with the Adori Sandstone is apparently conformable and shows local scouring. There is a marked contrast between the dark brown, generally calcareous, labile sandstone and siltstone of the Birkhead Formation and the white clayey, sublabile Hutton Sandstone, but the contact itself is transitional (see Hutton Sandstone).

The Birkhead Formation is represented in the following bores, in this area:-

Well	Interval	Thickness
Amoseas Westbourne No.1	1880-2244	364
Amoseas Boree No.1	2149-2454	305
SPL Birkhead No. 1	0-516?	516+
Phillips Carlow No.1	2878-3338	460

In Westbourne No.1 (Gerrard, 1964a) the sequence consists mainly of dark grey and brown fissile shales with minor interbeds of locally calcareous siltstone. Boree No.1 (Gerrard, 1964b) has an interbedded interval of white, quartzose, locally calcareous, granular to fine-grained sandstones, grey and brown calcareous siltstones and rare coal and lignite beds. Spore assemblages for both intervals indicate a Middle Jurassic age. In Westbourne, Boree and Carlow wells, the Birkhead Formation is overlain by the Adori Sandstone and rests on a Lower Jurassic sandstone sequence, which is probably a correlate of the Hutton and Precipice Sandstones.

Lithological descriptions in Birkhead No.1 (SPL 1957) are not very detailed. The subdivisions of this well, shown in Plate 5, were made with the aid of electric logs. The interval to 516 feet of mainly grey silty shale and fine-grained white sandstone is taken to be the Birkhead Formation. It overlies the medium to coarse grained grey sandstone of the Hutton Sandstone.

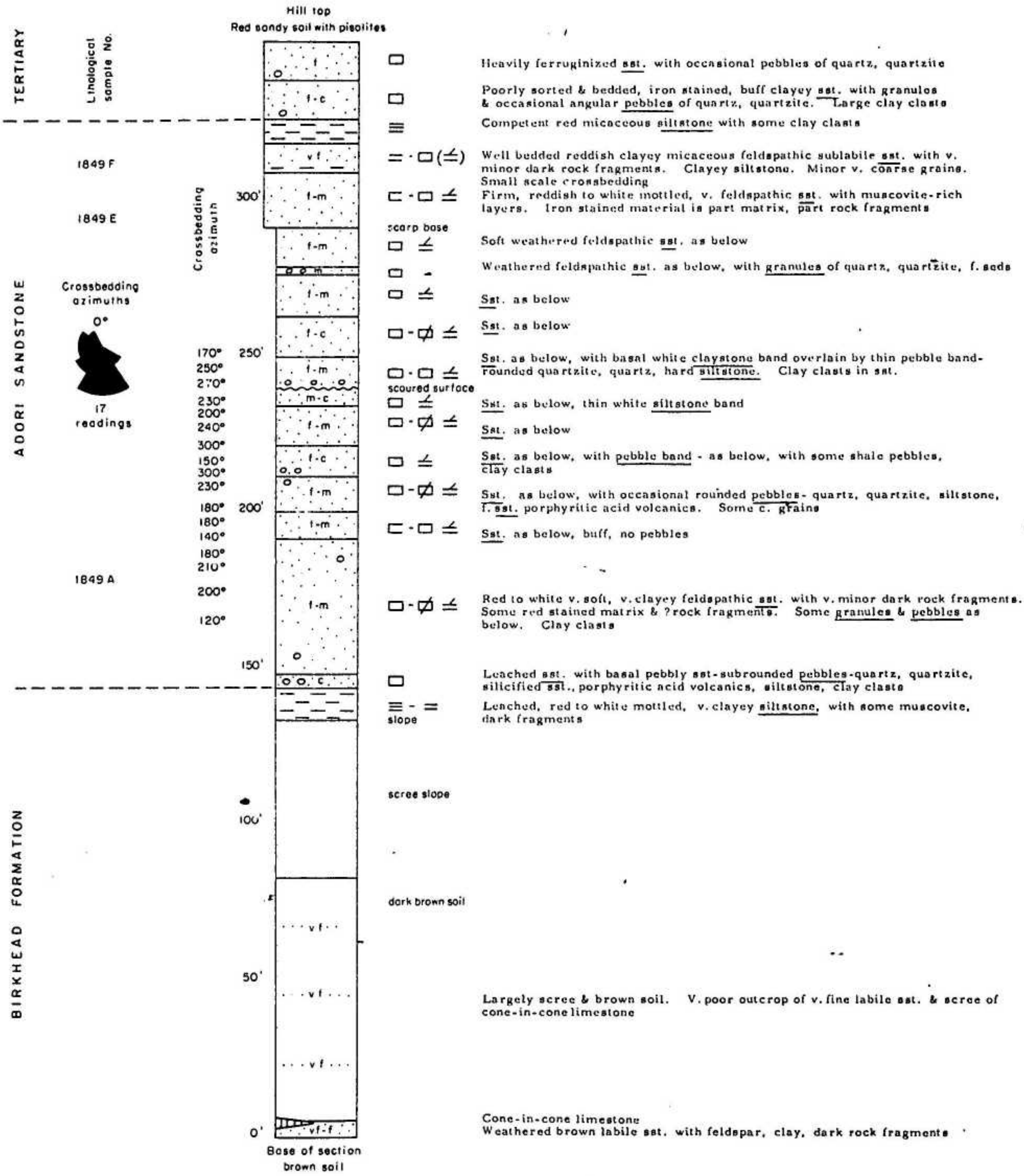
Spores from cuttings at 197, 227, and 520 feet are characteristic of the Hutton Sandstone and the base of the Walloon Coal Measures north of Roma (Evans, 1962). This determination does not conflict with the interpretation proposed above.

A well was drilled, by the Malta Oil Company, 35 miles east of Tambo (latitude 24°55'S, longitude 146°50'E) to a doubtfully authenticated depth of 1,385 feet. A well sited at this point would have penetrated almost the whole of the Adori Sandstone before reaching the Birkhead Formation. However, the sketchy lithologic log available (Geol. Surv. Qld Publ. 299) shows that the well passed through only 22 feet of sandstone and then coaly grey and brown

ADORI SANDSTONE - Type Section (S2)

Fig 6

Measured to NW up Adori Hill using Abney Level set at 1°



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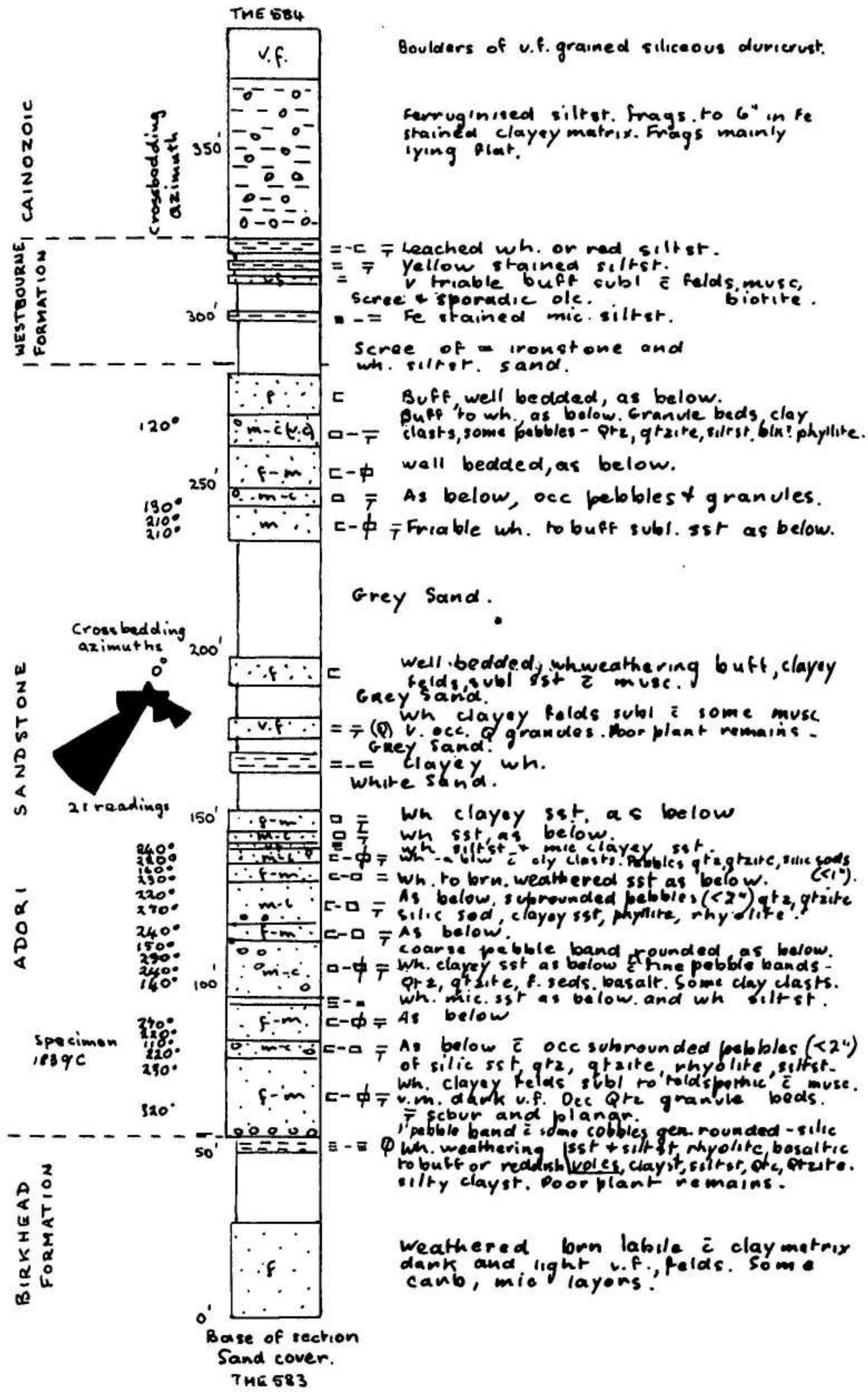
To accompany Recod 1966/89

Fig. 7

MEASURED SECTION S3

BIRKHEAD FORMATION, ADORI SANDSTONE, WESTBOURNE SILTSTONE

Measured to SW up scarp, 3 miles S of Myall Grove Homestead.
Measured by N.F. Exon with Abney Level set on 2°
(between points THE 583-4; Tambo, Run 9, Photo 5069)



shale to 485 feet, grey sandy shale to 810 feet and sandstone to 1,065 feet. The interval from 0-22 feet could be considered to be Adori Sandstone and from 22 to 810 feet to be Birkhead Formation. This would mean that the location of the bore as given above is not accurate. No trace of this well was found during the present survey. A registered water bore, No. 6396, in the general area of the oil well, is 900 feet deep but there are no particulars of the year it was drilled or of the strata penetrated.

Lacustrine conditions were dominant in this area, with minor fluviatile and coal-measure phases. Sedimentation probably took place in an area of restricted drainage as the high calcium carbonate content indicates. Erosion must have proceeded quite rapidly to produce the immature sediments of the Birkhead Formation. Fresh intermediate volcanic detritus in the formation suggests possible contemporaneous vulcanism.

In outcrop in this area the Birkhead Formation is approximately 500 feet thick, although the paucity of outcrop precludes an accurate estimate of the thickness. The unit becomes much thinner in the north of the Tambo Sheet. However, because of an extensive sand cover in this area, the thickness of the formation cannot be accurately established.

Indeterminate plant debris is quite common in the Birkhead Formation. Palynological evidence (Evans, in prep., a) points to a Middle Jurassic age; the assemblages belong to his palynological division J4 (Evans, 1966). The equivalent coal measure sequence near Injune is of Middle Jurassic age (De Jersey and Paten, 1964).

Adori Sandstone

Woolley (1941a) introduced the name Adori Sandstone for a white, pebbly quartz sandstone of Jurassic age, enclosed by his Upper and Lower Intermediate Beds, but did not publish it. He gave the type area as Adori Hill, 22 miles east-north-east of Tambo. The name was first published in Hill and Denmead (1960). The formation was formally defined in Exon (1966), as a medium to fine-grained, somewhat pebbly, sandstone with its type section at Adori Hill (Section S2, Fig. 6).

The Adori Sandstone is quite widespread in the Eromanga Basin, but pinches out against the Nebine Ridge. The formation crops out, in this area, in a narrow belt from the Nive River in the south-east of the Tambo Sheet area, to Sydenham Homestead in the north. In the type area the unit forms a rugged landscape eroding to scarps, which in places have two benches. In the north of the Tambo area the formation is exposed in low benches, which in places have a thin cap of Cainozoic sediments.

The type section S2, and section S3 (Fig.7), are representative of the lithologies of the Adori Sandstone; it is composed mainly of buff and white, medium and fine-grained, medium bedded, clayey, sublabile to labile sandstone; clay clasts, quartz, and volcanic pebbles are quite common and the formation is usually poorly sorted. Clayey, labile sandstone is an important lithology, while beds of white siltstone also occur. Planar and scour cross-bedding is well developed, and although current directions are somewhat variable, the dominant direction varies between south and south-west, which indicates a source north-east or north of the outcrop area. In section S3, 22 miles north of Tambo, sandstone in the lower part of the section is planar cross-bedded to the south-west, while in the upper part current directions are to the south-east. In this section, which shows the full sequence, there is a lower sandstone sequence, 100 feet thick, a middle silty sequence, 80 feet thick, and an upper sandstone sequence 50 feet thick.

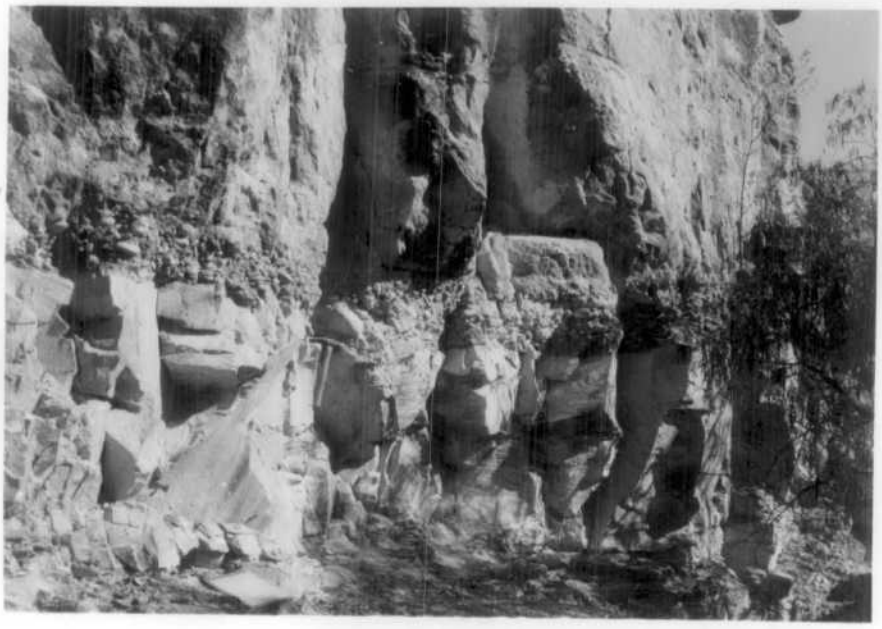
The sandstone is very similar to that of the adjacent Eddystone Sheet area, where thin section examination (Mollan, Forbes, Jensen, Exon and Gregory, in prep.) showed it to contain about 45 percent quartz and quartzite fragments, 5 percent feldspar, 5 percent shaly fragments, and 25 percent clay matrix. Accessories included muscovite, biotite, zircon and iron oxide.

Pebbly sandstone and conglomerate are largely confined to the lower part of the unit. A typical basal conglomerate is shown in two photographs (Plate 3). Pebbles, and the few cobbles, consist largely of quartz, quartzite and black chert, with locally abundant claystone and fine siltstone. There are also some pebbles of porphyritic acid volcanics, and a few fragments of fossil wood, phyllite, porphyritic basalt and rhyolite.

In the area covered by this report, the Adori Sandstone is overlain conformably by the Westbourne Formation, and in turn rests conformably on the Birkhead Formation. The generally pebbly and gritty, sublabile, planar cross-bedded sandstone of the Adori Sandstone contrasts strongly with the siltstone, mudstone and calcareous, lithic sandstone of the Birkhead Formation. The contact is scoured, wherever seen, and the underlying Birkhead Formation is generally leached (e.g. photographs, Plates 3a and 3b).

The thin bedded, micaceous, grey, weathering to yellowish-brown siltstone, and very fine sandstone, of the Westbourne Formation are quite different from the medium-grained, white or light brown, pebbly sublabile to labile Adori Sandstone.

PLATE 3



(a)

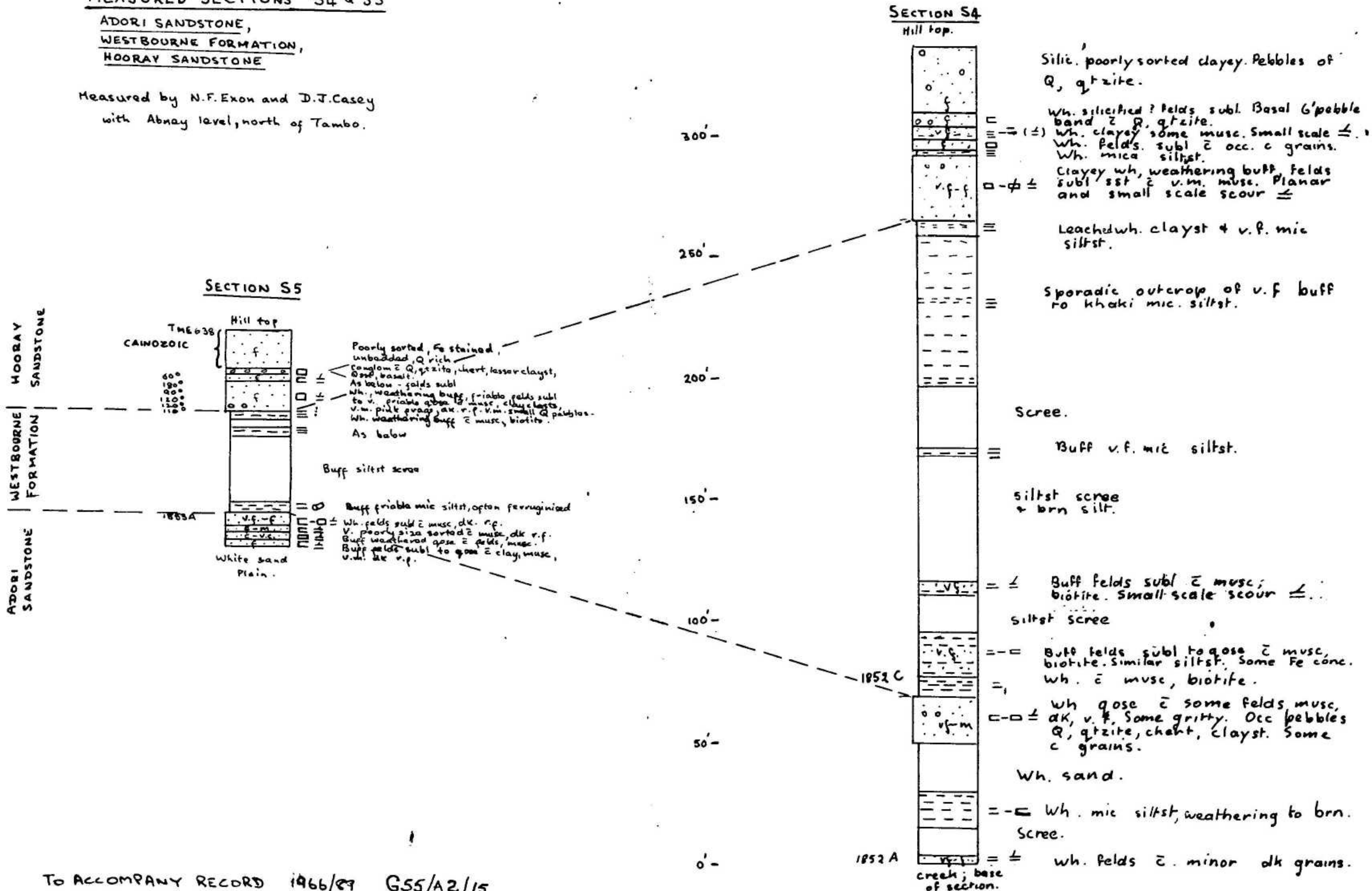
(b) Basal conglomerate of the Adori Sandstone contains pebbles of scoured and leached sediments of the uppermost Birkhead Formation (Tambo Sheet area grid reference 446,933).

Fig. 8

MEASURED SECTIONS S4 & S5

ADORI SANDSTONE,
WESTBOURNE FORMATION,
HOORAY SANDSTONE

Measured by N.F. Exon and D.J. Casey with Abney level, north of Tambo.



To ACCOMPANY RECORD 1966/89 G55/A2/15

The Adori Sandstone can be recognized in the following oil wells drilled in the area mapped:-

Well	Interval	Thickness
Westbourne No. 1	1651-1880	229
Boree No.1	1981-2149	168
Carlow No. 1	2785-2878	93

In Westbourne No.1 (Gerrard, 1964a) the formation is composed of medium-grained, quartz-rich planar cross-bedded sandstone with interbedded siltstone and shale. In Boree No.1 (Gerrard, 1964b) the unit is finer-grained and better sorted than in Westbourne No.1; the top portion is silty and argillaceous. The Adori Sandstone is overlain by the Westbourne Formation, and is conformable on the Birkhead Formation, in all 3 above wells.

The poor size sorting, planar cross-bedding and fairly coarse sediments indicate a shallow water, high energy fluviatile environment of deposition. The fairly high proportion of fresh feldspar in the unit indicates that the sediments have not been transported a great distance. Lower Jurassic sandstones to the north of the outcrop area of the formation provide a possible source for some of the material; the dominant current direction, as stated earlier, is in agreement with this theory. Depositional breaks are indicated by erosional surfaces, and clay fragments, within the unit.

In the type section, which is in only the lower part of the unit, the Adori Sandstone is 182 feet thick; in section S3, in which the enclosing units are present, the formation is 233 feet thick. North-west of the Birkhead Anticline it becomes much thinner and possibly lenses out, but the thickness cannot be estimated because of an extensive sand cover. To the south-east, it pinches out near Mount Elliott, in the central-south of the Eddystone Sheet area. In the subsurface, it thins westwards (see Plate 5).

No microfossils were found in the present survey. However, on palynological evidence, Evans (1966) suggests that the formation belongs to his J5 division, which is of Middle to Upper Jurassic age. Plant fossils collected from the silty middle part of the unit, are considered by White (1966; and Appendix 4), to be of Upper Triassic to Jurassic age.

Westbourne Formation

This name was proposed and defined by American Overseas Petroleum in Gerrard (1964b) but was not published. A description, adapted from that of Amoseas by incorporating the results of later field work, was published with their agreement in Exon (1966). In outcrop, in the area north-east of Tambo, this formation is Woolley's (1941a) "Upper Intermediate Series".

The unit is named after Amoseas Westbourne No.1 well, in the central north of the Augathella Sheet area (latitude 25°11'27"S, longitude 146°08' 02"E), and the type section is the interval 1279 to 1651 feet, in that well. The sequence in the type section consists of shale, siltstone and lesser, very fine-grained, sandstone.

The formation is widespread in the subsurface in the eastern part of the Eromanga Basin (see Table in Exon, 1966), and crosses the Maranoa Anticline into the Surat Basin. It crops out in the Tambo, Augathella, Eddystone and Mitchell Sheet areas. In this area, it forms a south-east trending belt, south from Sydenham Homestead, across the Tambo Sheet area and the north-eastern corner of the Augathella Sheet area. North of Sydenham Homestead it disappears under sand cover. This unresistant unit, which forms only scattered outcrops, generally forms a low area between the surrounding sandstone units, and is characterised by very severe gullying and erosion. It supports a fairly open cover of small trees, on clayey brown soil.

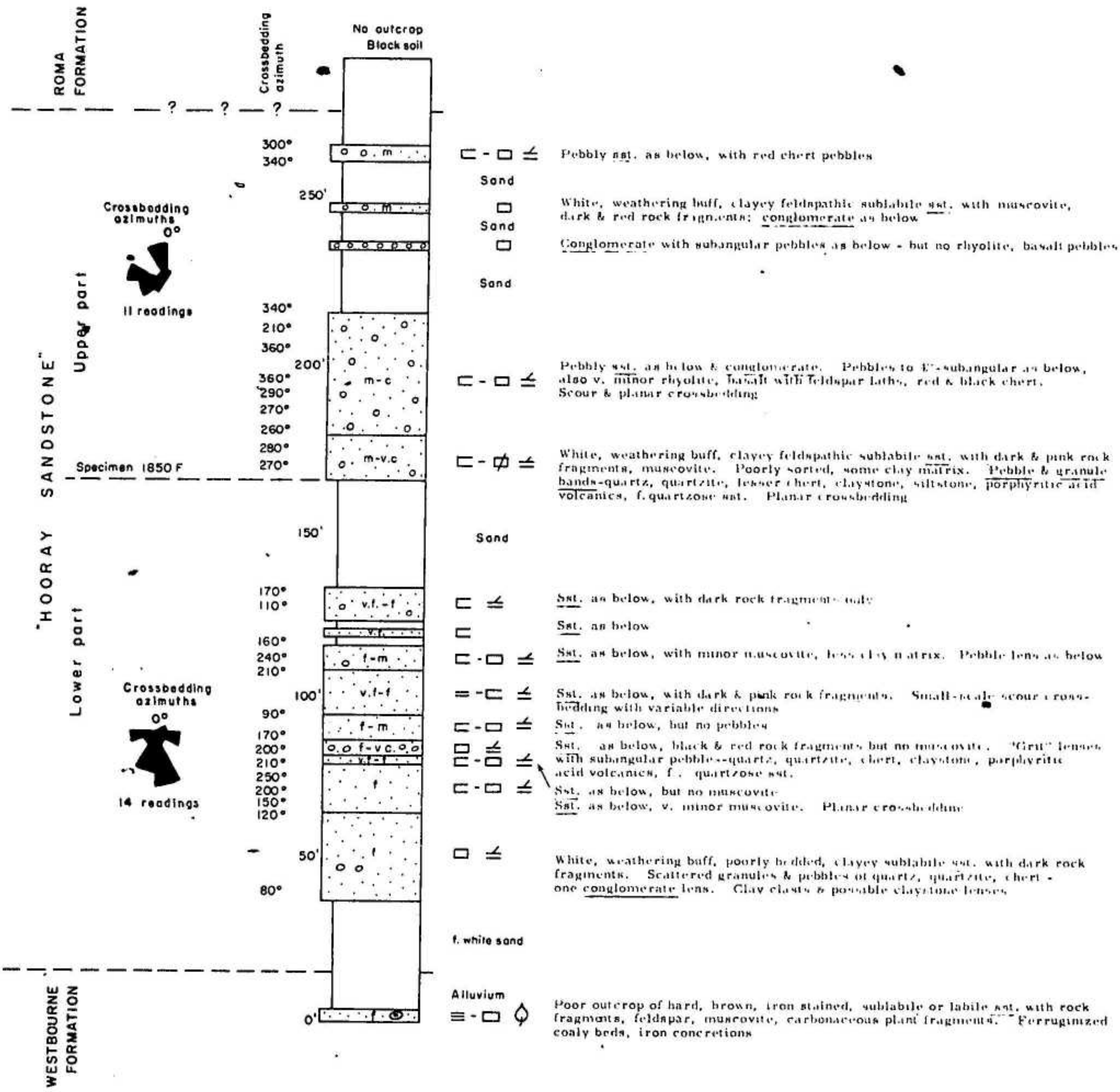
The formation consists essentially of <u>siltstone</u>, <u>mudstone</u>, and very fine-grained quartz-rich <u>sandstone</u>. The <u>siltstone</u> is grey to khaki, carbonaceous and micaceous, calcareous in places, and grades into mudstone. It is laminated to thinly bedded, and in some outcrops contains discoidal ironstone concretions, which were probably originally calcareous. Thinly bedded siltstone scree, largely ferruginized, commonly litters the surface of flat areas developed on the formation. The <u>sandstone</u> is buff, thinly to thickly bedded and cross-bedded. Most cross-bedding is low-angled, but planar and scour cross-beds are also developed. Cross-bedding directions may vary through 360°, as is well illustrated in inter-bedded siltstone and sandstone outcrops in cuttings on the Alpha/Tambo road. Here combinations of scour cross-beds are ferruginized to give bodies up to 6 feet long, and not unlike ironstone concretions. Ripple marks are found on some bedding planes. The sandstone contains feldspar, a little muscovite and biotite, and some black chert fragments. It is generally quartz-rich, but in places is labile, containing shaly fragments. The grainsize, although generally very fine, varies up to medium in some beds, especially low in the formation, where small quartz pebbles occur in a few horizons.

The formation contains plant remains, generally fragmentary, and roots in some beds; worm casts and tracks are abundant at some levels.

"HOORAY SANDSTONE" - Type Section (S1)

Fig.5

Measured for 2 miles down Hooray Creek, finishing 1 mile N of Mt Pleasant Homestead, using Abney level set at 2°.



To accompany Record 1966/89

G55/A2/8

Three measured sections in the Westbourne Formation, S3, S4, and S5, are illustrated in Figs. 7 and 8. These illustrate the fact that the dominant outcropping lithology is siltstone. Shallow drill hole BMR Tambo No.4 (see Fig. 10), spudded just below the "Hooray Sandstone". In this hole, the upper part of the sequence is largely carbonaceous, micaceous siltstone grading to mudstone, and lesser fine-grained sublabile to labile sandstone. The sandstone contains quartz, rock fragments and feldspar, and lesser chlorite, muscovite and biotite. The gamma ray log of the hole shows that there is 100 feet of moderately sandy section, overlying a silty section. The silty section develops the high density gamma ray log which characterises the unit in the subsurface, and makes it a good marker horizon.

The Westbourne Formation is the upper part of the Injune Creek Group. It conformably overlies the Adori Sandstone in this area, and the boundary is transitional. The base of the Westbourne Formation is taken as the base of the lowest thick siltstone or mudstone bed.

The fine grainsize, thin bedding, low-angle cross-bedding, and the presence of calcareous and abundant carbonaceous material, suggest that the formation was largely deposited in a lacustrine environment. The sandstone, which often contains high-angle cross-beds, with very variable cross-bedding directions, was probably largely deposited in deltaic conditions on lake margins. The presence of rare acritarchs in BMR Tambo No.4, suggests possible marine influence at some levels.

The maximum thickness seen at the surface is about 400 feet and this thickness persists south-eastwards. The unit thins northwards; outcrop sections measured show that it is 400 feet thick near Tambo (Woolley, 1941a), 200 feet thick 30 miles to the north (Section S4, Fig. 8); in L.O.L. Alice River No.1, north of this area, it is 76 feet thick. Subsurface thicknesses from east to west across the area are fairly constant (see Plate 5).

No marine macrofossils and only fragmentary plant remains have been found in the unit. Spores and acritarchs, from BMR Tambo No.4, are of Evans' (1966) spore division J5 (see Appendix 2). Evans has elsewhere found spores of division J6 near the top of the unit. These spore divisions are of Upper Jurassic Age (Evans, in prep., a).

"Hooray Sandstone"

Woolley (1941a) named this unit from Hooray Creek, and measured a section in Hooray and Mount Pleasant Creeks. He stated, "The beds can here be subdivided into Lower and Upper Hooray..........these subdivisions probably only hold good locally". The name was first published in Hill and

Denmead (1960). The first published description, and the type section (see Fig. 9), in Hooray Creek 12 miles east-north-east of Tambo, appear in Exon (1966). The section consists of 250 feet of very fine to pebbly, white sublabile sandstone and conglomerate.

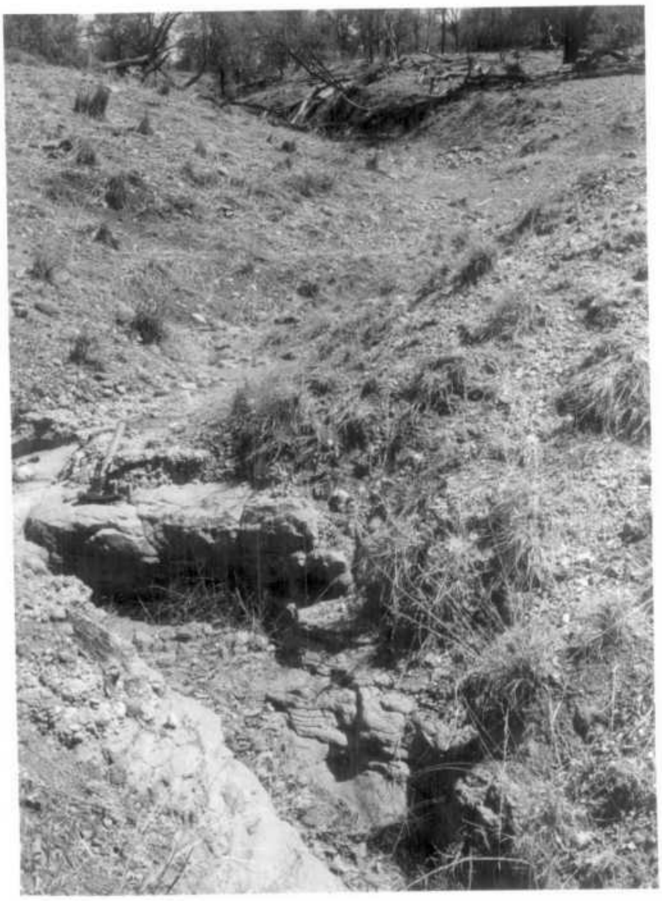
The lower and upper parts of the unit (see Fig.9), are the same as Woolley's "Lower and Upper Hooray", and are unconformable. Exon (1966) stated that his description "should be regarded as a discussion rather than a formal definition". The inverted commas around "Hooray Sandstone" signify that the name is informal. With further work, the two parts could be mapped as separate formations.

The "Hooray Sandstone" crops out in the Tambo, Augathella, Eddystone and Mitchell Sheet areas. It is widespread in the subsurface in the eastern part of the Eromanga Basin; occurrences in wells, in this area, are shown in Plate 5. In this area, the "Hooray Sandstone" forms generally poor outcrops in a sinuous north-westerly trending belt, south from Winooka Homestead, across the Tambo Sheet and the north-eastern corner of the Augathella Sheet. North of Winooka Homestead it disappears under sand cover. In places it forms scarps and cuestas, especially where it has a hard Cainozoic capping. The poor sandy soil overlying the unit, generally supports a light cover of small eucalypts.

The unit consists largely of cross-bedded, thinly to thickly bedded, white clayey sublabile <u>sandstone</u>, with some pebbly sandstone and polymictic <u>conglomerate</u> (see Fig. 9). It is a good aquifer. In the lithological logs of Amoseas Westbourne No.1 and Boree No.1 wells, the lower part consists of a lower fine-grained sandstone sequence, and an upper silty or shaly sequence; the upper part is conglomerate. In Amoseas Boree No.1, the lower sequence is 129 feet thick, the shaly sequence is 99 feet thick, and the uppermost (conglomeratic) sequence is 59 feet thick. In this well (Gerrard 1964b), minor glauconitic "nests" were reported in the shaly sequence. A little glauconite was also identified in the "Hooray Sandstone", in shallow drill holes near the Maranoa Anticline (Exon, Casey and Galloway, in prep.). These were BMR Mitchell No.7 (16 miles south-east of the corner of the Augathella Sheet), and BMR Mitchell No.4 (25 miles farther east).

The <u>lower part</u> of the unit, in outcrop, consists of thinly to thickly bedded, fine-grained sandstone and siltstone, with lesser medium-grained sandstone. There are a few beds of small quartz pebbles in some areas. Small scale scour and planar cross-beds, with highly variable azimuth directions, are a characteristic feature. These show an azimuth average, thoughout the

PLATE 4



(a) Very thin upper "Hooray Sandstone" conglomerate between overlying Roma Formation and underlying lower "Hooray Sandstone". Approximately 20 miles west of Caldervale Homestead, Augathella Sheet area.

(b) Scoured contact between fine-grained lower Hooray Sandstone and conglomeratic upper Hooray Sandstone. Approximately 20 miles west of Caldervale Homestead, Augathella Sheet area.

area, to the south. The sandstone in Fig. 9, although coarser-grained and thicker bedded than average, is petrologically typical. It is generally clayey and sublabile, with black rock fragments, feldspar and, in places, muscovite and red rock fragments. Fossil wood, worm casts and ripple marks occur in some beds.

The upper part of the unit consists of white, medium to very coarse - grained sublabile sandstone, pebbly sandstone and conglomerate (as in Fig.9). The sandstone is petrologically indistinguishable from that of the lower part. Large scale scour and planar cross-bedding, with an average azimuth consistently to the north-west or north, and thick beds, are characteristic. Thin sections from the sandstone of the Eddystone Sheet area (see Mollan, Forbes, Jensen, Exon and Gregory, in prep.), which is indistinguishable from that of this area in hand specimen, consist of 40 to 60 percent quartz and quartzite, 5 to 10 percent feldspar, and up to 15 percent shaly fragments, the remainder of the rock being largely clay matrix and pore space. Accessories include iron ore, mica, zircon and tourmaline. The conglomerate contains subangular to subrounded pebbles, and some cobbles, of quartz, quartzite and fine-grained sediments, lesser black and red chert and porphyritic acid volcanics and, in some places, a little porphyritic basalt, rhyolite and phyllite. The unresistant sandstone, siltstone and claystone fragments are derived from the underlying lower part of the unit; silicified sandstone and other resistant pebbles probably came originally from the Palaeozoic sequence, perhaps through several cycles.

The lower part of the "Hooray Sandstone" conformably overlies the Westbourne Formation. The contact, where seen, is completely conformable, though it may be marked by the presence of a few small pebbles. Sediment type changes markedly from the grey carbonaceous siltstone and mudstone, and the clean quartz-rich sandstone, of the Westbourne Formation, to the very clayey white siltstone and sandstone of the "Hooray Sandstone". The "Hooray Sandstone" is equivalent to the Gubberamunda Sandstone, Orallo Formation and Blythesdale Formation of the Surat Basin. These three units are recognizable where the silty Orallo Formation appears, in the eastern flank of the Nebine Ridge.

The lower part of the "Hooray Sandstone" was deposited, by southerly flowing mature streams and currents, in shallow lakes and deltas. It lapped up against the high area of the Maranoa Anticline, to the south-east. Later there was renewed uplift of the Maranoa Anticline, and the coarser, pebbly, fluviatile upper part of the unit was deposited by fast-flowing streams, coming from the high area to the south-east. These streams eroded away considerable thicknesses of the lower part of the unit, and much clayey material was incorporated in the new sandstone deposits. The contact is strongly scoured wherever it is seen (e.g. photograph, Plate 4b), with pebbly cross-beds overlying fine-grained sandstone.

Predictably, the thickness of both parts varies greatly; four miles north-east of Enniskillen Homestead (425, 945), the pebbly upper part of the unit appears to directly overlie the Westbourne Formation. The presence of minor glauconite, in drill holes, suggests periods of marine influence.

The unit varies from 150 to 400 feet thick in outcrop, and is probably thicker in Springleigh Bore (see Plate 5). Both parts also vary greatly in thickness. The lower part, absent north-east of Enniskillen Homestead, and also, probably, to the south-east on the Augathella Sheet, has a maximum thickness of 230 feet in Amoseas Boree No.1. The upper part is only 18 inches thick (see photograph, Plate 4a), at one locality in the Augathella Sheet area, and has a maximum outcrop thickness of 200 feet.

No marine fossils or identifiable plants, have been found in the unit. On stratigraphic grounds its age extends from Upper Jurassic to Lower Cretaceous.

LOWER TO UPPER(?) CRETACEOUS ROLLING DOWNS GROUP

The Rolling Downs Group was first referred to as the Rolling Downs Formation by Jack (1886), and was later named and defined as the Rolling Downs Group by Whitehouse (1954). The sediments of the group grade upwards from a marine argillaceous sequence to a freshwater argillaceous and fine-grained arenaceous sequence.

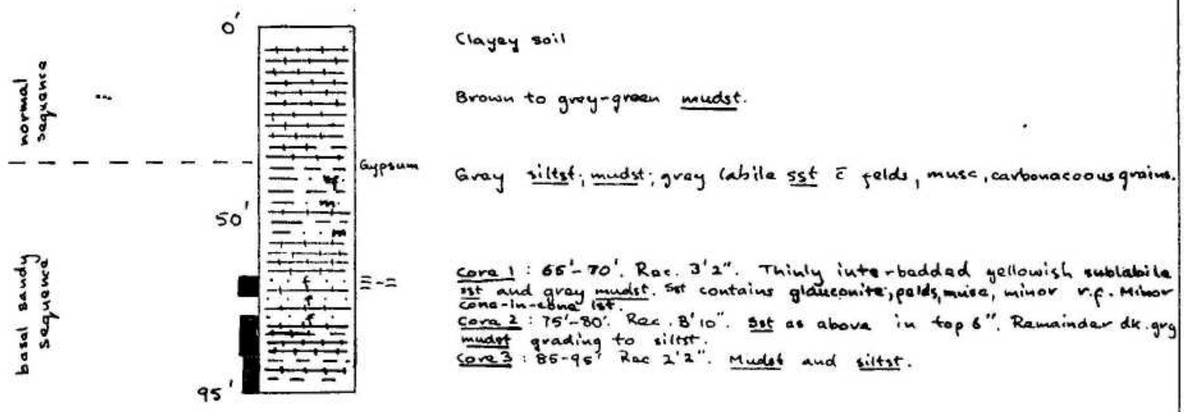
The group overlies the "Hooray Sandstone" and is locally unconformably overlain by Tertiary and Recent sediments.

The group was divided into three formations, namely the Roma, Tambo and Winton Formations by Whitehouse (op.cit.). He did not note any lithological differences between the Roma and Tambo sequences (op.cit., p.10), and he regarded the boundary between these two formations as representing either a faunal break, or a period of non-deposition. Mapping in the northern Eromanga Basin has shown that sedimentation was continuous from Roma to Tambo time. Field mapping by the Bureau of Mineral Resources, and the Queensland Geological Survey, in the northern Eromanga Basin, has led to definition of new units which are lithologically different. The nomenclature was defined by Vine and Day (1965). Table 4, shows probable correlations with the faunal divisions of Whitehouse (1954), and the lithological subdivisions of Vine and Day (1965) and Vine, Jauncey, Casey and Galloway (1965).

Fig. 10

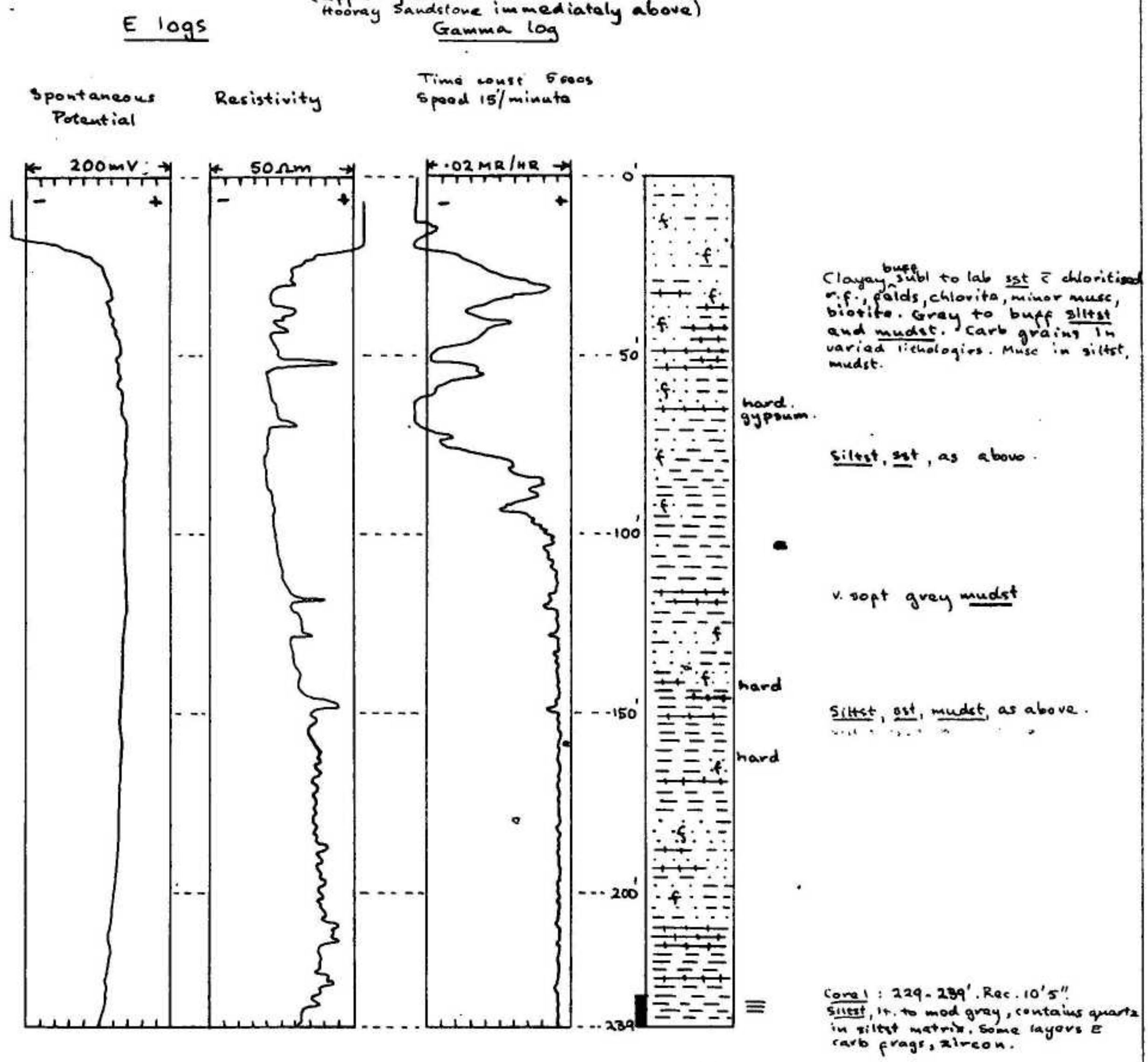
BMR TAMBO 3.

ROMA FORMATION



BMR TAMBO 4

WESTBOURNE FM
(upper part - Hooray Sandstone immediately above)



SHALLOW DRILL HOLE LOGS TAMBO 3 & 4

ROMA FORMATION, WESTBOURNE FORMATION

TO ACCOMPANY RECORD 1966/89 G55/A2/16

TABLE 4

ROLLING DOWNS GROUP NOMENCLATURE

<table>
<tr><th colspan="2">Subdivisions in this report</th><th colspan="2">Nomenclature, after Vine & Day, 1965; Vine et al., 1965</th><th>Nomenclature, after Whitehouse, 1954</th></tr>
<tr><td colspan="2">Winton Formation</td><td colspan="2">Winton Formation</td><td>Winton Formation</td></tr>
<tr><td colspan="2">Mackunda Formation</td><td colspan="2">Mackunda Formation</td><td rowspan="3">Tambo Formation</td></tr>
<tr><td rowspan="3">Wilgunya Formation</td><td>Allaru Member</td><td rowspan="4">Wilgunya Formation</td><td>Allaru Member</td></tr>
<tr><td>Toolebuc Member</td><td>Toolebuc Member</td></tr>
<tr><td>Coreena Member</td><td>Ranmoor Member
Coreena Member Vine et al., 1965</td><td>Non Deposition</td></tr>
<tr><td colspan="2">Roma Formation</td><td>Doncaster Member</td><td>Roma Formation</td></tr>
</table>

Although calcareous sediments constitue only a small proportion of the total stratigraphic column, they are tougher and more resistant to weathering, and consequently they are the sediments seen most commonly in the field.

Roma Formation

The formation was first named the "Roma Series", after the town of that name, by Whitehouse (1926). He renamed it the Roma Formation, and designated the type area as "the banks of Bungeworgoroi Creek just north and south of the railway line", in 1954.

The unit crops out over much of the Surat Basin, and in the south-east part of the Eromanga Basin. It forms poor rubbly outcrops in an area of rolling downs around Tambo, and extends north and south-east of the town. It also occurs east of Augathella.

The unit is predominantly dark blue-grey mudstone, but includes some fine-grained glauconitic labile siltstone; both the mudstone and siltstone weather buff-yellow. Gypsum is common throughout, and the unit is locally fossiliferous. The mudstone is massive, laminated or thinly laminated. In the lower 100 feet of the formation, in the Augathella Sheet area, mudstone and minor fine-grained glauconitic sandstone occur. The mudstone contains randomly scattered angular quartz granules. The lower part of the formation, where it is exposed north of Hoganthulla Creek, consists of part silicified, part calcareous, sublabile sandstone and gritty sandstone.

The Roma Formation conformably overlies the "Hooray Sandstone". There is a transitional sandstone sequence in the lower part of the Roma Formation in much of the Tambo Sheet area (see following section). Elsewhere, Roma Formation mudstone directly overlies the "Hooray Sandstone". The lower Roma Formation sandstone is green, glauconitic, and lithic sublabile to lithic; the sandstone of the "Hooray Sandstone" is white, sublabile and seldom glauconitic. Where the sandstone sequence is present, the base of the lowest green sandstone in outcrop, and of the lowest siltstone or mudstone in the subsurface, can be taken as the base of the Roma Formation. Also, marine macrofossils are quite common in the Roma Formation, but absent from the "Hooray Sandstone".

The Roma Formation, defined in the Roma area, and the Doncaster Member of Vine and Day (1965), defined in the northern part of the Eromanga Basin, are time equivalents, and are similar lithologically. The exact relationship of the two units is not resolved as yet, and awaits the coming year's mapping in the Mitchell and Roma Sheet areas.

Shelly fossils are preserved whole, and are not fragmentary as in the coquinites of the Coreena Member or Mackunda Formation. Ammonites are commonly filled with coarsely crystalline calcite; the outer body chambers, where preserved, are filled with silt. This indicates that the siphuncle was not ruptured prior to preservation, and implies death and preservation in an environment almost devoid of currents and wave action. The muddy sediments, presence of gypsum, and the mode of preservation of the fauna, especially the ammonites, indicates deposition in an extremely shallow epicontinental sea, surrounded by lowlands capable of supplying only clay and silt size detritus.

The unit is 700 feet thick in Phillips Carlow No.1 and Amoseas Boree No.1, but thins to 500 feet south of these wells, and maintains this thickness to the southern edge of the Augathella Sheet area.

The fauna is diverse; it includes mainly pelecypods and some ammonites. An Aptian age is indicated (see Day, in Appendix 1).

Sandstone body in the lower part of the Roma Formation

The sedimentary rocks shown on the Tambo Sheet by a stippled pattern superimposed on the Roma Formation have been loosely referred to as "transition beds". They are regarded as being part of the Roma Formation and represent a transition in type of sedimentation from the commonly sandstone sequence of the "Hooray Sandstone", to the mainly argillaceous marine sequence of the Rolling Downs Group. The small stippled area, north of Hoganthulla Creek, in the Augathella Sheet area, also represents a sandy lower part of the Roma Formation.

In the Tambo Sheet area, a glauconitic lithic sublabile to lithic sandstone in the lower part of the Roma Formation was traced south-east from near Tralee Homestead to Mount Pleasant Homestead. Areas of no outcrop, within the sandstone sequence, probably largely represent siltstone and mudstone.

A section measured north-west of Tralee Homestead consists mainly of medium to fine-grained, gritty, poorly sorted, extremely clayey, glauconitic, lithic sublabile sandstone. Marine fossils occur, but they are not common. Cobbles and boulders of the sandstone weather brown but, where fresh, the sandstone is usually pale grey to light green. The brown colour may be due to weathering of the glauconite.

In the section measured, 104 feet of sandstone is exposed; the top of the sandstone sequence is concealed. The outcrop width of the sandstone sequence is consistent with a thickness of about 150 feet.

60 feet of this sequence was penetrated in shallow drill hole BMR Tambo No.3 (Fig. 10). It consists of grey mudstone grading to siltstone, and thinly interbedded, fine to medium-grained, labile sandstone, containing glauconite, feldspar, rock fragments and muscovite.

A specimen of medium-grained sandstone, from three miles north-east of Enniskillen Homestead, examined in thin section, was identified as a glauconitic lithic sandstone, consisting of subangular quartz grains and aggregates (45%), glauconite pellets (10%), fine-grained volcanics (15%), siltstone (5%), feldspar (3%), chloritic clay matrix (15%), and interstitial limonite and minor rounded iron oxide.

Day has identified various marine fossils from the sandstone; these are discussed in Appendix 1. The fauna indicates an Aptian age, the same as for the rest of the Roma Formation. This sandstone is conformable on the Jurassic/Cretaceous "Hooray Sandstone". In BMR Jericho No.1, 75 miles to the north, there is no transitional sequence between the terrestrial arenaceous and marine argillaceous sequences. The "transition beds" may be a littoral facies of the Roma Formation, marginal to positive topographic features which may also correspond to positive structural features.

The Minmi Member of the Blythesdale Group in the Roma-Mungallala area, and the "transition beds", are lithologically, stratigraphically and faunally comparable. The two areas are 120 miles apart.

Wilgunya Formation

In this area the Wilgunya Formation consists of the Coreena, Toolebuc and Allaru Members. Further north (e.g. Vine et al., 1965), the basal member of the unit is the Doncaster Member, which underlies the Coreena Member. The present survey has found little difference between the Roma Formation and the Doncaster Member, in this area and the Surat Basin. For the present, the authors prefer the name Roma Formation rather than Doncaster Member, for the sequence between the "Hooray Sandstone" and the Coreena Member, in this area.

Coreena Member of the Wilgunya Formation

The Coreena Member is a sequence of coarse-grained siltstone, grading to very fine and fine-grained sandstone interbedded with mudstone. It overlies the Roma Formation and is overlain by the Toolebuc Member, or where this is not present, by the Allaru Member. The sequence is conformable.

Vine et al. (1965), named this unit, and nominated the type area as along the western boundary of Coreena Station north of Barcaldine; a type section was not measured because of poor exposure.

The member crops out around the eastern margin of the Eromanga Basin, from the Muttaburra Sheet area southwards. In the Tambo and Augathella Sheet areas, the unit is exposed as floaters and rubbly outcrops in a belt roughly parallel to the Landsborough Highway, mostly west of the highway. Topographic relief on this unit is slightly greater than on either the underlying Roma Formation or overlying Allaru Member, and is comparable to that on the Toolebuc Member. The western subsurface limit of the unit is not known.

The most common rock types seen in the field are very fine to fine-grained labile sandstone and coarse siltstone; medium-grained sublabile sandstone occurs very rarely. The sediments with a calcareous matrix are tougher and more resistant to weathering than the non-calcareous sediments, and are thus more commonly seen in the field. Thin sets of cross-beds were noted, but no consistent trend of foreset directions was detected.

Logs of water bores and oil exploration wells, indicate that non-calcareous sediments are more common, and mudstones are much more common, than might be expected from field observations.

Good supplies of water are obtained from aquifers within this unit. On Oakwood and Wansey Downs holdings certain flowing bores derive their entire water supplies from this unit. This may indicate the presence of clean permeable sandstone which has not been seen in outcrop.

The member is roughly divisible into lower and upper sections; the lower section being characterised by the presence of coquinites containing abundant shell fragments and beds of the small pelecypod "Barcoona"; the upper section by the presence of intraformational conglomerates, wood fragments and the absence of marine macro-fossils. The two sections are apparent from latitude 25°20'S southwards.

The rich shelly marine fauna, consisting mainly of pelecypods indicates an age ranging from Lower Albian at the base to Middle Albian at the top (see Day, Appendix 1). Worm trails were noted and a few fragmentary ammonites were seen. In the lower part of the unit the presence of worm tubes, coquinites and intraformational conglomerates, and random cross-bedding directions, suggests deposition in a marine, beach or near-shore environment, where erosion and reworking took place. The interbedded mudstone probably indicates short lived changes in depth of water, or temporary base levelling of streams draining the source areas. The upper part of the unit, having an abundance of wood fragments, no marine microfossils or macrofossils, intraformational conglomerates and worm tubes, was probably deposited under terrestrial conditions similar to the conditions which prevailed while the Winton Formation was being deposited.

The Coreena Member conformably overlies the Roma Formation, and north of this area, its correlate, the Doncaster Member. The Coreena Member occupies the same stratigraphic position as the Ranmoor Member in the north of the Eromanga Basin. The Ranmoor Member is almost entirely mudstone, whereas the Coreena Member contains abundant sandstone and siltstone.

The thickness of the unit varies considerably. In its type area north of Barcaldine, the thickness was estimated from outcrop and bore information as 300 feet. In Phillips Carlow No.1 and Amoseas Boree No.1 the unit is about 85 feet thick.

In Phillips Bury No.1 and registered bore 120, near the north-west corner of the Augathella Sheet area, the thickness of the member is 440 feet. Farther south at latitude 25°45'S, in bores 4096 and 311, a 570 foot section of the member was intersected.

Toolebuc Member of the Wilgunya Formation

The unit was defined by Casey (1959), from outcrops on the east bank of the Hamilton River, east of Boulia.

It is a very widespread unit in the Great Artesian Basin. In the area studied, it crops out in a sinuous north-west trending belt as far south as latitude 24°45'S. Scattered discontinuous outcrops, suggesting lensing of the member, persist to 25°20'S. South of latitude 25°20'S the unit does not crop out. West of the Enniskillen Anticline, the unit can be identified on gamma-ray logs by a sharp increase in radioactivity. East of the Enniskillen Anticline, the gamma-ray logs do not show this strong increase in radioactivity at the horizon where the Toolebuc Member could be expected. Thus the unit was probably not deposited in the area south of latitude 25° 20'S, and east of the Enniskillen Anticline. This is coupled with the development of the terrestrial upper part of the Coreena Member south of latitude 25°20'S, in a similar stratigraphic position to that occupied farther north by the Toolebuc Member.

The Toolebuc Member consists of fine-grained, pale grey, silty limestone, and the outcrop is characterised by spherical concretions up to two feet in diameter. Minor white and pink, finely crystalline to earthy, concretionary limestone also occurs. The member conformably overlies the Coreena Member.

The widespread occurrence of the limestone of the Toolebuc Member, throughout almost the entire Northern Eromanga Basin, reflects a major regional tectonic event or climatic change. The restricted fauna indicates development of an environment unsuitable for most of the macrofauna present in the underlying and overlying sediments. Possibly, a sudden warming of the whole area, coupled with limited access to the open ocean, would be sufficient to increase evaporation, and also produce conditions favourable for precipitation of calcium carbonate. A shoreline for the "Toolebuc sea", is indicated south of 25°30'S and east of the Enniskillen Anticline, where the terrestrial upper part of the Coreena Member is stratigraphically equivalent to the Toolebuc Member.

The thickness in outcrop is about 10 feet; gamma-ray peaks extend over intervals ranging from 15 to 25 feet.

The unit is richly fossiliferous but the macrofauna is restricted to only a few species including mainly the pelecypods *Inoceramus* sp. and *Aucellina hughendenensis* (Appendix 1). The age of the member is Albian (Lower Cretaceous).

Allaru Member of the Wilgunya Formation

This unit was defined by Vine and Day (1965). Its type area is along the Richmond-Winton Road, from Richmond south to Twenty Mile Creek.

The member is widespread in the Eromanga Basin. In this area it forms a belt of rubbly outcrops, within rolling downs, extending from north of Blackall, south to the Ward River at latitude 25°00'S, thence farther south along and east of the Ward River. The unit is identifiable on wireline logs, as an argillaceous interval below the Mackunda Formation and above the Toolebuc Member.

The unit occurs in the field as irregular pebble and cobble size 'floaters' of fine calcareous siltstone and calcareous mudstone, which are dark blue-grey when fresh, or buff when weathered. From bore information, non-calcareous sediments constitute about 90% of the unit. Thin beds of cone-in-cone limestone are also present. The unit is thought to contain more siltstone here than in the Longreach Sheet area (Vine et al., 1965). The member overlies the Toolebuc Member, or where that is not present, the Coreena Member.

Shelly fossils are preserved whole, and are not fragmentary as in the coquinites of the Coreena Member or the Mackunda Formation. Ammonites are commonly filled with coarse crystalline calcite, except for the outer body chambers which are filled with silt. This indicates that the siphuncle was not ruptured prior to preservation. This would necessitate death and preservation in a marine environment, almost devoid of currents and wave action. The muddiness of the sediments, presence of gypsum, and the mode of preservation of the fauna, especially the ammonites, indicate deposition in an extremely shallow epicontinental sea surrounded by lowlands capable of supplying only clay and silt size detritus.

At the north of the Blackall Sheet area, the unit is about 850-900 feet thick; it thins to 600 feet in Phillips Carlow No.1 and 498 feet in Amoseas Boree No.1. It thickens to 600-800 feet in the north-west corner of the Augathella Sheet area.

A rich marine fauna, including many species of ammonites and pelecypods, is present. Day (Appendix 1), regards the fauna as Albian (Lower Cretaceous), probably Upper Albian, in age. The ammonites are particularly common in a belt coinciding with a ridge, which extends from fossil locality G2096 south to G2064, G2063 and G2053.

Mackunda Formation

The unit was defined by Vine and Day (1965). The type area is in the headwaters of Mackunda Creek on Gnalta Station, in the Mackunda Sheet area.

The Mackunda Formation is widespread in the Eromanga Basin. In this area, it forms numerous rubbly outcrops, on extensive rolling downs north of Blackall and along the southern half of the western edge of the Tambo Sheet area. It also occurs in the Augathella Sheet area:- west of the Ward River, as an inlier in the axial part of the Noella Syncline, which is east of the Ward River, and as an inlier along the axis of the Biddenham Syncline in the south-central portion of the area.

The unit consists of labile to sublabile siltstone and sandstone interbedded, thinly interbedded and interlaminated, with mudstone. The sandstone is very fine and fine-grained; medium-grained sandstone is rare. The grains are well sorted and the matrix is argillaceous or calcareous. The calcareous sandstone grades to sandy limestone. The sand fraction commonly consists of lithic and feldspathic grains, with minor amounts of quartz. Some of the sandstones are sublabile, and lack calcareous or argillaceous matrix; these are aquifers. The mudstones are similar to those of the Allaru Member. The unit is fossiliferous and contains some coquinite beds. Coquinite beds are less common than in the Longreach and Maneroo Sheet areas (Vine et al., 1965). Fossils are always fragmentary and pelecypods are disarticulated. The formation conformably overlies the Wilgunya Formation.

The Mackunda Formation is very similar to the lower part of the Coreena Member, and the marine sediments of both were probably deposited near the shore, perhaps largely on beaches (see Coreena Member).

Numerous bores produce sub-artesian water from aquifers within this formation. The thickness of the formation appears to be less than in the Sheet areas immediately to the north. Thicknesses of the unit penetrated in various bores are:-

1) About 445 feet in the Springleigh bore (R3489), located in the centre of the Blackall Sheet area.

2) About 500 feet in Phillips Carlow No.1, in the south-east of the Blackall Sheet area.

3) 358 feet in bore 120, in the north-western corner of the Augathella Sheet area.

The unit contains a rich fauna, comprised mainly of pelecypods; Day (Appendix 1) regards the fauna as Upper Albian (Lower Cretaceous), in age.

Winton Formation

Dunstan (1916) named the Winton Series, without formal definition. Whitehouse (1954) changed the name to Winton Formation, and described it as "the blue shales and sandstones, with intercalated coal seams, met within the bores in and about Winton".

The Winton Formation is widespread in the Eromanga Basin. The unit forms rubbly outcrops on extensive rolling downs, in the central and western portions of the Blackall Sheet area. It also occurs in deeply weathered exposures in the slopes of duricrust-capped hills, in the central southern portion of the Blackall Sheet area, and the western portion of the Augathella Sheet area, adjacent to the Langlo River.

The unit is mainly interbedded mudstone and labile sandstone; intraformational conglomerate is common. The sediments may have a calcareous or argillaceous matrix. Because of their greater resistance to weathering, the calcareous sediments more commonly crop out. Small seams of coal and peat occur scattered throughout the formation, but are most common in the lowermost parts of the formation, in the western portion of the Augathella Sheet area; the peat is commonly silicified in outcrop.

In contrast with the Mackunda Formation, the Winton Formation lacks coquinites and shelly fossils. It also contains coal, peat and intraformational conglomerate which do not occur in the Mackunda Formation. The sandstones are more commonly coarser-grained (fine and medium-grained) in the Winton Formation. The bedding in the Winton Formation is generally from 2 to 30 feet thick, whereas in the Mackunda Formation it is usually less than a foot thick. Aquifers in the unit produce sub-artesian water.

The Winton Formation conformably overlies the Mackunda Formation, and the contact is transitional. The Winton Formation represents the continuation of Mackunda-type sedimentation in exclusively freshwater environments.

The lack of marine fossils, and the presence of plant remains and intraformational conglomerate, indicate a terrestrial environment of deposition. The fineness of the sediments suggests deposition in sluggish streams, lakes and lake deltas. The sediments were, from time to time, dessiccated and subsequently inundated, to produce intraformational conglomerate.

The total thickness of the unit is unknown, as no conformably overlying unit has been recognised. In the Springleigh bore (R3489), 1550 feet of the formation were penetrated. The unit probably thick westwards and southwards.

Abundant non-diagnostic plant fragments and fossil wood occur in the unit. Regional mapping farther north (Vine and Day, 1965), and a few plant determinations, suggest that the lower part of the formation was deposited in Lower Cretaceous time, and that sedimentation continued into the Upper Cretaceous. Palynological work on AAP Mayneside No.1 (AAP, 1965b), and

AAP Fermoy No.1 (AAP, 1965a) also indicates a Lower Cretaceous age. In the Longreach and Maneroo Sheet areas to the north, a freshwater pelecypod was found in BMR Longreach scout hole No.1 at 143'3". In AAP Fermoy No.1, marine Peridiniens sp. (microplankton) were found 920 feet above the base of the formation.

CAINOZOIC

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

The well bedded sediments, which have been stream transported, are referred to as Tertiary. The poorly bedded sandstone, which is invariably derived from adjacent or underlying strata, and the duricrust, are referred to as "undifferentiated Cainozoic".

Tertiary Basalt

The only young basalt seen in the area occurs as one hill capping, and two dykes, in the extreme south-east of the Tambo Sheet area. The basalt is very fine-grained, uniform, and contains olivine phenocrysts. Two thin sections were examined, one from a flow, one from a dyke. Both are typical olivine basalts, with porphyritic olivine in a fine augite/andesine/glass groundmass.

The hill capping, eight miles west of Mount Playfair Homestead, consists of about 15 feet of basalt overlying "billified" Adori Sandstone. This hardening of the immediately underlying sandstone, siltstone and conglomerate, is probably related to the extruded basalt. The basalt, although only present as rubble, was probably a flow, rather than a shallow intrusive, as it is very fine-grained.

The two dykes, six and eight miles south-east of Mount Playfair Homestead, trend north-west, as does a nearby dyke in the Springsure Sheet area. They parallel the strike of the shallow-dipping surrounding sediments.

These isolated basalt bodies were probably once part of a quite extensive basalt complex including Mount Playfair and Mount Pluto, which are east of here. As the similar basalt bodies farther east are Tertiary in age (Mollan, 1965), it is assumed that these basalts are also Tertiary.

Tertiary Sediments

Fluviatile, well-bedded, sandstone and conglomerate, and lesser siltstone and claystone, form hill cappings, up to 100 feet thick, which are quite common in a belt across the Tambo Sheet from the north-eastern to the south-western corner, and in the north-west and south-east of the Augathella Sheet. Often these are ferruginized, leached or mottled.

In the far north-east there are mesas with quartz-rich sandstone and conglomerate, probably derived from the Colinlea Sandstone, overlying the Joe Joe Formation. The basal beds in these sediments often contain angular fragments of quartzose sandstone and, in places, siltstone comparable to that in the Joe Joe Formation.

In many mesas overlying the Triassic sequence, the basal part of the Tertiary sediment comprises breccia-like conglomerate consisting of angular fragments of sandstone similar to that in the Rewan and Moolayember Formations. Most of these fragments are only a few inches in maximum dimension, but some are several feet across. The upper part of the mesas consists of mostly medium-grained quartzose sandstone showing moderate sorting but generally lacking bedding.

Where they overlie the Moolayember Formation the sediments are generally better sorted, with only minor quartz-pebble conglomerate. These sediments are mainly clayey, leached and structureless quartz-rich sandstones. Some are crossbedded, thick bedded, in places ripple marked, and some contain wood fragments. They were probably largely derived from the Jurassic sandstone units to the south-west.

The Tertiary sediments overlying the Jurassic/Cretaceous sequence consist largely of poorly thickly bedded, fine to medium-grained, clayey sandstone and conglomerate. A basal conglomerate consisting of angular pebbles and cobbles, up to six inches across, in a sandstone matrix is commonly developed (e.g. 1 mile east of Highlands Homestead). Pebbles are largely quartz, quartzite, and silicified sandstone, with lesser siltstone and chert, and minor porphyritic acid volcanics. Higher up the Tertiary sequence the conglomerates contain almost entirely quartz, quartzite and chert. Thick white siltstone and claystone sequences are prominent in some areas. The Tertiary sediments can usually be readily distinguished from the Adori Sandstone or "Hooray Sandstone", by their poorer bedding, stronger weathering (often "blocky"), and quartz-pebble conglomerates.

The large plateau areas in the Warrego and Enniskillen Ranges, and in the south-east part of the Augathella Sheet, are blanketed with sand; Tertiary outcrops are found only around the plateaux edges. The fine-grained clayey sandstone of the Tertiary may be difficult to tell from weathered Rolling Downs Group sandstone. The sequence in this area, generally less than 50 feet thick, is thinner overall than elsewhere.

All these deposits, which post-date the Cretaceous, are assumed to be of Tertiary age. In Tertiary times there was an extensive river system which derived material from the underlying sediments. The fine material was mostly carried away, but the coarser material was deposited, often quite close to its source. These sediments were ferruginized in part; pisolitic surfaces are still present in the extreme north of the Tambo Sheet area, north-east of Marston Homestead, and in the south-east of the Augathella Sheet area. Later erosion left only the present-day high-level outliers.

Undifferentiated Cainozoic Sediments

The poorly bedded, or unbedded, sediments are weathering products of underlying units, which have been recemented after little or no movement. Clayey sandstones, overlying sandstone units, are widespread, but siltstone and claystone predominate in some deposits.

In the far north-east, where they overlie the Colinlea Sandstone, these sediments form mesas of extremely poorly sorted breccia-like conglomerate and quartzose sandstone. Large included fragments of quartzose sandstone indicate that they were derived from the Colinlea Sandstone.

In the Glen Avon Homestead area in the north-east, thin boulder deposits rest, apparently conformably, on low dipping cuestas of pre-Tertiary sediments. They contain "billy" boulders, and cobbles and boulders of silicified wood. The conglomerates are overlain by poorly sorted lateritised sandstone.

Low mounds of clayey quartz-rich sandstone have formed at the base of the Jurassic sandstone escarpment; these slope gently away from the scarp, and are consolidated scree slopes.

Poorly bedded ferruginized or "billified" deposits have formed on the Adori Sandstone and "Hooray Sandstone". These are generally less than 15 feet thick, but are considerably thicker in places. The division between this material and "Tertiary" sandstone, is somewhat arbitrary.

A duricrust surface was also developed in Cainozoic time. It is not a sedimentary deposit, but an in situ alteration product of the pre-Cainozoic sediments. This forms plateaux and mesas, especially in the Gowan Range area in the southern part of the Blackall Sheet, and in the western half of the Augathella Sheet. "Billy" boulder deposits are present around some Tertiary mesas in the north-east of the Tambo Sheet.

QUATERNARY

Unconsolidated sands, gravels and clays deposited in the beds, flood plains and outwash fans of present day rivers, are considered to be Quaternary (Qa). General sand cover, widespread on sandy units, and on the

Moolayember Formation and the Rolling Downs Group, and thick soil cover, is also assigned to the Quaternary (Qs). Old river terraces, back from and above the present river banks and flood plains, are also mapped as Qs.

STRUCTURE

The main structural elements with surface expression were detected by field mapping, supported by photogeological interpretation. Overall, there is a regional dip to the south-west, on which is superimposed north-north-easterly trending fold axes. Progressively older units are exposed from south-west to north-east (see cross-sections, Plates 7 and 8). Dips, measured in the post Triassic sediments of the Tambo Sheet by Woolley (1941a), suggest a regional dip of about half a degree. The regional dip probably flattens gradually to the south-west. In the pre Jurassic sediments exposed in the north-east, the regional dip is steeper, being steepest in the oldest units (about three degrees in the Lower Permian). Dips in the flanks of the fold axes vary from an average of about five degrees in the older units to about half a degree in the Cretaceous units. Most structures have continued to grow from Carboniferous to Cretaceous times - probably spasmodically. Most were formed by a combination of tectonic and drape folding.

Data from drillers logs of water bores, and from wireline and lithological logs of oil exploration wells, have been integrated with field observations, photogeological interpretation and, in some places, seismic data, to compile structural form-line maps on the top of the "Hooray Sandstone" (Figs. 11, 12 and 13). These maps show the north-north-easterly structural grain and the regional south-westerly dip.

Three minor cross-folds have been mapped in the central part of the Augathella Sheet area. No significant faulting has been detected at the surface in Jurassic/Cretaceous sediments.

Folding in the pre Jurassic sequence of the Tambo Sheet (Plate 7), is generally reflected by more gentle folding in the overlying sequence. However, two small but moderately strongly folded structures, near Brumby Creek, are not reflected in the Jurassic sediments. Fold axes are sinuous and bifurcate in places; they trend north-north-east overall and plunge to the south. Dips to the south-east are generally steeper than those to the west. The folding has been complicated either by basement relief, or by a secondary stress direction, or perhaps both. Folds in this sequence are commonly box-like, probably caused by two directions of stress.

Major faulting, visible at the surface, is confined to the Mount Beaufort Anticline. One large fault cuts out the whole of the Ducabrook Formation on the western flank of the anticline.

Mount Beaufort Anticline

This structure, in the extreme north-east of the Tambo Sheet area, is the only one in which Devonian and Lower Carboniferous rocks are exposed. Only the southern part of the northerly trending anticline is within the area mapped. Earlier mapping, by Veevers, Mollan, Olgers and Kirkegaard (1964b), has shown it to be asymmetrical, with the eastern flank steeper than the western.

In this area, folding is moderately strong, with dips up to 35 degrees having been recorded. Several post-folding faults complicate the anticline. The largest of these trends north-north-west, and cuts off the fold axis where it intersects the Belyando River. It is a scissors-fault, with downthrow to the west, in the north, of more than 4000 feet, and to the east, in the south, of a few hundred feet. This fault lies on the trend of the Belyando Feature (of Vine et al., 1965) to the north, and is probably related to that feature, which was "interpreted as a major structural discontinuity".

The other main structures from west to east are:-

The Enniskillen Anticline

This broad symmetrical anticline can be traced from the central part of the Tambo Sheet area across the north-western corner of the Augathella Sheet. It is named after the Enniskillen Range, in the south-western corner of the Tambo Sheet area. The anticline is marked by the southward deflection of the outcrop of the Jurassic and Cretaceous units along the axis of the anticline, and by photo-interpreted dips on the Jurassic units.

The fold correspond with the Pleasant Creek Arch which in pre-Permian time formed the eastern margin of the Adavale Basin. The southern part of the Pleasant Creek Arch has been delineated on Jurassic, ?Triassic and Permian horizons by a seismic reflection survey (Fjelstul and Tallis, 1963). The results of this survey suggest erosion of the Upper Permian sediments from the crest of the structure, before deposition of the Mesozoic sequences.

Phillips Bury No.1 well was drilled on a closure on the western limb of the anticline, but the results of this drilling were confidential at the time of writing.

The Woolga Syncline

This broad synclinal warp, to the east of the Enniskillen Anticline, is named after Woolga Holding in the north-west of the Augathella Sheet area. On the top of the "Hooray Sandstone", structural relief between the crest of the Enniskillen Anticline and the trough of the Woolga Syncline is of the order of 500 feet.

The syncline is evident from the northward deflection of Cretaceous and Jurassic units along the axis of the structure, and photo-interpreted dips in Jurassic units.

During the Tambo Seismic Survey (Petty, 1963b) the syncline was mapped between latitude 24°35' and 25°00'S, on reflections from horizons within the "upper Blythesdale", "lower Blythesdale", pre-Permian, and from the unconformity at the base of the Permian. South of latitude 25°00'S the syncline was mapped in the Highfields Seismic Survey (Fjelstul and Tallis, 1963) on Blythesdale and Triassic reflections.

The Birkhead-Ward River Anticline

This symmetrical anticline trends north-north-east and plunges southwards. The Birkhead Anticline, named after Birkhead Homestead, near the centre of the Tambo Sheet, extends right across that Sheet to 25°99'S. At 25°00'S the axis of the structure is displaced five miles to the east, and then continues southwards as the Ward River Anticline.

The structures are evident from the southern deflection of units along their axes and from airphoto-interpreted dips in the Carboniferous to Jurassic units on the Birkhead Anticline.

Both structures were recognised in the Tambo Seismic Survey (Petty, 1963b) and the Highfields Seismic Survey (Fjelstul and Tallis, 1963). Between latitude 25°00'S and 25°15'S, only a single anticline has been interpreted from seismic reflections from the unconformity at the base of the Permian sequence; two separate anticlines are suggested by field mapping and by the "lower Blythesdale" seismic reflection. Pre-Mesozoic faulting probably divided the anticline into two structures.

Widening of the structure occurs between 25°00'S and 25°15'S where the Birkhead Anticline converges on the Ward River Anticline at latitude 25°15'S; north of 25°00'S the Ward River Anticline appears to merge into the eastern flank of the Birkhead Anticline.

Amoseas Westbourne No.1 was drilled on the Ward River Anticline.

The Birkhead Anticline has had a profound influence on the history of this area, and is the dominant structure of the Tambo Sheet. It has grown slowly through time, and most units thin over the crest; the thinning is depositional in some cases, and probably erosional in others. The Permian Peawaddy Formation, which extends several hundred miles to the east of the anticline, changes facies, and is not identifiable, west of the anticline. The Dunda Beds of the north-west, also become unrecognizable at the anticline, where they pass laterally into the upper part of the Rewan Formation. The Jurassic Precipice and Boxvale Sandstones were deposited by streams running down the eastern side of the topographically high Birkhead Anticline, and pinch out a little west of the anticline. The sandy, probably littoral, facies of the lower part of the Roma Formation, is only seen near the Birkhead Anticline.

There is a culmination on the anticline, which is well defined by the cliffs of the Adori Sandstone, south of Killarney Park Homestead. SPL Birkhead No.1, a dry hole, was drilled in the northern part of this culmination.

Normal faults are developed parallel to the axis, on the northern flank of the anticline, in the pre-Jurassic sediments.

Noella Syncline

This structure extends southwards from the extreme north of the area and plunges southwards. It is named after Noella Holding, which is situated on the trough of the syncline in the central western part of the Augathella Sheet area.

In the Jurassic/Cretaceous sequence it is asymmetrical; the western limb is more gentle than the eastern limb. Its axis is generally less than five miles east of the Ward River - Birkhead Anticline between latitudes 24°00'S and 25°30'S, but farther south, the axes diverge slightly. The dip between the structures north of latitude 25°30'S is higher than other flank dips in the region (see form-lines on the top of the "Hooray Sandstone", Fig. 12), and seismic maps (Petty, 1963b). Thus, a basement fault between the structures is suggested.

The Avonmore Anticline, Glen Avon Syncline and Voltiguer Anticline

The Avonmore Anticline trends, and plunges, southwards from Avonmore Homestead in the north-east of the Tambo Sheet. It is a sinuous structure; south-westerly trending anticlines join it at several places. The most northerly such anticline is west of the Avonmore Anticline, east of Alpha Homestead. The Voltiguer Anticline, named from Voltiguer Creek, joins it, from the east, near Duck Creek; a strongly developed anticline in the

Moolayember Formation, joins, from the west, at the same point. Between these anticlines are the Glen Avon Syncline, named from Glen Avon Homestead, and an unnamed syncline along Brumby Creek.

The three major structures have markedly folded the Joe Joe Formation sediments, and somewhat less markedly, the Permo/Triassic sequence. The Voltiguer Anticline may be related to the Mount Beaufort Anticline. The Avonmore Anticline has gently folded the Lower and Middle Jurassic sediments, but dies out below the Westbourne Formation, near Truno Homestead in the south-east of the Tambo Sheet.

Castlevale Syncline

This syncline, which trends north-north-easterly, is named from Castlevale Homestead in the central east of the Tambo Sheet area. It is well developed in the Upper Permian near Balmy Creek, but becomes gentler up the succession. In the Jurassic it is a broad warp which cannot be traced south of the Nive River.

Cross Folds in the Augathella Sheet area

Three structures lie normal to and east of the Noella Syncline; they are, from north to south, the Downlands Syncline, the anticlinal Raincourt Structure and the Kennedy Syncline. All structures terminate westward at the Noella Syncline.

The Downlands Syncline. This distinct syncline, plunging westwards, which is evident from surface and seismic mapping, and from structure contours on the base of the "Hooray Sandstone", is named after Downlands Homestead. The syncline probably dies out eastwards where it intersects the southern continuation of the Valetta Anticline.

The Raincourt Structure, named after Raincourt Holding, in the centre of the Sheet, is an irregular anticlinal structure which has been delinated by surface mapping, and by structure contours on the top of the "Hooray Sandstone". It has a number of plunge reversals along its axis. It terminates westwards in the Noella Syncline; its eastern extent is unknown.

In the Augathella Seismic Survey (Geophysical Associates, 1965), a closure on an Upper Permian reflector, on an extension of the eastern end of the structure, was named the Balfour Structure. Amoseas Balfour No.1, was drilled on this structure. A closure on the Upper Permian, on the western end of the Raincourt Structure, was named the Narrga Anticline (Geophysical Associates, op. cit.). The closures seem to coincide with intersections with north-north-east trending anticlines, and the saddles with complementary synclines. The Narrga Anticline is the intersection of the

Raincourt Structure and the Oakwood Anticline; the Balfour Structure is the intersection of the Raincourt Structure and the Cunno Anticline. The Raincourt Anticline may be a later structure superimposed on the older north-north-east trending structures.

The <u>Kennedy Syncline</u>, named after Kennedy Homestead, is a small syncline evident from surface mapping. It is situated south of the Raincourt Structure and plunges westwards. It possibly dies out eastwards where it meets the Oakwood Anticline.

<u>The Oakwood Anticline</u>

The Oakwood Anticline, named after Oakwood Homestead, is east of the Noella Syncline in the south central portion of the Augathella Sheet area. It trends, and plunges, southwards. The anticline has been defined by surface mapping and is portrayed in Fig. 12 by structure form-lines on the top of the "Hooray Sandstone". Its eastern limb is evident in the one seismic line which was shot over its eastern half (Geophysical Associates, 1965).

<u>The Biddenham Syncline</u>

This syncline, east of the Oakwood Anticline, is named after Biddenham Homestead. It trends, and plunges, southwards and is indicated by a large inlier of the Mackunda Formation in the south central portion of the Augathella Sheet area. It is portrayed by the structure form lines on the top of the "Hooray Sandstone" (Fig. 12). Its presence is evident on the one seismic line shot across the structure (Geophysical Associates, 1965). The structure probably extends north-north-eastwards until it dies out in the southern limb of the Raincourt Structure.

<u>The Valetta Anticline</u>

This anticline, named after Valetta Holding, is situated in the north-eastern portion of the Augathella Sheet area. Its presence is suggested from the outcrop pattern of the "Hooray Sandstone" and the occurrence, east of part of the "Hooray Sandstone", of Roma Formation lithologies in cuttings from seismic shot holes. It appears to trend, and plunge, southwards. The structure is confirmed by the seismic line along Stockade Creek. The structure contours on the top of the "Hooray Sandstone" (Fig. 12) also reflect the presence of the anticline. Minor faulting parallel to the axis of the anticline is evident in the field.

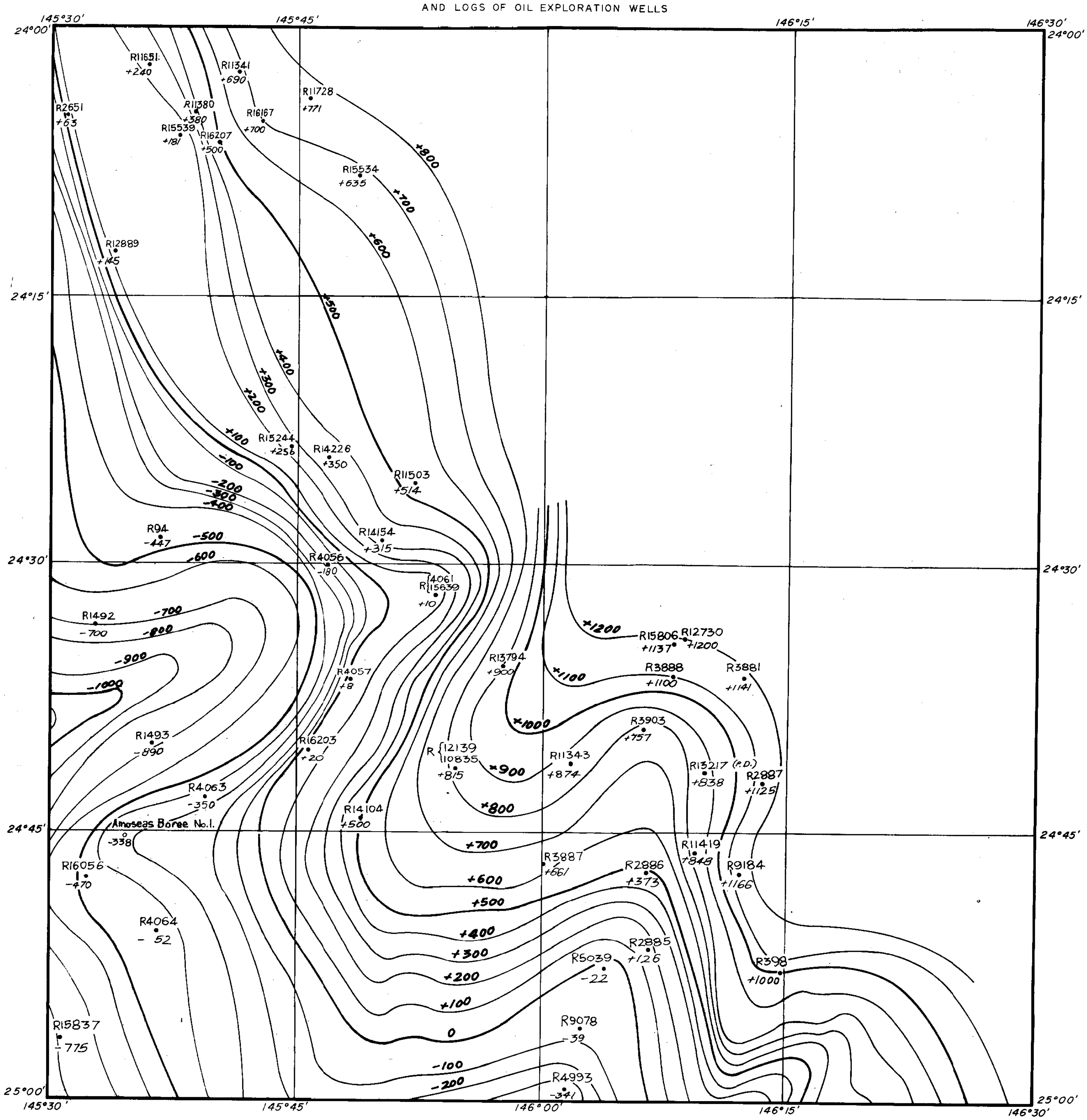
<u>The Cave Syncline</u>

This syncline, which appears to trend and plunge southwards, is east of the Valetta Anticline and is named after Cave Creek. It is evident along Stockade Creek, from the outcrop pattern of the "Hooray Sandstone", and the

TAMBO 1:250,000 SHEET AREA
CONTOURS ON THE TOP OF THE "HOORAY SANDSTONE"

FIG.11

INTERPRETED FROM WATER-BORE DRILLERS' LOGS
AND LOGS OF OIL EXPLORATION WELLS



SCALE

5 0 5 10 15 MILES

Bureau of Mineral Resources, Geology and Geophysics, May 1966

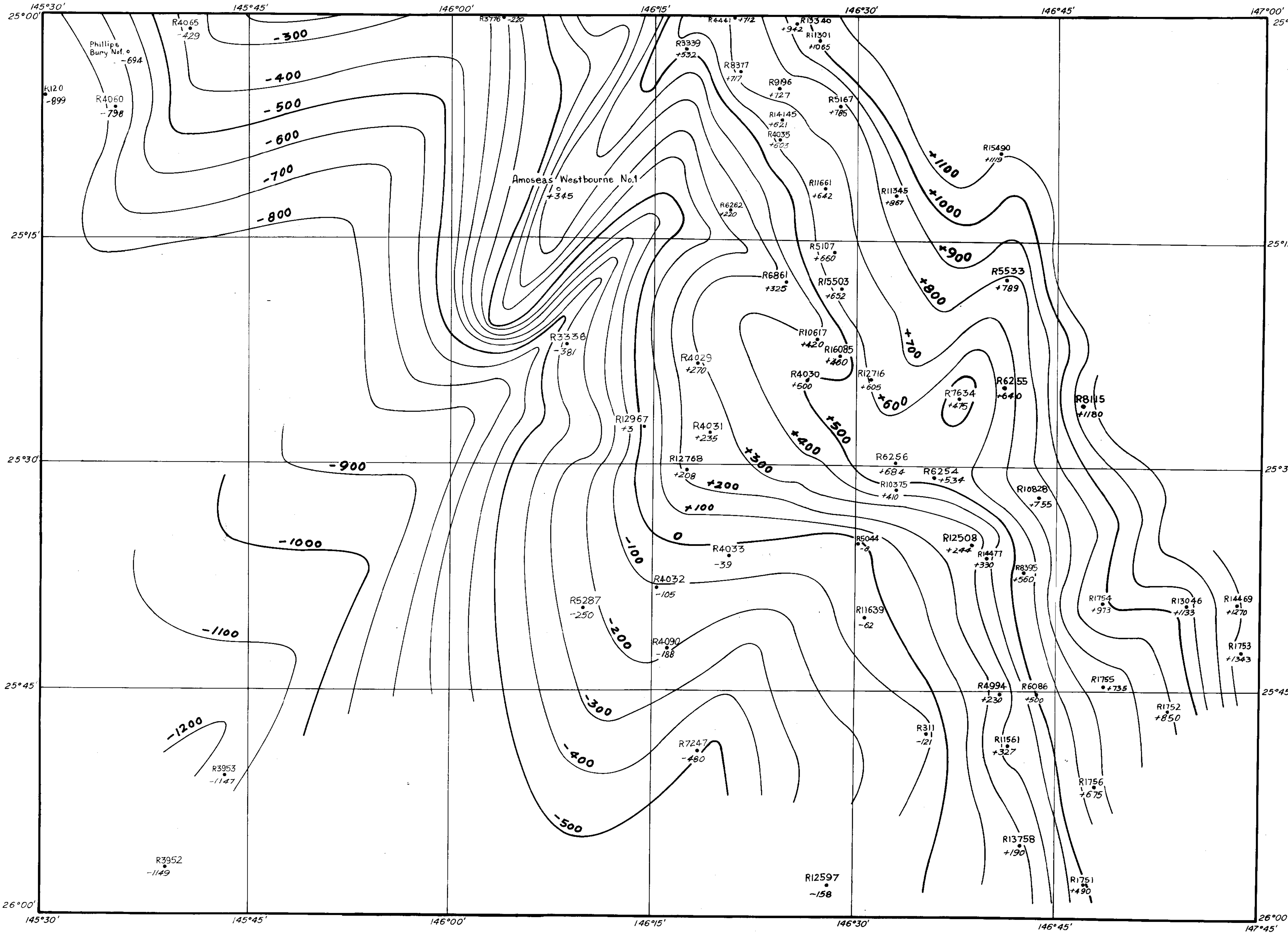
R5039	Registered number of bore	┴┴┴┴?┴┴┴┴	Outcrop margin of Wilgunya Formation
•	Bore position	x	Spot height
-500'	Elevation on the base of Wilgunya Formation		
○ Amoseas Boree No.1	Oil exploration well		Datum - Mean sea level. Contour interval 100 feet

To accompany Record 1966/89

AUGATHELLA 1:250,000 SHEET AREA
CONTOURS ON THE TOP OF THE "HOORAY SANDSTONE"

FIG. 12

INTERPRETED FROM WATER BORE DRILLERS' LOGS AND LOGS OF OIL EXPLORATION WELLS



SCALE

5 0 5 10 15 MILES

Bureau of Mineral Resources, Geology and Geophysics, May 1966

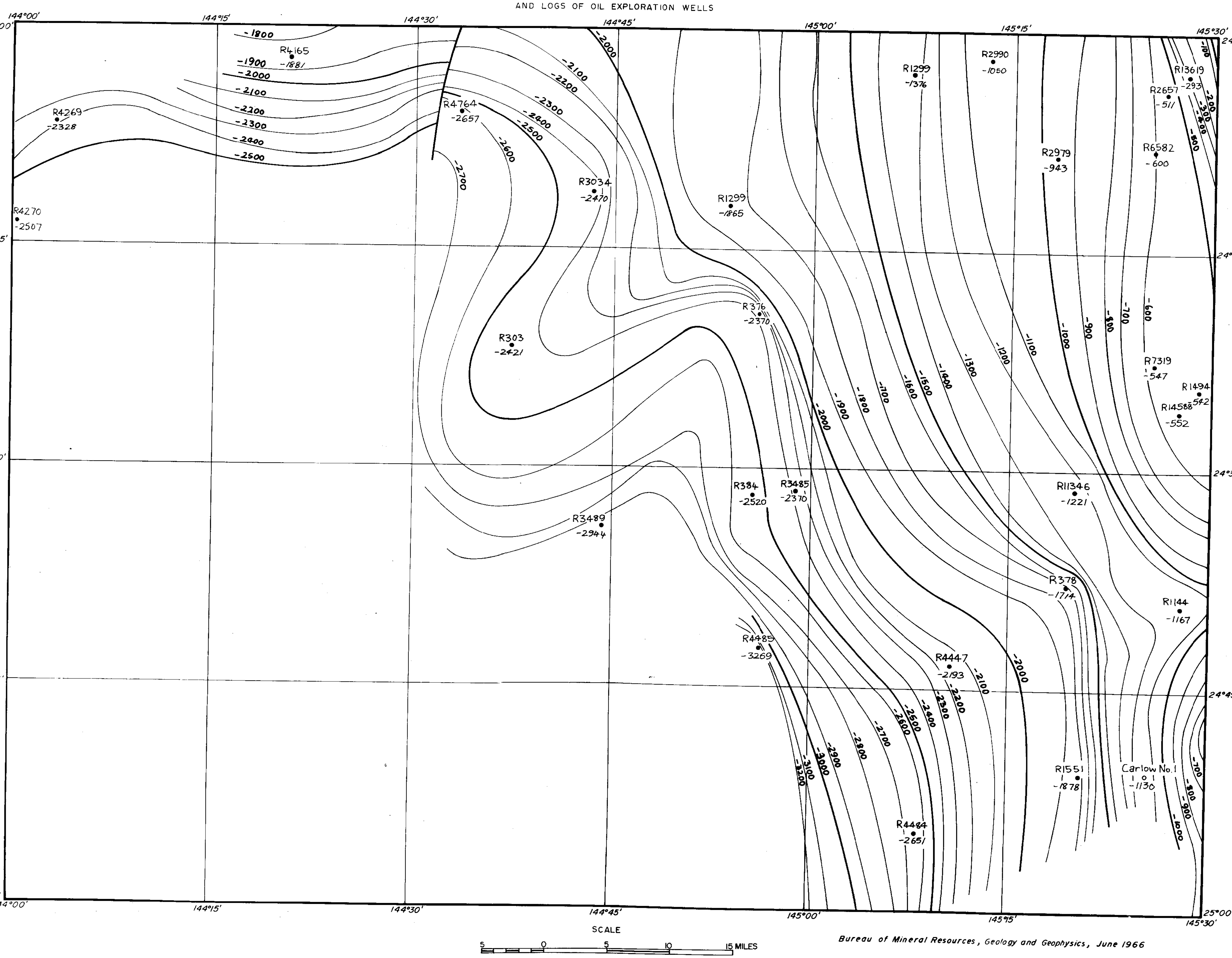
R12508	*Registered number of bore*		*Outcrop margin of Wilgunya Formation*
•	*Bore position*	x	*Spot height*
-500'	*Elevation on the base of Wilgunya Formation*		*Datum - Mean sea level*
Amoseas Westbourne No.1 •	*Oil exploration well*		*Contour interval 100 feet.*

To accompany Record 1966/89

BLACKALL 1:250,000 SHEET AREA CONTOURS ON THE TOP OF THE "HOORAY SANDSTONE"

FIG. 13

INTERPRETED FROM WATER BORE DRILLERS' LOGS AND LOGS OF OIL EXPLORATION WELLS



Bureau of Mineral Resources, Geology and Geophysics, June 1966

R4270	*Registered number of bore*		*Outcrop margin of Wilgunya Formation*
•	*Bore position*	x	*Spot height*
-500'	*Elevation on the base of Wilgunya Formation*		
○ Carlow No. 1	*Oil exploration well*		*Datum - Mean sea level. Contour interval 100 feet*

To accompany Record 1966/89

presence of Roma Formation lithologies in cuttings from seismic holes between the "Hooray Sandstone" outcrops on either side of the syncline. The presence of the syncline is confirmed by the seismic line along Stockade Creek (Geophysical Associates, 1965). Seismic evidence suggests faulting between this structure and the Valetta Anticline.

The Cunno Anticline

The Cunno Anticline, situated south-east of the Cave Syncline, across the northern part of the Augathella/Eddystone Sheet boundary, is named after Cunno Parish. Its axis trends north-east and the plunge is southwards. It was defined by outcrop pattern and airphoto interpreted dips in the "Hooray Sandstone", Injune Creek Group and, in the Eddystone Sheet area, the Hutton Sandstone. It does not seem to be reflected in the structure form-line pattern (Fig. 12), possibly because there is insufficient bore information. Amoseas Cunno No.1 was drilled on the anticline, in the Eddystone Sheet area.

Seismic evidence (Geophysical Associates, 1965) indicates that the structure extends south-westwards until it intersects the Raincourt Structure where a local closure, on Permian and Mesozoic reflectors, the Balfour Structure, has been detected. The southern flank of the anticline is almost certainly faulted (Geophysical Associates, op. cit.), and there is a very strong lineament visible in the formation boundaries along the flank.

Structures south of the Cunno Anticline

The Waverley Syncline and two other unnamed structures, all of which plunge southwards, occur south of the Cunno Anticline. They have been defined by outcrop pattern and airphoto interpreted dips in the "Hooray Sandstone" and Injune Creek Group, and are reflected in the structural form-line pattern on the top of the "Hooray Sandstone" (Fig. 12).

ECONOMIC GEOLOGY

Water

Underground Water

Most of the area covered in this survey is part of the Great Artesian Basin, and both artesian and sub-artesian aquifers are sources of underground water. The "Hooray Sandstone" and the Adori Sandstone are the main aquifers and produce good supplies of potable water. In the eastern part of the basin, there is only a thin cover of marine Cretaceous sediments and it is economic for drilling to continue to the very good supplies in the Lower Jurassic sandstones. Descriptions in drillers' logs are not good enough to distinguish between the Hutton, Boxvale and Precipice Sandstones in the Lower Jurassic. Most of the bores which have penetrated the artesian aquifers originally flowed, but many of these, particularly in the deeper part of the basin, have now ceased to flow and the water is pumped from shallow depths. The Westbourne and Birkhead Formations are generally aquicludes, although rarely small supplies come from these formations.

Sandstone beds in the Winton and Mackunda Formations contain aquifers which are important sources of water on Blackall Sheet and the western part of the Augathella Sheet. Bores are shallow, mostly less than 1,000 feet deep. None of these bores is flowing and the water, which is usually brackish, may eventually become too saline even for stock. Some flowing bores derive their water from the Coreena Member of the Wilgunya Formation, in the Augathella Sheet area.

East of the outcrop area of the Precipice Sandstone, the Clematis and Colinlea Sandstones are good suppliers of water. The water from the Clematis Sandstone is usually potable, but water bores in the Colinlea Sandstone generally produce brackish to saline water. Other units below the Clematis are not reliable sources of water although small supplies can be obtained from the Joe Joe and Ducabrook Formations.

The Engineering Section of the Geological Survey of Queensland is at present preparing a series of hydrogeological maps of Queensland at 1:1,000,000 scale. Salinity of the water, reservoir characteristics, and principal sources utilized, will be shown on these maps.

Surface Water

Underground water is the most reliable source of water, in this area of inconsistent rainfall. However, there are numerous earth tanks and dams, in and near creeks, gullies and depressions, especially in areas of clayey soil. These tanks and dams are particularly common on the black and brown soils of the Rolling Downs Group and the Birkhead Formation.

Oil and gas

Six wells have been drilled in the search for oil and gas in this area, and a general summary of each is given in Table 1. No significant petroleum shows have yet been seen in the area, but the density of drilling is only about one hole to 4000 square miles.

The best targets would appear to be the Adavale Basin sequence, and any possible marine Permian (Peawaddy Formation or its equivalent). Traces of oil were found in the marine Minmi Member of the Blythesdale Group, in the Mitchell Sheet area (Galloway and Duff, 1966), and its equivalent in this area, the "transition beds" (see Roma Formation), is a possible target. In fact, the entire marine Cretaceous sequence should not be discounted, as clean sandstones, which produce water supplies in bores, are present in both the Coreena Member and the Mackunda Formation. Depth of burial may have been much greater in the past than the present.

Boththe Triassic and Jurassic sequences contain acritarchs at some levels, which suggest periods of marine influence. The Devonian Dunstable Formation, if present, may be partially marine, but it is generally blanketed by the thick, hard Silver Hills Volcanics, which are not an economic drilling proposition.

If oil was formed anywhere in the sequence, there is an abundance of porous sandstone units, which would be excellent reservoirs. These include the Mount Hall Conglomerate, Colinlea Sandstone, Dunda Beds, Clematis Sandstone, the Precipice, Boxvale and Hutton Sandstones, the Adori Sandstone and the "Hooray Sandstone". There are numerous anticlinal and synclinal structures in this area. These generally persist throughout the sequence, and are strongly developed in the oldest rocks, but are little more than drape structures in the Jurassic and Cretaceous sediments. Several such structures have been drilled where there is closure. Formations frequently thin across the larger structures; this thinning is probably a combination of depositional and erosional, varying from situation to situation. There must be stratigraphic traps developed on the flanks of many of the anticlines (for more detail regarding the various structures see Structure). Faulting has been shown to occur in the subsurface, and fault traps could be present.

More siesmic work will reveal more possible traps, and the area still has potential for hydrocarbon production.

Construction Materials

Materials suitable for road construction are very scarce in the black soil parts of the area mapped, and inferior quality road construction materials have to be used. Lenses of tough, calcareous sandstone are common in the Cretaceous sediments, but they are not usually extensive enough to be useful as a source of paving material. "Gidgea gravel", an ironstained siliceous gravel, is quite common in the area as a thin surface layer and is used in sealing main roads. In places the duricrust capping on hills of Cretaceous sediments has been used in road surfacing but this material is not satisfactory.

In the largely sandy country in the north-eastern part of the Tambo Sheet area, roads are generally not surfaced, except in particularly boggy muddy patches, where local gravels are used. Roads in this area are passable, except after very heavy rain.

There are two unexploited possible sources of road metal in the Tambo Sheet area. One is the basalt-capped hill in the south-east of the area, some 40 miles east of Tambo town. This basalt, which is fine-grained and durable, is only 3 miles south of the formed road from Tambo to Mount Playfair. The hill has gentle slopes, and access to the metal would be no problem. The second is the various extrusive igneous rocks of the Silver Hills Volcanics in the Mount Beaufort Anticline, in the extreme north-east of the area. This area is about 12 miles east of the formed road from Star Downs Homestead to Alpha; Alpha is about 30 miles north of a possible intersection with this road.

The hard, massive, welded blocky ash flows and tuffs of the Silver Hills Volcanics, which form high ridges in the Mount Beaufort Anticline, would make very decorative and practical ornamental stone. This material is dominantly red or green in colour, with varicoloured fragments of other included volcanics. It varies from terrazzo-like to much finer or coarser-grained.

Bentonite

Although none has been seen, there is no doubt that the abundant bentonite in the Black Alley Shale to the east, persists across the north-eastern part of the Tambo Sheet area (see Black Alley Shale). Thompson and Duff (1965), proved some of the bentonite from the Springsure-Serocold Anticline "to be bentonite of high quality and, after treatment with dilute sodium carbonate solution, to be comparable with Wyoming Bentonite as a base for drilling mud". Leases have been taken up in the Springsure Sheet area as far west as Mantuan Downs Homestead, which is only 15 miles east of the Tambo Sheet boundary.

Torbanite

Torbanite crops out in the Colinlea Sandstone in a small creek two miles north of Glen Avon Homestead, in the north-eastern part of the Tambo Sheet area. The extent of this torbanite and the associated coal was proved by drilling by the Queensland Department of Mines (Connah, 1964). Estimated reserves are 150 to 180 million gallons of distillate.

Coal

Probably the most significant coal occurs in the Blackwater Group, in the north-eastern part of the Tambo Sheet area (see Blackwater Group). There have been a few reports of coal bands in drilling, and the electric log of SPL Birkhead No.1 suggests the presence of several coal seams (about 6 feet thick), near the top of the formation.

Coal is also present in the Birkhead Formation; seismic shot holes in the Caldervale Homestead - Cunno Homestead area (at the junction of the Tambo, Augathella, Eddystone and Springsure Sheet areas), contain appreciable coal. Drillers' logs show coal seams in the Winton Formation. Thin coal bands are probably present in the Colinlea Sandstone and some Jurassic sandstone units.

ACKNOWLEDGEMENTS

The authors wish to thank various geologists for helpful discussions; in particular J.E. Thompson, R.R. Vine and P.R. Evans of the Bureau of Mineral Resources, and R.W. Day of the Australian National University.

Thanks are also due to various oil companies, who were willing to provide us with ideas and material. Particular mention must be made of the geologists of American Overseas Petroleum Ltd and Phillips Petroleum Company. The photogeological maps of the area, by Geophotos Resources Consultants, provided by various companies, were much appreciated.

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APPENDIX 1

LOWER CRETACEOUS MACROFOSSILS FROM THE TAMBO AND AUGATHELLA 1:250,000 SHEET AREAS

by

R.W. Day

(a) APTIAN MACROFOSSILS FROM THE TAMBO SHEET AREA

Collections GAB1831, 2102 and 2115 are from a coarse sandstone at the base of the unit shown as Roma Formation on the preliminary edition of this sheet. Collection GAB2123 is from about the middle of the unit, and collections GAB2094 and 2101 are stratigraphically within 30-50 feet of the top of the unit.

Locality: GAB1831 Tributary of Barcoo River about 4 miles W. of "Gartmore" (m.r. 425916 Tambo mil. map).
In medium-grained, glauconitic sandstone.

Collector: N. Exon

Determinations:
Maccoyella barklyi (Moore)
Fissilunula clarkei (Moore)
"*Myacites*" *planus* (Moore)
Cyrenopsis opallites Etheridge Jnr.
Tatella maranoana (Etheridge Jnr.)
Worm burrows

Age: Aptian

Locality: GAB2102: Hillcrest on a track about 1 mile N. of Birkhead Creek and about 3 miles N.E. of "Enniskillen" (m.r. 424944 Tambo mil. map). In medium/coarse-grained, glauconitic sandstone.

Collector: R.W. Day

Determinations:
Fissilunula clarkei (Moore)
Cyrenopsis opallites Etheridge Jnr.
Tatella maranoana (Etheridge Jnr.)
Naticoid gastropod

Age: Aptian

Locality: GAB2115: About 1.5 miles N. of Tambo racecourse, and 2.5 miles N.E. of Tambo township (m.r. 430908 Tambo mil. map). In medium/coarse-grained, glauconitic sandstone.

Collector: R.W. Day

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

Age: Aptian

Locality: GAB2123: W. bank of Mount Pleasant Creek, just N. of where the road to "Truno" and "Mount Pleasant" crosses (m.r. 437904 Tambo mil. map). In grey mudstone and calcareous siltstone.

Collector: R.W. Day

Determinations:
Tropaeum australe? (Moore)
Maccoyella barklyi (Moore)
Inoceramus sp.
Teredo bored wood
Naticoid gastropod

Age: Aptian

Locality: GAB2094: Earth tank on road from Tambo to "Narada", about $\frac{3}{4}$ mile E.N.E. of "Narada" (m.r. 420897 Tambo mil. map). In silty sandstone and a coquinite band in calcareous siltstone.

Collectors: R.W. Day and M.C. Galloway

Determinations:
Peratobelus australis? (Phillips)
Barcoona trigonalis (Moore)
Nuculana sp. ind.
Euspira reflecta (Moore)
?Turritella sp.
Tracks of ?ditaxic gastropods

Age: Probably Aptian

Locality: GAB2101: E. side of road about 400 yards W. of Greendale bore (R11419) (m.r. 417919 Tambo mil. map). In coquinite bands in calcareous siltstone.

Collector: R.W. Day

Determinations:
Peratobelus selheimi (Tenison Woods)
Peratobelus australis? (Phillips)
Nototrigonia cf. cinctuta (Etheridge Jnr.)
Pseudavicula anomala (Moore)
Maccoyella corbiensis (Moore)
Fissilunula clarkei? (Moore)
Tancredia sp. 2
Nucula sp. 1
Euspira reflecta (Moore)
Laevidentalium sp.
Fossil wood

Age: Aptian

Remarks: The suggestion of Whitehouse (1954) that sediments at Tambo township were of Aptian age, is confirmed by the occurrence of a large Tropaeum species at GAB2123. The specimen, which is incomplete, has whorl sections, ribbing, and size comparable with Tropaeum australe (Moore, 1870, pl.15, fig.3) from the "Upper Maranoa", and is doubtfully identified with it.

Of the fauna from the basal sandstones only Cyrenopsis opallites has not been observed in the Minmi Member and the Roma Formation of the Roma area. In view of this faunal similarity, the basal sandstones near Tambo are assigned a general Aptian age. C. opallites, originally described from White Cliffs, N.S.W., by Etheridge Jnr. (1902, p.29, pl.5, figs. 12-17), is more orbicular than the common form in the Roma area referred to as Cyrenopsis cf. C. meeki by Day (1964).

Unlike the Minmi Member of the Roma area, these basal sandstones lack Meleagrinella species of Neocomian affinity. This may mean the basal sandstones of the Tambo area are not as old. However, their absence may only result from collection failure. A collection in the University of Queensland, Department of Geology made by Dr. F.W. Whitehouse from a coarse grained sandstone "2 miles N.E. of Mount Enniskillen" (apparently close to GAB2102), contains 3 species not found in the present collections. They are:- Camptonectes cf. socialis (Moore), Laevitrigonia lineata (Moore) and Thracia sp. Whitehouse's collection also includes 3 species reported here:- Maccoyella barklyi (Moore), Fissilunula clarkei (Moore) and Tatella maranoana (Etheridge Jnr.).

Species lists given by Dickins (1960) from the Longsight Sandstone and the Gilbert River Formation include Maccoyella barklyi, Fissilunula clarkei and Cyrenopsis cf. opallites. These units and the basal marine sandstones near Tambo are probably of similar age.

Maccoyella barklyi (Moore) is represented by single left valves at GAB1831 and GAB2123. The species has previously been reported from the Doncaster Member in the Richmond, Hughenden and Muttaburra areas. It also occurs in the Minmi Member, Wrotham Park Sandstone and the Maryborough, Roma, Blackdown, and Gilbert River Formations.

Maccoyella corbiensis (Moore) is represented at GAB2101 by several small and medium sized left valves and a few right valves. M. corbiensis occurs in the Doncaster and Jones Valley Members of the Hughenden and Richmond areas and in the Maryborough, Roma and Blackdown Formations.

Pseudavicula anomala here reported from GAB2101 and Fissilunula clarkei now reported from GAB1831, 2102, 2115 and doubtfully from GAB2101 have the same geographic and stratigraphic distribution as M. corbiensis, and in addition, occur in the Minmi Member.

Specimens of Tatella maranoana from GAB1831, 2102 and 2115 resemble those reported by Day (1964) from the Minmi Member and the Roma Formation in the Roma area.

"Myacites" planus (Moore) now recorded from GAB1831 has previously been reported from the Doncaster Member of the Richmond and Hughenden areas, the Minmi Member near Roma, and from the Blackdown and Roma Formations.

Nototrigonia cf. cinctuta (Etheridge Jnr.) is represented at GAB2101 by several quite well preserved left and right valves. The species has previously been reported from the Jones Valley Member of the Richmond area.

The ovate taxodont Nucula sp. 1 from GAB2101 is probably conspecific with forms reported from the Hughenden area at GAB1137 and 1145 (Doncaster Member) and GAB1139 (Jones Valley Member) as Nucula sp.

Internal and external moulds of Tancredia sp. 2 from GAB2101 resemble those reported by Day (1964) as Tancredia sp. from the Minmi Member of the Blythesdale Formation.

The erect species of Inoceramus represented at GAB2123 by a specimen with slightly displaced valves is unlike any Australian Albian species. Inoceramus is very rare in Aptian sediments in Australia.

A number of specimens of the small, trigonal shaped pelecypod Barcoona trigonalis (Moore) from GAB2094, comprise the first record of this species below the Coreena Member. The species is apparently a "facies fossil" as it forms coquinas in the overlying Coreena Member and Mackunda Formation.

The scaphopod Laevidentalium sp. from GAB2101 and the gastropod Euspira reflecta from GAB2094, 2101 and 2115 are long ranging Aptian-Albian species.

Peratobelus selheimi (Tenison Woods) is represented at GAB2101 by two belemnite guards which are incomplete apically, but show the large, deep alveòlus which houses the very large phragmocone of this species. One of the guards shows the ventrolateral grooves characteristic of the genus Peratobelus. P. selheimi is known from the Doncaster Member, and the Blackdown and Roma Formations. It appears to be restricted to the upper parts of these units.

Belemnites from GAB2094 and 2101 are doubtfully identified with Peratobelus australis (Phillips) because they resemble a specimen of P. australis from "Wollumbilla" figures by Moore (1870, pl.16, fig.6) as Belemnites paxillosus? However, the guards do not show ventrolateral grooves and their identification must remain tentative.

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ADDITIONAL APTIAN FOSSILS FROM THE TAMBO 1:250,000 SHEET AREA

Locality: GAB2130: Near fence corner about 1½ miles E. of the Landsborough highway about 8 miles S.E. from the turn-off to Mount Pleasant (m.r. 447891 Tambo mil. map).

Collector: M.C. Galloway

Lithology: Limestone concretions

Determinations: Aioloceras cf. jonsei (Gregory and Smith)
Pholadid bored wood

Age: Aptian

Remarks: The ammonite Aioleceras cf. jonesi is represented by a large specimen which is greater than 300mm. in diameter, and by several smaller specimens. In lateral view they resemble the type (and only known specimen) figured from the "Mitchell River" by Gregory and Smith (1903, pl.22) as Desmoceras jonesi. However, the whorl section of D. jonesi is not given, while the present material does not show the falcate ribbing on the initial whorls as strongly as does the type. Whitehouse (1926, p.207) referred Gregory and Smith's species to his new genus Aioloceras. The type species Cleoniceras argentinum Bonarelli and Nagera (1921, pl.4, figs. 3, 6, 7) from Patagonia, was originally assigned as Albian age. Whitehouse (1926, p.206) presumed its age to be Upper Aptian, for in the Lake San Martin area of Patagonia, it underlay rocks with Sanmartinoceras. Although attributed a Cenomanian age by its authors (Bonarelli and Nagera) this ammonite genus was regarded as a typical Upper Aptian one by Whitehouse. Evidence reviewed by Casey (1961, p.132) supports this view. Casey (1961, p.169) refers Aioloceras to the subfamily Pseudosaynellinae, an Aptian group which foreshadows the Albian Cleoniceratinae in their oxyconic form.

In Australia, the only previous report of Aioloceras and A. jonesi seems to be that of Gregory and Smith from the "Mitchell River", a locality assumed to be in Queensland. The present occurrence, stratigraphically and geographically close to locality GAB2123 with the Aptian ammonite Tropaeum, tends to confirm the Upper Aptian age attributed to Aioloceras jonesi by Whitehouse. If the type specimen is from the Mitchell River in North Queensland, it is probably from the Blackdown Formation of the Carpentaria Basin.

Several blocks of wood retain valves of boring pelecypods. They resemble those of living Pholadid rock and wood borers rather than those of the more specialized Teredo. Bored wood is occasionally found in all units of the marine Cretaceous of the Eromanga Basin.

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APTIAN MACROFOSSILS FROM THE AUGATHELLA 1:250,000 SHEET AREA

Locality: GAB1800: About 1 mile N.N.E. of "Willara".

Collector: N. Exon

Lithology: Calcareous, glauconitic siltstone

Determinations:
- Maccoyella reflecta (Moore)
- Camptonectes socialis (Moore)
- Euspira reflecta (Moore)
- Indet. small gastropods
- Lingula cf. subovalis Davidson
- Calcareous tubes (?annelid)

Age: Aptian

Locality: GAB1803: On track about 4 miles E.N.E. of "Lochinvar".

Collector: N. Exon

Lithology: Black limestone concretions

Determinations:

Tatella maranoana (Etheridge Jnr.)
Maccoyella sp. ind.
Peratobelus sp. ind.
Calcareous tubes (?annelid)

Age: Aptian

Locality: GAB2118: Earth tank about 1 mile E. of "Bellona".

Collector: M.C. Galloway

Lithology: Black limestone concretions

Determinations:

Ammonite fragment
Pseudavicula anomala (Moore)
Nuculana randsi Etheridge Jnr.
Camptonectes sp. ind.

Age: Aptian

Locality: GAB2116: On track about ½ mile N. of "Pleona Downs".

Collector: M.C. Galloway

Lithology: Grey mudstone

Determinations: Peratobelus oxys? (Tenison-Woods)

Age: Aptian

Locality: GAB2117: About 3½ miles S.S.E. of "Connemara".

Collector: M.C. Galloway

Lithology: Mud-pebble conglomerate and calcareous siltstone

Determinations:

Cyrenopsis cf. meeki (Etheridge Jnr.)
Camptonectes sp. ind.
Maccoyella fragments
Euspira reflecta (Moore)
Peratobelus oxys? (Tenison-Woods)
Peratobelus australis (Phillips)

Age: Aptian

Locality: GAB2142: 3½ miles S. of "Connemara".

Collector: M.C. Galloway

Lithology: Silty limestone concretion

Determinations: *Australiceras* sp. ind.

Age: Aptian

Locality: GAB2092: Earth dam near a tributary of Gidya Creek, about 4 miles N.E. of "Marento". (About 100 ft. stratigraphically below the base of the overlying Coreena Member).

Collectors: R.W. Day and M.C. Galloway

Lithology: Grey mudstone and silty limestone concretions

Determinations:
Peratobelus selheimi? (Tenison-Woods)
Pseudavicula anomala (Moore)
Camptonectes socialis (Moore)

Age: Aptian

Locality: GAB2089: Earth dam on a small tributary creek of Augathella Creek from the south, about 3 miles E.S.E. of "Burenda". (About 50-80 ft. stratigraphically below the base of the overlying Coreena Member.

Collectors: R.W. Day and M.C. Galloway

Lithology: Silty limestone concretions

Determinations:
Aconeceras sp.
Peratobelus selheimi (Tenison-Woods)
Tatella maranoana? (Etheridge Jnr.)
Nucula sp.
?*Cyrenopsis* sp. ind.
Worm burrows

Age: Aptian

Remarks: The occurrences of the typically Aptian (Roma) pelecypod species *Maccoyella reflecta*, *Pseudavicula anomala*, *Camptonectes socialis*, *Tatella maranoana*, together with species of the belemnite *Peratobelus* and the ammonites *Australiceras* and *Aconeceras*, indicate an Aptian age for sediments of the Augathella 1:250,000 Sheet area mapped as Roma Formation. Faunally they belong to the "Roma Series" of Whitehouse (1926). Similar faunas occur in the Doncaster Member of the northern Eromanga Basin and in the Roma Formation of the Surat Basin.

Whitehouse (1930, p.38) postulated overlap of the "Roma Series" by the "Tambo Series" along the eastern margin of the Eromanga Basin between Hughenden and Augathella. Occurrences of Roma faunas in the Doncaster Member of the Muttaburra area, and in the Roma Formation of the Tambo and Augathella areas have demonstrated that this view is incorrect.

The Aptian ammonite genus Australiceras is represented at GAB2142 by a comparatively small incomplete specimen which resembles A. irregulare (Tenison-Woods).

The presence of a small, well preserved specimen of the Barremian-Lower Albian genus Aconeceras close to the top of the unit indicates that these sediments are no younger than Lower Albian. In view of the occurrence of Australiceras in this unit an Aptian age is preferred for this Aconeceras species. Aconeceras sp. from the lower Ranmoor Member of Hughenden area is not conspecific.

The belemnite genus Peratobelus is represented by a number of cylindrical guards and occasional phragmocones. A large phragmocone and an apically incomplete guard from GAB2089 are identified as those of Peratobelus selheimi. The species is known from the upper part of the Aptian sequence in the Carpentaria, Eromanga and Surat Basins. Occurrences in basal and near basal sections of the overlying Coreena Member in the Tambo and Augathella areas are interpreted as remanié ones derived from Aptian mudstones. The guards are quite robust, and are thought to be capable of withstanding erosion and transport during the early Albian (Coreena) regression.

Longitudinal sections of belemnite guards doubtfully identified with Peratobelus australis have subcentral apices and axial lines. In those doubtfully identified with P. oxys, these features are more dorsally situated.

Maccoyella reflecta is represented by a few left valves, and a ventrally incomplete right valve. The species occurs in the upper parts of the Doncaster Member of the Hughenden area, and in the upper part of the Roma Formation of the Roma area.

Two small left valves of Pseudavicula anomala from GAB2092 and 2118 exhibit the typical shape and ornament of this Aptian species.

P. anomala also occurs in the Roma Formation of the Tambo area to the north and the Mitchell area to the south-east. Its geographic and stratigraphic distribution are given in the report on Aptian macrofossils from the Tambo area.

Tatella maranoana has a similar distribution. It is represented at GAB1803 by a specimen with slightly opened valves, and possibly at GAB2089 by a specimen with closed valves.

Internal and external mould of a left valve of Nuculana randsi from GAB2118 resembles specimens reported from the Roma Formation of the Mitchell area to the south-east.

Nucula sp. from GAB2089 is a small trigonal-shaped form like those common in the overlying Albian units.

Cyrenopsis cf. meeki is represented at GAB2117 by a specimen with closed valves and a right valve showing dentition. Closely similar forms occur in the Roma Formation of the Mitchell and Roma areas.

Two right valves of Camptonectes socialis from GAB1800 and a left valve from GAB2092 are also like specimens from the Roma and Mitchell areas.

Gastropods are represented in these collections by a few specimens of the long-ranging Naticid Euspira reflecta.

The collections also contain a single linguloid brachiopod, and various "worm" burrows which include thick calcareous tubes like those reported from the Roma Formation of the Mitchell area.

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(b) APTIAN AND LOWER ALBIAN MACROFOSSILS FROM THE COREENA MEMBER IN THE TAMBO 1:250,000 SHEET AREA

Locality: GAB1933: N.W. bank of Greendale Creek where Tambo-Blackall road crosses (m.r. 412921 Tambo mil. map).

Collectors: R.W. Day and D.J. Casey, 1965

Lithology: Coquina bands in fine, calcareous silty sandstone

Determinations:

Dimitobelus diptychus (McCoy)
Dimitobelus cf. liversidgei (Etheridge Jnr.)
Peratobelus selheimi (Tenison-Woods)
Fissilunula clarkei (Moore)
Tatella maranoana (Etheridge Jnr.)
Maccoyella corbiensis (Moore)
Pseudavicula papyracea Etheridge Jnr.
Nototrigonia cf. cinctuta (Etheridge Jnr.)
Barcoona trigonalis (Moore)
Cyrenopsis cf. meeki
Nuculana sp. ind.
Euspira reflecta (Moore)
Anchura? sp.
Laevidentalium sp.
?Laevidentalium sp.

Age: Lower Albian

Locality: GAB1936: On a fence line on E. side of Tambo - "Oakwood" road, about 6 miles from Tambo, and 1½ miles E. of this road (m.r. 431894 Tambo mil. map).

Collector: D.J. Casey, 1965

Lithology: Coquinite bands in fine, calcareous silty sandstone

Determinations:

Barcoona trigonalis (Moore)
Pseudavicula papyracea Etheridge Jnr.
"Corbula" superconcha Etheridge Jnr.
Maccoyella rockwoodensis? (Etheridge Jnr.)
Tancredia? sp. 1
Nuculana sp. nov. B

Age: Albian

Locality: GAB2107: S. side of "Minnie Downs" road about 1 mile from its junction with the Blackall-Tambo road (m.r. 418908 Tambo mil. map near locality 15 and 15a).

Collectors: R.W. Day and W. Jauncey, 1964

Lithology: Fine-grained, calcareous silty sandstone

Determinations:

Barcoona trigonalis (Moore)
Pseudavicula papyracea Etheridge Jnr.
Nuculana sp. nov. B
Tancredia sp. 1
?Fissilunula sp.
?"Avellana" sp.
Cycloid fish scales

Age: Albian

Locality: GAB2108: W. side of Tambo-Blackall road, about ½ mile S. of turn off to "Greendale" (m.r. 418913 Tambo mil. map).

Collectors: R.W. Day and W. Jauncey, 1964

Lithology: Coquinite bands in fine, calcareous silty sandstone

Determinations:

Barcoona trigonalis (Moore)
Pseudavicula papyracea Etheridge Jnr.
Nuculana sp. nov. B
Tancredia? sp. 1
Nototrigonia sp. ind.
Cycloid fish scales

Age: Albian

Remarks: Apart from long ranging species such as Pseudavicula papracea, Barcoona trigonalis, Euspira reflecta and Laevidentalium sp., these collections do not have much in common with those reported by Day (1965) from the Coreena Member of the Longreach area to the north. The present collections lack Myloceras sp., Aucellina hughendenensis, Inoceramus constrictus, Thracia cf. primula and Camptonectes sp.. Possibly they are older, as all are close to the base of the Coreena Member, while those from the Longreach area (where the base is not exposed) are from near the top of the unit.

Collection GAB1933 contains a unique and remarkable mixed Roma-Tambo fauna which has not been observed hitherto by the writer. Species typical of the Roma fauna, Peratobelus selheimi, Fissilunula clarkei, Tatella maranoana, Maccoyella corbiensis, Cyrenopsis cf. meeki, and Nototrigonia cf. cinctuta, occur in association with the typical Albian species, Dimitobelus diptychus, D. cf. liversidgei, Pseudavicula papyracea and Barcoona trigonalis. The belemnites Peratobelus selheimi, Dimitobelus diptychus and D. cf. liversidgei occur in conglomerate bands with mud-pebbles. Other species occur in coquinas composed mainly of countless numbers of the small pelecypod Barcoona trigonalis. From the nature of their occurrence it seems clear that none of the species are in their living position and that all are "derived". The locality is very close to the base of the Coreena Member.

A similar, but less striking mixed Roma-Tambo fauna was reported by Dickins (1960, p.7) from "7½ miles N.W. of Tambo along road to Blackall" (apparently near GAB2108). This locality is also very close to the base of the Coreena Member.

References to the mixing of Roma and Tambo faunas were made by Bryan and Jones (1946) and Whitehouse (1955). Bryan and Jones (1946, p.62) state "........the belemnites Tetrabelus and Peratobelus which occur jumbled together in countless profusion on one horizon at the top of the (Roma) series...." Whitehouse (1955, p.10) states "....and begin this latter (Tambo) sequence usually with a coquina and a belemnite bed with typical fossils of the later Tambo horizons, but with a few Roma genera (Peratobelus and Maccoyella) particularly persisting....." None of these authors localized the occurrences, but evidently all were referring to coquinas like that at GAB1933 at the base of the Coreena Member.

The observed mixing of the Aptian Roma and Albian Tambo faunas may be explained by any of three hypotheses:-
(i) all species are contemporaries and the range of the Roma species is here extended up into the Albian;
(ii) all species are contemporaries and the range of the Tambo species is extended down into the Aptian;
(iii) the Aptian Roma fossils are remanié ones derived from the erosion of the underlying Aptian mudstones and subsequently reincorporated, together with Tambo species in sediments of Albian age. The last mentioned is preferred for the following reasons.

The mixing of the two faunas occurs at the base of the sandy Coreena Member which represents a regressive phase during which sea-level fell. Erosion of the underlying Aptian mudstone to the east is therefore likely under such conditions.

Peratobelus selheimi, Maccoyella corbiensis, Nototrigonia cf. cinctuta and probably Fissilunula clarkei occur in silty coquinas near the top of the underlying Roma Formation at GAB2101, less than 3 miles E. of GAB1933. In addition both Tatella maranoana and Fissilunula clarkei are known from GAB1831 about 8 miles E.S.E. of GAB1933. Thus all the Aptian Roma species occur in the immediate geographic vicinity.

Erosion of Aptian sediments containing these species would make the Roma fossils available for incorporation in later (Albian) coquinas. The mode of occurrence of the fossils is not in conflict with this interpretation.

The most complete and best exposed marine Aptian-Albian sequence in the Eromanga Basin occurs in the Hughenden and Richmond areas. This sequence may be used as a standard of reference for determining the ranges of Roma and Tambo species. Comparison of the present occurrence with the Hughenden-Richmond sequence shows that Peratobelus selheimi, Tatella maranoana, Nototrigonia cf. cinctuta, Maccoyella corbiensis, Cyrenopsis cf. meeki and Fissilunula clarkei are found only in the Aptian units (Doncaster Member/Jones Valley Member). Dimitobelus diptychus characterizes the earliest Albian horizon in the lower part of the Ranmoor Member, and occurs 50-60 feet stratigraphically above the youngest Aptian horizon. If D. diptychus is the same age in the Tambo area, the Aptian Roma species associated with it are probably remanié fossils.

It is perhaps unfortunate from the viewpoint of intercontinental correlation that Dimitobelus diptychus is only a local fossil. The Lower Albian age attributed to it, is inferred from its stratigraphic occurrence in Flinders River sections, between the underlying Upper Aptian (dated by the ammonites Australiceras and Tropaeum) and the overlying Lower Albian (dated by the association of Beudanticeras and Eoneceras).

Interpretation of the Roma species at GAB1933 as remanié fossils has the additional advantage that it preserves the valuable distinction between Roma (Aptian) and Tambo (Albian) faunas, which can readily be made elsewhere.

Dimitobelus diptychus is represented at GAB1933 by numerous large guards associated with Dimitobelus cf. liversidgei and Peratobelus selheimi in belemnite mud/pebble conglomerates. Unlike the specimens of Peratobelus selheimi these guards show a strong development to the pseudalveolus. They are very clavate. None show the lateral lines as well as those figured by Phillips (1870, pl.16, figs. 3-4) from "Ward Creek" just S. of this area. In addition to occurrences in the Ranmoor Member, D. diptychus apparently also occurs in the Coreena Member near Aramac as Etheridge Jnr. (1892, pl.35, fig.9) figures a well preserved specimen from the "Aramac Town Well".

Dimitobelus cf. liversidgei is equally abundant and a number of the small spindle shaped guards retain their phragmocones. The species was originally described by Etheridge Jnr. (1892, pl.35, figs. 17-20) from Aramac as Belemnites? liversidgei. The species has previously been reported from the Allaru Member and the Mackunda Formation.

Peratobelus selheimi is represented by numerous guards which have a deep alveolus for the large phragmocone. Several show the single pair of deeply impressed ventrolateral grooves characteristic of this genus. The occurrence of Peratobelus selheimi in the upper parts of the Aptian sequences in the Carpentaria, Eromanga and Surat Basins has been noted previously (Day, 1964).

The single left valve of Tatella maranoana from GAB1933 shows the hinge features, and is a typical representative of this Aptian species.

Fissilunula clarkei is represented at this same locality by a large internal mould of a right valve showing hinge features and by three ventrally incomplete external moulds of right valves. They compare closely in shape, ornament and hinge features with specimens from the underlying Roma Formation. Fissilunula clarkei occurs in the oldest Aptian sediments (Minmi Member, Gilbert River Formation, Longsight Sandstone) and ranges to the top of the Aptian sequence (Jones Valley Member).

About 10 left valves of Maccoyella corbiensis are present at GAB1933. A few retain the characteristic multicostate ornament of this species, but most are exfoliated to some degree.

Nototrigonia cf. cinctuta is represented at GAB1933 by three large internal and external moulds of left valves which have more flank ribs than the Albian species N. minima. N. cf. cinctuta has previously been reported from the adjacent locality GAB2101 (Roma Formation), and from the Jones Valley Member of the Richmond area.

Several internal and external moulds of right and left valves from GAB1933 are very like that figured from this area by Etheridge Jnr. (1907, pl.62, figs. 1-3) as Cytherea? moorei. The type of this South Australian species figured by Hudleston (1884, pl.11, figs. 7a and b) as Cyprina? sp., and refigured by Etheridge Jnr. (1892, pl.34, figs. 12-13) is less similar. The hinge features of the present specimens are those of the genus Cyrenopsis, and the overall form closely resembles that of the typically Aptian C. meeki.

Pseudavicula papyracea is represented at GAB1933, 1936, 2107 and 2108 by numerous right and left valves. The species is known from the Coreena and Allaru Members and the Mackunda Formation.

Nuculana sp. nov. B, a species with an almost squarely truncate posterior has not been previously reported from the Coreena Member. At GAB1936, 2107 and 2108 it is represented by several well preserved internal and external moulds of both valves. Nuculana sp. from GAB1438 in the Coreena Member of the Longreach area is similar, but has slightly more central umbones. Reports of Nuculana sp. nov. B have previously been confined to the Allaru Member and the Mackunda Formation.

The small, trigonal shaped pelecypod Barcoona trigonalis forms coquinas at GAB1933, 1936, 2107 and 2108. The species ranges from the top of the underlying Roma Formation to the Mackunda Formation.

None of the specimens of Tancredia? sp. 1 from GAB1936, 2107 and 2108 reveal the hinge features. However, in their expanded posteriors and narrower, bluntly rounded anteriors, they closely approach the shape of ?Tancredia sp. from the Coreena Member of the Longreach area (GAB1703).

?Fissilunula sp. is represented at GAB2107 by numerous internal and external moulds of closed valves. The overall form is cyprinoid, but the lack of hinge features and musculature makes generic identification impossible. The umbones seem less prominent than those of the Aptian species Fissilunula clarkei. A somewhat similar specimen was reported from GAB1433 in the Coreena Member of the Longreach area.

Several anteriorly rostrate right and left valves from GAB1936 closely resemble specimens (F.10313; F.10334; F.10335; F.10337 - F.10339; F.10341; F.10608; F.10622 - F.10625 Aust. Mus.) described from this area by Etheridge Jnr. (1907, p.324) as Corbula superconcha, but not figured. They are small to medium in size, but unfortunately lack hinge features.

The single, small trigonal shaped taxodont Nucula sp.from GAB1936 resembles similar small forms reported from the Jones Valley, and Allaru Members and from the Mackunda Formation.

The long ranging Aptian-Albian scaphopod Laevidentalium sp. is represented at GAB1933 by several thin shelled specimens. Larger, thicker shelled forms which are more numerous at this locality are designated ?Laevidentalium sp.

Gastropods are not well represented in these collections. A few specimens of the Aptian-Albian species Euspira reflecta occur at GAB1933, together with an indeterminate turreted form referred to as Anchura? sp.. A single, small, poorly preserved specimen designated ?"Avellana" sp. occurs at GAB2107.

In addition, collections GAB2107 and 2108 contain a few cycloid fish scales.

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APTIAN AND LOWER ALBIAN MACROFOSSILS FROM THE COREENA MEMBER IN THE AUGATHELLA 1:250,000 SHEET AREA

Locality: GAB2090: Hillcrest about ½ mile W. of GAB2089, and about 2½ miles E.S.E. of "Burenda".

Collectors: R.W. Day and M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: *Barcoona trigonalis* (Moore)
Tancredia? sp.1?

Age: Albian

Locality: GAB2088: Small quarry on N. side of road about 1½ miles N.E. from GAB2087.

Collectors: R.W. Day and M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: *Barcoona trigonalis* (Moore)
Camptonectes sp.
Nuculana sp. nov. B
?*Fissilunula* sp.
Tatella? sp. 2
Laevidentalium sp.
Euspira reflecta (Moore)

"Avellana" spp.
?Anchura sp.

Age: Albian

Locality: GAB2087: Small quarry on S. side of road about 1½ miles E.N.E. of "Burenda".

Collectors: R.W. Day and M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations:

Barcoona trigonalis (Moore)
Thracia cf. primula Hudleston
Nuculana sp. nov. B
Tancredia? sp. 1
?Fissilunula sp.
Tatella? sp. 2
Euspira reflecta (Moore)
Laevidentalium sp.
Indet. belemnite

Age: Albian

Locality: GAB2057: Corner of cultivated paddock on "Westquarter" about 1½ miles E. of Artesian bore 5634, and about 4 miles W.S.W. of "Yandala".

Collectors: R.W. Day and M.C. Galloway

Lithology: Coquina bands in fine-grained sandstone

Determinations:

Dimitobelus diptychus (McCoy)
Dimitobelus cf. liversidgei (Etheridge Jnr.)
Peratobelus selheimi (Tenison-Woods)
Barcoona trigonalis (Moore)
Indet. trigoniid
Euspira reflecta (Moore)
"Vanikoropsis" stuarti Etheridge Jnr.
Shark tooth
Worm burrows

Age: Lower Albian

Locality: GAB2059: Tributary of the Ward River about 3 miles S. of "Baneda"

Collector: M.C. Galloway

Lithology: Silty coquina

Determinations:

Dimitobelus diptychus (McCoy)
Peratobelus selheimi (Tenison-Woods)
Barcoona trigonalis (Moore)
Pseudavicula papyracea Etheridge Jnr.
Maccoyella sp. ind.
Nototrigonia sp. ind.
Tancrediid aff. "Myacites" planus Moore
Indet. naticoid gastropods

Age: Lower Albian

Locality: GAB2055: Near fence about 2½ miles S. of "Chatham"

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: *Barcoona trigonalis* (Moore)

Age: Albian

Locality: GAB2039: Near intersection of two tracks about ¼ mile N. of "Callala".

Collector: M.C. Galloway

Lithology: Coquina band in calcareous sandstone

Determinations:
Dimitobelus diptychus (McCoy)
Peratobelus selheimi (Tenison-Woods)
Barcoona trigonalis (Moore)
"*Corbula*" *superconcha* Etheridge Jnr.
Nuculana sp. nov. B
Maccoyella sp. ind.
Euspira reflecta (Moore)
Anchura sp. ind.
Shark tooth

Age: Lower Albian

Locality: GAB2041: On road about 1½ miles S.E. of "Callala"

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations:
Barcoona trigonalis (Moore)
"*Corbula*" *superconcha*? Etheridge Jnr.
Indet. belemnite
Carbonaceous plant fragments

Age: Albian

Locality: GAB2061: Tributary of Ward River about 5 miles N.E. of "Westbourne"

Collector: M.C. Galloway

Lithology: Fine-grained friable sandstone

Determinations:
Barcoona trigonalis (Moore)
Nuculana sp. ind.

Age: Albian

Locality: GAB2062: Tributary Ward River where it crosses "Landsdowne" - "Westbourne" road, about 9 miles from "Landsdowne".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: *Barcoona trigonalis* (Moore)

Age: Albian

Locality: GAB2022: On road near small creek about 2½ miles E.N.E. of "Raincourt".

Collector: M.C. Galloway

Lithology: Silty mud-pebble conglomerate

Determinations: Indet. belemnite

Age: Probably Albian

Locality: GAB2043: Turn off to "Ashby Downs" about ½ mile E.N.E. of GAB2022.

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: *Barcoona trigonalis* (Moore)

Age: Albian

Locality: GAB2086: About ¼ mile N.E. of "Burenda".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations:
Barcoona trigonalis (Moore)
Maccoyella sp. ind.
Laevidentalium sp.

Age: Albian

Locality: GAB2079: On tributary of Augathella Creek about 1 mile E.N.E. of "Bonfield".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations:
Dimitobelus diptychus (McCoy)
Dimitobelus cf. *liversidgei* (Etheridge Jnr.)
Barcoona trigonalis (Moore)
Nucula sp.
Anchura sp. ind.

Age: Lower Albian

Locality: GAB2081: Near road about 2 miles S.E. of "Bonfield".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: Barcoona trigonalis (Moore)
"Corbula" superconcha Etheridge Jnr.
Euspira reflecta (Moore)

Age: Albian

Locality: GAB2084: Near earth tank about 4 miles S.S.E. of "Overshot".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: Barcoona trigonalis (Moore)
"Corbula" superconcha Etheridge Jnr.
Nuculana sp. nov. A?
Laevidentalium sp.
"Vanikoropsis" stuarti Etheridge Jnr.

Age: Albian

Locality: GAB2083: About ¼ mile N.W. of "Warrah".

Collector: M.C. Galloway

Lithology: Silty and sandy coquinite

Determinations: Dimitobelus diptychus (McCoy)
Dimitobelus cf. liversidgei (Etheridge Jnr.)
Indet. pelecypod shell fragments

Age: Lower Albian

Locality: GAB2085: About ½ mile E. of "Warrah".

Collector: M.C. Galloway

Lithology: Fine-grained calcareous sandstone

Determinations: Barcoona trigonalis (Moore)
Tancredia? sp. 1

Age: Albian

Locality: GAB2056: Road junction about 2 miles W. from "Chatham".

Collector: M.C. Galloway

Lithology: Silty coquinite

Determinations: Barcoona trigonalis (Moore)
"Corbula" superconcha Etheridge Jnr.
Nucula sp.
Nuculana sp. ind.

Age: Albian

Remarks: The 19 collections reported from the Coreena Member in the Augathella 1:250,000 Sheet area are listed in approximate stratigraphic order. Marine fossils appear to be restricted to the lower part of the unit. The upper parts are highly carbonaceous, lack marine fossils, and may be non-marine.

At 3 localities, GAB2039, 2057 and 2059, in the lower part of the unit, the Upper Aptian Roma belemnite Peratobelus selheimi was found in association with the Lower Albian Tambo belemnite Dimitobelus diptychus in coquinas. A similar mixed Roma-Tambo fauna was reported from GAB1933 at the base of the Coreena Member in the Tambo 1:250,000 Sheet area. At GAB1933 more Roma species were present, but the three Augathella localities are not as close to the base of the member. Reasons for considering occurrences of Roma species in the Coreena Member as remanié ones are given in the report on Coreena macro-fossils from the Tambo 1:250,000 Sheet area.

The Coreena fauna from the Augathella 1:250,00 Sheet area closely resembles that of the adjacent Tambo 1:250,000 Sheet area to the north. Dimitobelus diptychus, D. cf. liversidgei, Barcoona trigonalis, Pseudavicula papyracea, Nuculana sp. nov. B, Tancredia? sp. 1, "Corbula" superconcha, Fissilunula? sp., Laevidentalium sp. and Euspira reflecta occur in both areas. Like Coreena collections from the Tambo area, the present collections contain no ammonites and no Aucellina or Inoceramus species. The occurrence of these forms in Coreena faunas from the Longreach and Muttaburra areas stands in distinct contrast. This may mean that in Coreena (early Albian) time the northern Longreach-Muttaburra areas were closer to open seaways than the southern Tambo-Augathella ones. Alternatively, the faunal differences may be due to differences in age or to a combination of palaeogeographic and time factors.

The small trigonal shaped pelecypod Barcoona trigonalis is extremely abundant in almost all the collections reported here. Although, the species is also known from the top of underlying Roma Formation in the Tambo area, and the Mackunda Formation of the Manuka area, the bulk of its occurrences are in the Coreena Member.

Several internal and external moulds of right and left valves from GAB2059 appear to be conspecific with forms reported from the Mackunda Formation of the Manuka, Tangorin, and Muttaburra areas as Tancrediid aff. "Myacites" planus.

Thracia cf. primula is represented at GAB2087 by a well preserved left valve which closely resembles a specimen from GAB1406 in the Coreena Member of the Longreach area. Thracia primula was originally described by Hudleston (1890, pl.9, fig. 7) from "Primrose Springs" in South Australia. It is also known in the Minmi Member of the Roma area and in N.W. New South Wales.

The species designated Camptonectes sp. is represented at GAB2088 by two small left valves. Specimens figured by Etheridge Jnr. (1892, pl.21, figs. 7, 8, 9) are conspecific. The species is known from the Coreena Member of the Longreach and Muttaburra areas, and from the Allaru Member and the Mackunda Formation.

Forms tentatively identified as Tancredia? sp. and ?Fissilunula sp. compare closely with similarly designated forms reported from the Coreena Member of the Tambo and Longreach areas.

A few small specimens from GAB2087 and 2088 are congeneric with the Aptian species figured by Etheridge Jnr. (1892, pl.28, figs. 2 and 3) from the Maranoa River near Mitchell as Corbicella ? maranoana? An anteriorly incomplete right valve reported from GAB1304 in the Mackunda Formation of the Muttaburra area as Tatella? sp. 2 may be conspecific. Similarly shaped forms also occur in the Allaru Member in B.M.R. Longreach S.H. 2 from 222'2½" - 222'4" and at GAB1433 in the Coreena Member of the Longreach area. The Albian specimens seem to have more posterior umbones than the Aptian ones.

Specimens of "Corbula" superconcha from GAB2039, 2041, 2056, 2081 and 2084 closely resemble those reported from GAB1936 in the Coreena Member of the Tambo area.

Pseudavicula papyracea is not as well represented in these collections as in those from the Tambo and Longreach areas. Specimens from GAB2059 are quite large for this species. P. papyracea from the Coreena Member to the Mackunda Formation.

Nuculaceans are quite numerous in these collections. Small trigonal shaped specimens of Nucula sp. occur at GAB2056 and 2079. They closely resemble a specimen from GAB1936 in the Coreena Member of the Tambo area. Similar forms are abundant in the Allaru Member and the Mackunda Formation. The species Nuculana sp. nov. B reported from GAB2039, 2087 and 2088, has been discussed in the report on Coreena macrofossils from the Tambo area. A small internal mould of a right valve from GAB2084 doubtfully identified with Nuculana sp. nov. A differs in being posteriorly rostrate. Unfortunately, the ornament is not known. N. sp. nov. A characteristically has strong concentric ribs. The species is known from the Mackunda Formation of the McKinlay area (GAB652 and 653), the Allaru Member in AAO Penrith No.1, and from the Coreena Member from 111'10½" - 112' in B.M.R. Longreach S.H. 5.

The long-ranging Aptian-Albian naticid gastropod Euspira reflecta is extremely abundant in collections from GAB2039, 2057, 2087 and 2088. Other gastropods are less common. "Vanikoropsis? stuarti Etheridge Jnr. (1902, pl.6, figs. 18-20) from the Lake Eyre basin of South Australia is represented at GAB2057 and 2084 by several well preserved internal and external moulds. The species has previously been observed in collections from the Mackunda Formation. Small spirally ribbed forms from GAB2088 are designated "Avellana" spp. as they resemble those figured by Etheridge Jnr. (1920) under this name. There are also a few turreted gastropods tentatively referred to the genus Anchura.

The collections also contain a few, small, smooth scaphopods referred to Laevidentalium sp., shark teeth, worm burrows, and carbonaceous plant fragments.

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ETHERIDGE, R. Jnr., 1892: In JACK, R.L., and ETHERIDGE, R. Jnr. The geology and palaeontology of Queensland and New Guinea. Geol. Surv. Qld Publ., 92, 2 vols.

ETHERIDGE, R. Jnr., 1902 - The Cretaceous mollusca of South Australia and the Northern Territory. Mem. Roy. Soc. S. Aust., 2 (1), 1-54.

ETHERIDGE, R. Jnr., 1920 - Small gasteropoda from the Lower Cretaceous of Queensland. Geol. Surv. Qld. Publ., 269, 8-20.

HUDLESTON, W.H., 1890 - Further notes on some mollusca from South Australia. Geol. Mag., 7 (N.S.), 241-246.

(c) ALBIAN FOSSILS FROM THE TOOLEBUC MEMBER IN THE TAMBO 1:250,000 SHEET AREA

Locality: GAB1926: On track about 2 miles N.N.E. of "Harden Park" (m.r. 375974 Tambo mil. map).

Collector: D.J. Casey, 1965

Lithology: Silty limestone concretions

Determinations: *Aucellina hughendenensis* (Etheridge Snr.)
Inoceramus fragments
Cycloid fish scales
Fragmentary fish bones

Age: Albian

Locality: GAB2035: Where track crosses a small stream about 4½ miles E.S.E. of "Fairview" (m.r. 384948 Tambo mil. map).

Collectors: D.J. Casey, R.R. Vine and M.C. Galloway, 1965

Lithology: Silty limestone concretions

Determinations: *Falciferella*? sp.
Dimitobelus sp. ind.
Aucellina hughendenensis (Etheridge Snr.)
Inoceramus fragments
Cycloid fish scales
Fish bone fragments

Age: Albian

Locality: GAB2036: ½ mile N.E. of "Bex Hill" (m.r. 396914 Tambo mil. map)

Collectors: D.J. Casey, R.R. Vine and M.C. Galloway, 1965

Lithology: Silty limestone concretions

Determinations: *Appurdiceras* sp.
Aucellina hughendenensis (Etheridge Snr.)
Inoceramus fragments
Indet. naticoid gastropod
Cycloid fish scales
Fish bones fragments

Age: Albian

Locality: GAB2106: On track about 4½ miles W.N.W. of "Swan Hill" (m.r. 385941 Tambo mil. map).

Collector: R.W. Day, 1965

Lithology: Silty limestone concretions

Determinations: Aucellina hughendenensis (Etheridge Snr.)
Inoceramus fragments
Cycloid fish scales
Fish bone fragments

Age: Albian

Remarks: The presence at GAB2036 of a hook and shaft referable to the hetermorph ammonite genus Appurdiceras indicates that these rocks are probably of early Upper Albian age. Appurdiceras is a component of the Myloceras-Labeceras ammonite fauna which characterizes the Allaru Member and has a sparse representation in the Toolebuc Member and the Mackunda Formation. It differs from the related genus Labeceras in possessing ventro-lateral tubercles. Appurdiceras species have previously been observed in the Toolebuc Member of the Richmond area, in the Allaru Member of the Hughenden, Tangorin and Muttaburra areas, and may occur at only one locality (GAB834) in the Mackunda Formation of the Manuka area.

Falciferella? sp. represented by a single, small, poorly preserved specimen from GAB2035, is similar to ammonites previously reported under this name from the Toolebuc Member of the Richmond area. Somewhat similar Binneyitids are known from the Ranmoor Member in the Hughenden area and from the Allaru Member in the Julia Creek and Richmond areas.

The single apically incomplete belemnite from GAB2035 is clearly a member of the Albian - Senonian genus Dimitobelus, but cannot be determined specifically. The phragomocone is preserved in place, and the position of the paired grooves on the same side as the siphuncle offers further confirmation of Glaessner's (1957) interpretation of the grooves as ventro-lateral.

Aucellina hughendenensis is represented at GAB1926, 2035, 2036 and 2106, by numerous large right valves, some of which are 45mm. high and are thus enormous for this species. The left valves in these collections tend to be smaller. Some of the left valves from GAB1926 to 2106 have broader umbones and less posterior obliquity than typical specimens. They closely resemble variants reported from GAB1125 and 1127 in the Ranmoor Member of the Richmond area. Aucellina hughendenensis is known from the Ranmoor, Coreena, Toolebuc and Allaru Members.

These collections also contain abundant prismatic Inoceramus fragments, an indeterminate naticoid gastropod, and numerous cycloid fish scales and fish bone fragments.

References

GLAESSNER, M.F., 1959 - Cretaceous belemnites from Australia, New Zealand and New Guinea. Aust. J. Sci. 20, 88-9.

APPENDIX 2

PALYNOLOGY OF SHALLOW DRILL HOLES IN THE TAMBO 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 Tambo 1:250,000 Sheet area, have been examined for their content of spores, pollen grains and micro-plankton. 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	56'3"	MFP3983	Triassic	Rewan	(Barren)
	2	121'	3984	Permian	Blackwater Group	P3d/P4
	3	161'10"	3985			P3d
2	1	87'2"	3986	Jurassic	Boxvale Sst.	J2
	3	210'	3987		Precipice Sst.	J1
4	1	227'4"	3982		Westbourne	J5

Prior to this study, unit P3d microplankton (acritarchs) had not been found west of the Denison Trough, where they are restricted to the Black Alley Shale (Evans, 1964, 1966). The Black Alley Shale on the Springsure Shelf, as seen in BMR5 (Springsure) did not appear to contain these fossils. The Black Alley Shale in outcrop or near surface in the Tambo area has not been examined, although samples from the formation's subsurface developments in the Birkhead, Boree and Westbourne wells had not yielded microplankton. The presence of the unit P3d microfossils in the Blackwater Group in the Tambo Sheet area may now be interpreted: either that there is a lateral facies change westwards, which brings the Blackwater Group lithology into the Tambo Sheet area at an earlier time than in the region of the Denison Trough; or the marine or brackish facies, in which the microplankton thrived, briefly returned to the Tambo area at a later time than its final withdrawal from the Denison Trough. BMR32 (Tambo), the top of which is about 200 feet stratigraphically lower than the sampled unit P3d horizon of BMR1 (Tambo), penetrated about 100 feet of Black Alley Shale, which will be examined for an acritarch content in an effort to clarify the issue.

The palynological ages of cores from BMR2 (Tambo) compare with the ages of the formations sampled elsewhere in the Great Artesian Basin. Core 1 appeared to come from near the base of unit J2, but there was no sign of acritarchs within the residue (cf. the base of J2 in the Surat Basin).

Rare acritarchs (*Micrhystridium* spp.) were observed in the core of J5 age from the Westbourne Formation in BMR4 (Tambo).

REFERENCES

EVANS, P.R., 1964 - A correlation of some deep wells in the north-eastern Eromanga Basin. Bur. Min. Resour. Aust.Rec. 1964/197 (unpubl.).

EVANS, P.R., 1966 - Palynological studies in the Longreach, Jericho, Galilee, Tambo, Eddystone and Taroom 1:250,000 Sheet areas, Queensland. Ibid., 1966/61 (unpubl.).

APPENDIX 3

EXAMINATION FOR FORAMINIFERA IN WILGUNYA FORMATION, AUGATHELLA SHEET AREA

by

G.R.J. Terpstra

Outcrop and shot-hole samples from the Augathella area, submitted by M.C. Galloway, have been examined.

The results are as follows:

Outcrop samples:

65582039 Weathered shale - no foraminifera
65582045 Sandstone and some shale - no foraminifera
65582071 Weathered shale with mica - no foraminifera

Shot-hole samples:

65582119 Quartz and lignite - no foraminifera
65582120 Quartz, some lignite - no foraminifera
65582121 Quartz and much glauconite, poor arenaceous fauna indicating a Lower Cretaceous age. From Coreena Member (M.C.G.).
65582122 Quartz some lignite and glauconite - no foraminifera

APPENDIX 4

PLANT FOSSILS FROM THE GREAT ARTESIAN BASIN

by

Mary E. White

(Adapted from Part 4 of B.M.R. Record 1966/111 which contains the illustrations referred to below)

Summary

Beautifully preserved Triassic/Lower Jurassic plants were collected from the Moolayember Formation at locality GAB1816. At locality GAB1822 in the Adori Sandstone an Upper Triassic/Lower Jurassic flora occurs.

1. Locality GAB1816: Springsure Sheet area. Moolayember Formation, at the unconformity with Precipice Ss. 2 miles E. of Tambo/Springsure Sheet boundary and 1 mile S. of the old Springsure/Tambo road. (This is locality SP664 collected in 1963).
   Photo: Tambo, Run 12A, 5053.

   Specimens Nos. F22702 - F22708.

These specimens are excellently preserved. The fossils are in the form of grey or brown-iron-stained impressions on the fine-grained purple sandstone.

The following plants are identified:-

Dicroidium odontopteroides (Morr.) Gothan
Pterophyllum nathorsti (Seward)
Otozamites obtusus L. & H.
?*Otozamites queenslandi* Walkom - terminal portion of pinnule only
Dicroidium feistmanteli (Johnst.) Gothan
Baiera bidens (Ten.-Woods)

Figure 2 of specimen F22702 and Figure 3 of specimen F22703 show all the diagnostic forms except *Baiera bidens*, which was identified on a lobe of the bifid pinna by its venation.

In the 1963 collection from the same locality (SP664) *Pterophyllum abnorme* Eth. fil. and *Dicroidium coriacium* (John.) Townrow were identified.

The flora is a Trias-Jurassic flora indicating that the Moolayember Formation is either Triassic or Lower Jurassic or transitional between the two.

Age: Triassic or Lower Jurassic

2. Locality GAB1822: Tambo Sheet area. From soft band about 100 feet from base of Adori Sandstone. On track between Myall Grove and Enniskillen, 2 miles west of Myall Grove.

   Specimens F22709 - F22716.

The fossils are in the form of excellently preserved impressions strained brown and red on pale grey, fine sandstone.

The following are identified:-

(a) *Lepidopteris stormbergensis* (Seward) nov. comb.

Illustrated in Figure 4 of specimen F22709. This excellent specimen suggests that the form identified in SP664 as *Dicroidium coriacium* (Johnst.) Townrow might be more accurately identified as Lepidopteris stormbergensis. Identification of these very similar forms from impressions only is not a simple matter.

(b) Taeniopteris spatulata McClelland. Illustrated in Figure 5 of specimen F22710.

(c) Cladophlebis australis (Morr.) - the common fern which ranges from Triassic to Lower Cretaceous.

(d) Ptilophyllum pecten (Phillips). Illustrated in Figure 6 of specimen F22712.

(e) Sphenopteris sp. cf. S. superba (Shirley). Fragments of fern with sphenopteroid venation.

(f) Ginkgo antarctica Saporta, a small leaf illustrated in Figure 7 of specimen F22715. This is an Upper Triassic/Jurassic flora.

Age: Upper Triassic/Jurassic.

APPENDIX 5

SHALLOW STRATIGRAPHIC DRILLING, TAMBO SHEET AREA, 1965

by

N.F. Exon

Five shallow drill holes were drilled in the Tambo Sheet area in 1964 (see Mollan, Exon and Forbes, 1965). The strata penetrated in these are illustrated in this record, in Figs. 3, 4 and 5.

During 1965, Exon supervised the drilling of four more shallow drill holes in the Tambo Sheet area (735 feet of drilling and 95 feet of coring), from the 10th to 19th November. The rig used was a Carey, belonging to the Petroleum Technology section of the BMR. 220 feet of drill pipe, two core barrels, and equipment for drilling with mud, were available. Three of the holes were logged with a Widco Portalogger, which produced gamma ray and electric logs.

Many problems came up with the drilling. The Carey, which came from a seismic party, had not been properly serviced; this led, in particular, to trouble with the hydraulic rotary head. Compared with previous Great Artesian Basin/Surat Basin drilling, using seismic contractor's Mayhew 1000 rigs, the Carey drilling was unsatisfactory. The four holes were drilled in nine full days at the various sites. This compares with 25 similar holes in 13 days in 1964 (Mollan et al., 1965).

This sort of drilling is aimed at:-

(1) obtaining lithological information of poorly exposed formations

(2) intersecting formation boundaries

(3) obtaining palynological information.

For these purposes, drilling of dry holes to 300 to 400 feet, with 10 foot cores perhaps every 50 feet, or as the well site geologist decides, has proved satisfactory; the dry cuttings give a good idea of general lithology, the cores of structure. A second useful method is to continuously core holes to, say, 250 feet. The Mayhew rigs can quickly and efficiently be used for both these methods.

The Carey, which generally must drill with mud below a few tens of feet, produces very inferior, and often misleading, cuttings. The speed with which pipe footage can be added is approximately half that for the Mayhew, and coring itself is a little slower. Thus every core takes twice the time to recover with this rig.

Again, the Carey has difficulty producing the power to drill below 200 feet, and such drilling is distinctly risky; the chance of losing drill pipe and core barrel is considerable.

To sum up, the Carey is much slower than the Mayhew, produces shallower holes, and very inferior material from those holes. When one considers that the weathering zone in this part of the Great Artesian Basin is about 70 feet thick, the advantages of a 250 to 300 foot hole, over a 150 to 200 foot hole, are very obvious.

The writer believes that the far greater speed and efficiency of a BMR Mayhew rig would outweigh the comparatively low capital cost of the Carey rig. The previous system of contract drilling with a Mayhew, is much preferable to using a BMR Carey, as far as the field geologist is concerned.

A summary of the drilling results appears below. Cuttings were collected from 10 foot intervals.

Shallow drill hole no.	Grid ref. Tambo 1:250,000 Sheet	Total depth (feet)	Drilling (feet)	Coring (feet)	Core recovery Actual	%	Remarks
BMR TM1 See Fig. 4	472,994	175	145	30	17'8"	60	16 hours actually drilling. Siltstone.
BMR TM2 See Plate 6	444,977	224	194	30	9'6"	32	14½ hours drilling. Coring in friable sandstone difficult. Sandstone.
BMR TM3 See Fig. 10	425,920	95	70	25	9'2"	36	5 hours actually drilling. Lost core barrel. Mudstone.
BMR TM4 See Fig. 10	434,917	239	229	10	10'5"	105	7 hours drilling. Siltstone and mudstone.

The cores and cuttings were logged with a binocular microscope by Exon and Galloway. Lithological logs of the holes, with electrical and gamma ray logs, are presented in Figs. 4 and 10, and Plate 6, in the body of this record. The stratigraphic results of the drilling are discussed in the text, and the palynological results in Appendix 2.

The cuttings and cores are stored at the BMR Core and Cuttings Laboratory, Fyshwick, Canberra, where they are available for reference.

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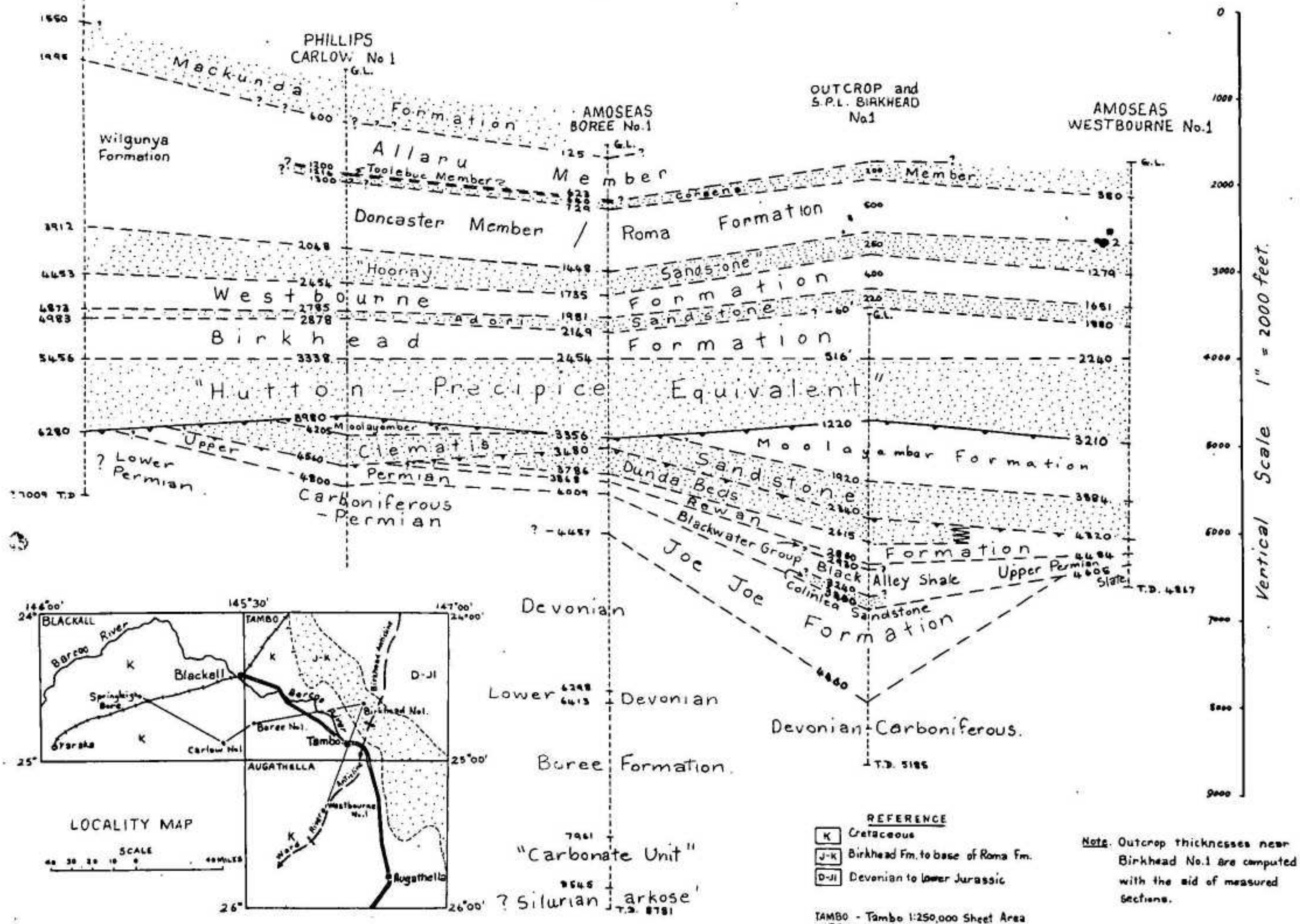
EXON, N.F., and KIRKEGAARD, A.G., 1965 - Notes on the stratigraphy of the north-east part of the Tambo 1:250,000 Sheet area. Bur. Min. Resour. Aust. Rec. 1965/90.

MOLLAN, R.G., EXON, N.F., and FORBES, V.R., 1965 - Shallow stratigraphic drilling, Bowen and Great Artesian Basins, 1964. Bur. Min. Resour. Aust. Rec. 1963/119.

CORRELATION OF OIL WELLS AND WATER BORE
BLACKALL, TAMBO AND AUGATHELLA 1:250,000 SHEET AREAS



To accompany Record 1966/89 G55/A2/18

CORRELATION CHART OF MEASURED SECTIONS S6-10 AND SHALLOW DRILL HOLE TAMBO 2, LOWER JURASSIC SEDIMENTS

TAMBO SHEET AREA

Sections S6-S9 measured by N.F. Exon using Abney level, S10 by D.J. Casey using anaeroid barometer.

TO ACCOMPANY RECORD 1966/89 G55/A2/17.

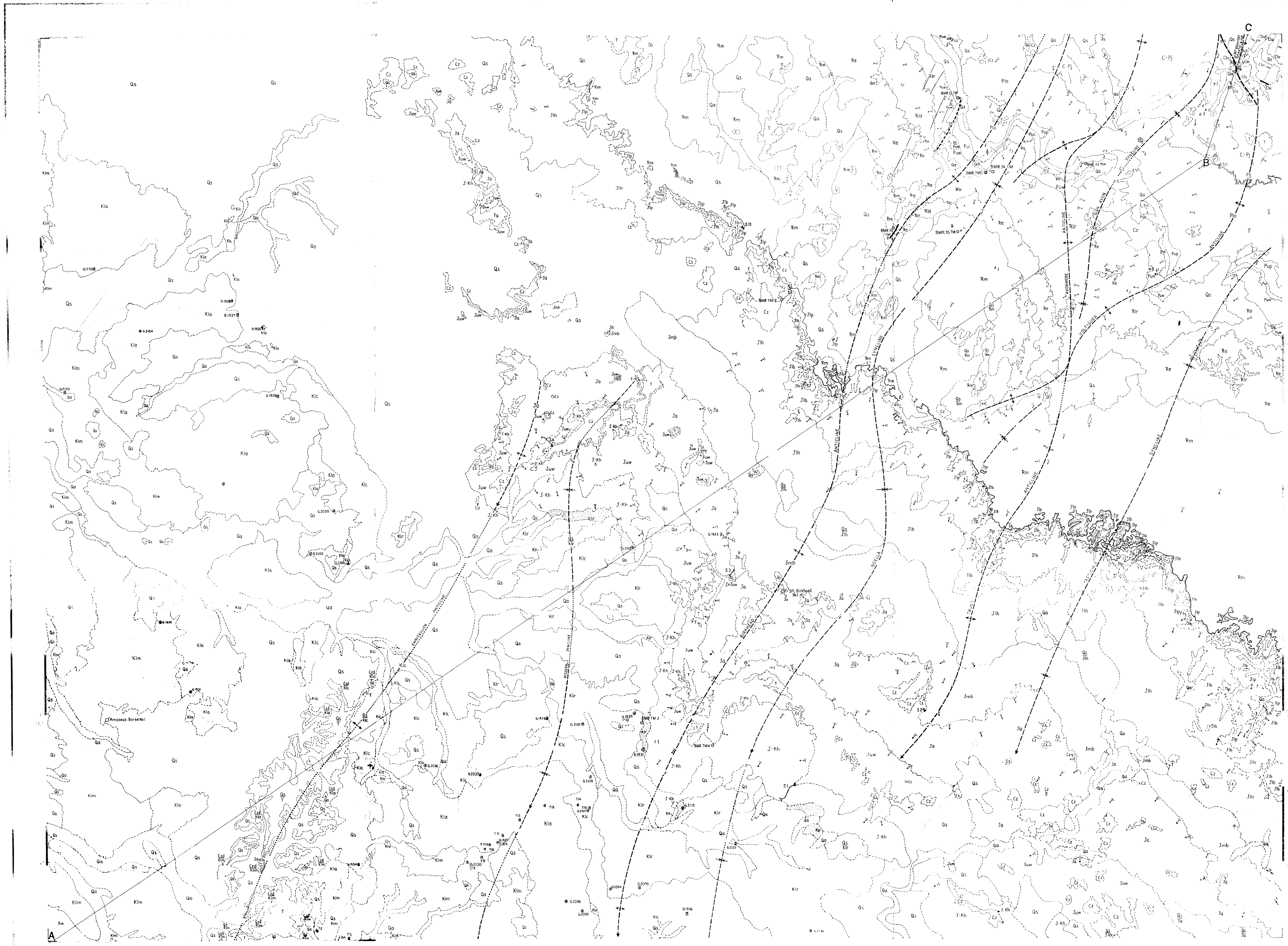
AUSTRALIA 1:250,000 GEOLOGICAL SERIES

TAMBO
QUEENSLAND

SHEET SG 55-2

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT



Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qs	Sand, gravel, soil
	UNDIFFERENTIATED		Cz	Poorly consolidated clayey sandstone
			Czd	Duricrust (silcrete, laterite)
	TERTIARY		T	Well bedded clayey sandstone and conglomerate; some white siltstone, mudstone
			Tb	Olivine basalt flows
MESOZOIC	LOWER – UPPER (?) CRETACEOUS	Winton Formation	Kw	Mudstone; siltstone; labile sandstone, in part calcareous; minor coal
	LOWER CRETACEOUS	Rolling Downs Group: Mackunda Formation	Klm	Mudstone; siltstone; fine grained labile sandstone, in part calcareous; coquinite
		Wilgunya Formation, Allaroo Member	Kla	Mudstone, minor siltstone, in part calcareous; minor limestone
		Toolebuc Member	Klo	Concretionary limestone, calcareous shale
		Coreena Member	Klc	Mudstone; siltstone; fine-grained labile to sublabile sandstone, in part calcareous; coquinite
		Roma Formation	Klr	Mudstone, siltstone; glauconitic sandstone lenses
	JURASSIC – CRETACEOUS	"Hooray Sandstone"	J-Kh	Cross-bedded clayey quartzose to feldspathic sandstone, pebbly in part; conglomerate, siltstone
	UPPER JURASSIC	Injune Creek Group: Westbourne Formation	Juw	Siltstone, mudstone, very fine-grained quartz-rich sandstone
	MIDDLE – UPPER JURASSIC	Adori Sandstone	Ja	Cross-bedded feldspathic to sublabile sandstone; pebbly in part, siltstone
	MIDDLE JURASSIC	Birkhead Formation	Jmb	Sublabile to labile sandstone, calcareous in part; carbonaceous siltstone and mudstone, minor coal
	LOWER JURASSIC	Hutton Sandstone	Jlh	Clayey quartzose to sublabile sandstone; siltstone
		Evergreen Formation, Boxvale Sandstone Member	Jlb	Cross-bedded quartzose sandstone, pebbly in part; siltstone
		Precipice Sandstone	Jlp	Cross-bedded quartzose sandstone, pebbly in part; siltstone
	MIDDLE – UPPER TRIASSIC	Moolayember Formation	Rm	Siltstone, mudstone, quartzose to labile sandstone, calcareous in part
		Clematis Sandstone	Re	Cross-bedded quartzose sandstone, minor pebbly; siltstone
	LOWER TRIASSIC	Dunda Beds	Rld	Quartzose to sublabile sandstone, siltstone
		Rewan Formation	Rlr	Sublabile to labile sandstone; grey, green and red siltstone and mudstone
PALAEOZOIC	UPPER PERMIAN	Blackwater Group	Puw	Labile sandstone, calcareous in part; carbonaceous siltstone and mudstone, minor coal, fossil wood
		Black Alley Shale	Puc	Carbonaceous mudstone, siltstone; minor white claystone, bentonitic claystone
		Peawaddy Formation	Pup	Quartzose to sublabile sandstone, carbonaceous siltstone and mudstone
	LOWER PERMIAN	Colinlea Sandstone	Plo	Cross-bedded quartzose to sublabile sandstone, conglomerate; minor siltstone
		Reids Dome Beds	Plj	Siltstone and sandstone
	CARBONIFEROUS – PERMIAN	Joe Joe Formation	C-Pj	Siltstone, sandstone, conglomerate, shale; minor tuff
	LOWER CARBONIFEROUS	Ducabrook Formation	Clu	Lithic sandstone, siltstone and shale, some tuffaceous, minor tuff
		Mount Hall Conglomerate	Clh	Cross-bedded quartzose sandstone and conglomerate
	UPPER DEVONIAN	Telemon Formation	Dut	Quartzose to sublabile sandstone, siltstone and shale, some tuffaceous; minor limestone
	MIDDLE DEVONIAN	Silver Hills Volcanics	Ds	Trachytic, acidic and basaltic flows, lithic tuff and agglomerate, ash flows

Important regional unconformity - base of Jlp
Geological boundary
Anticline
Syncline
Plunge of fold axis
Fault (D, U indicate relative movement down, up)

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

Strike and dip of strata
Horizontal dip
Dip < 5°
Dip 5° - 15°
Dip 15° 45°
Trend lines
Lineament
(air photo interpretation)

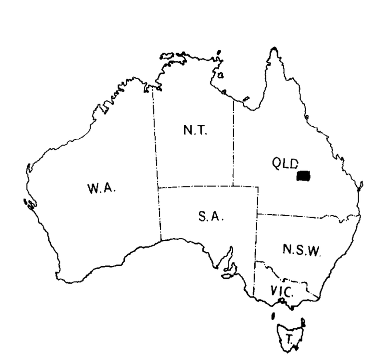
G2102, T8 Macrofossil locality with reference number
G1822 Plant fossil locality with reference number
Fossil wood locality
Fish scale locality
Basalt dyke
Measured section
Measured type section
S4 Measured section reference number
Torbanite deposit, unworked
BMR 32TM Shallow stratigraphic drill hole

Abandoned well with show of gas
Dry hole, abandoned

Artesian bore
Sub-artesian bore
Artesian bore, ceased to flow
Abandoned bore
I.W.S. registered water bore number
Earth tank or dam
Dam on stream
Bore drain
Windpump

Sealed road
Formed road
Vehicle track
Railway with station
Fence
Telephone line
Homestead
Building
Landing ground
Yard
Astronomical station
Spot elevation, approximate
Position doubtful

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Base map compiled by the division of National Mapping, Department of National Development. Aerial photography by Royal Australian Air Force; complete vertical coverage at 1:46,000 scale. Transverse Mercator Projection.



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EROMANGA SG 54-12	QUILPIE SG 55-9	CHARLEVILLE SG 55-10	MITCHELL SG 55-11	ROMA SG 55-12

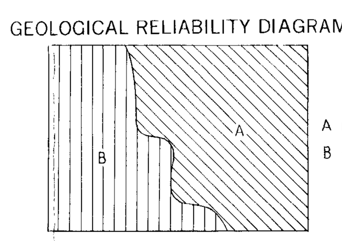
Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

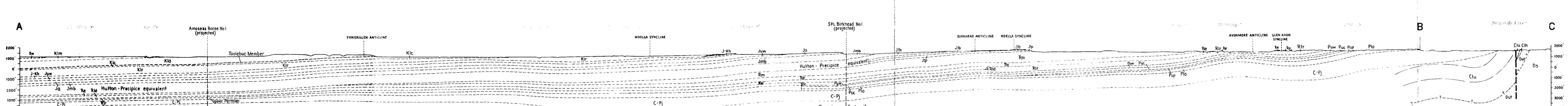
Geology, 1964-65, by: N.F. Exon, (B.M.R.), and D.J. Casey, A.G. Kirkegaard (G.S.Q.)
Compilation, 1965-66 by: N.F. Exon, E.H.J. Feeken
Drawn by: E.H.J. Feeken

GEOLOGICAL RELIABILITY DIAGRAM

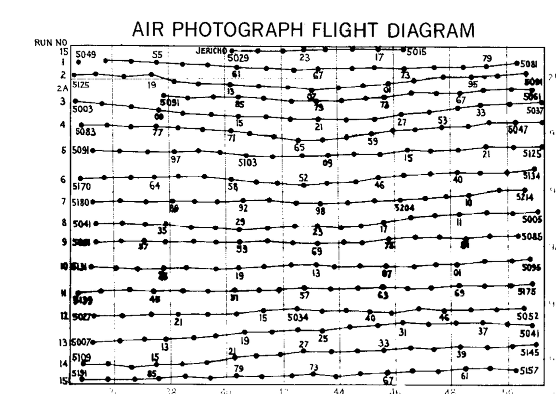


A Detailed reconnaissance
B General reconnaissance

Section
Folding schematic
(Qa, Qs, T omitted)



AIR PHOTOGRAPH FLIGHT DIAGRAM



TAMBO
SHEET SG 55-2

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

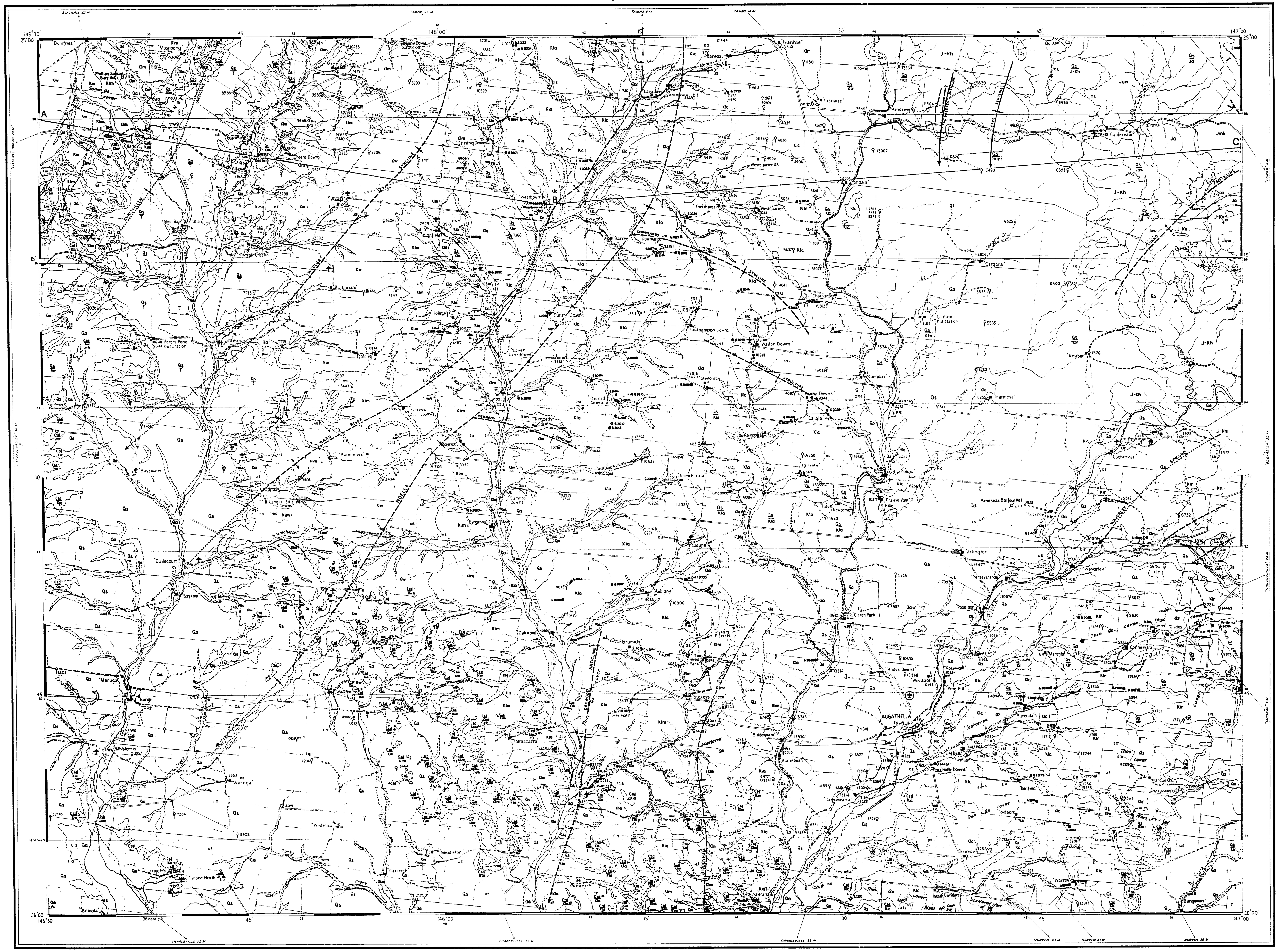
AUGATHELLA

QUEENSLAND

SHEET SG 55-6

PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT



Reference

CAINOZOIC	QUATERNARY		Qa	Alluvium
			Qs	Sand, gravel, rubble, soil
	UNDIFFERENTIATED		Cz	Poorly consolidated clayey sandstone, white siltstone and claystone
			Czd	Duricrust (laterite)
	TERTIARY		T	Sandy mudstone, muddy sandstone, conglomerate
MESOZOIC	LOWER - UPPER (?) CRETACEOUS	Winton Formation	Kw	Mudstone, fine to medium-grained labile sandstone, intraformational conglomerate, coal, peat. In part calcareous and gypsiferous
	LOWER CRETACEOUS	Mackunda Formation	Klm	Mudstone; siltstone; silty limestone; fine-grained labile to sublabile sandstone, glauconite common; gypsum
		Wilgunya Formation (Rolling Downs Group)	Klw	
		Allaru Member	Kla	Mudstone, siltstone, silty limestone, cone-in-cone limestone. Some glauconite, gypsum
		Toolebuc Member	Klo	Concretionary limestone
		Coreena Member	Klc	Mudstone, siltstone, silty limestone, labile to sublabile sandstone, coquinite in lower part, intraformational conglomerate in upper part. Common glauconite, some gypsum
		Roma Formation	Klr	Mudstone, glauconitic and gypsiferous siltstone, lenses with scattered quartz granules in lower part; sublabile sandstone near base
	JURASSIC TO CRETACEOUS	"Hooray Sandstone"	J-Kh	Cross-bedded clayey quartzose to feldspathic sandstone, pebbly in part; conglomerate, siltstone
	UPPER JURASSIC	Westbourne Formation (Injune Creek Group)	Juw	Siltstone, mudstone, very fine-grained quartz-rich sandstone
	MIDDLE - UPPER JURASSIC	Adori Sandstone	Ja	Cross-bedded, feldspathic to sublabile sandstone, pebbly in part; siltstone
	MIDDLE JURASSIC	Birkhead Formation	Jmb	Sublabile to labile sandstone, calcareous in part; carbonaceous siltstone and mudstone, minor coal
	LOWER JURASSIC		Jl	Quartzose to sublabile sandstone; scattered pebbles, minor siltstone
	MIDDLE - UPPER TRIASSIC	Moolayember Formation	Rm	Mudstone, siltstone, some calcareous; quartzose to sublabile sandstone
		Clematis Sandstone	Rc	Quartzose sandstone, some pebbly
	LOWER TRIASSIC	Rewan Formation	Rlr	Quartzose to sublabile sandstone; minor calcareous siltstone and sandstone (section only)
PALAEOZOIC	UPPER PERMIAN		Pu	Carbonaceous siltstone, some coal
	PRE-PERMIAN		Pz	Slate

Geological boundary

Anticline

Syncline

Plunge of fold axis

Fault

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

Strike and dip of strata

Dip < 5°, Trend lines — air-photo interpretation

Macrofossil locality

Microfossil locality

6302,T3 Fossil locality reference number

Dry exploratory hole - abandoned

Artesian bore

Artesian bore, ceased to flow

Sub-artesian bore

Abandoned bore

6527 I.W.S. registered water bore number

160 Well showing depth

Earth tank or dam

Dam on stream

Formed road

Vehicle track

Fence

"Oakwood" Homestead

Building

Airport

Landing ground

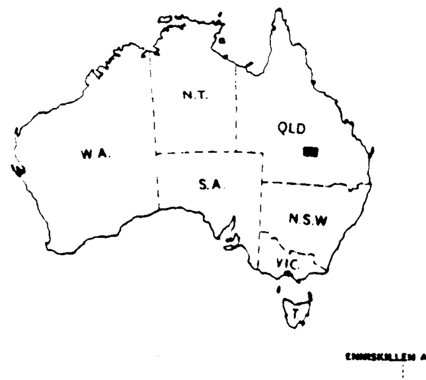
Yd Yard

Quarry

(PD) Position doubtful

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics Department of National Development. Base map compiled by the Royal Australian Survey Corps. Aerial photography by Royal Australian Air Force; complete vertical coverage at 1:46,000 scale. Transverse Mercator Projection.

Geology, 1965, by: M.C. Galloway and N.F. Exon
Compilation, 1966, by: M.C. Galloway, E.H.J. Feeken and N.F. Exon
Drawn by: E.H.J. Feeken



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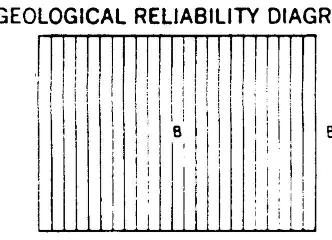
THARGOMINDAH SG 54-16	TOOMPINE SG 55-13	WYANDRA SG 55-14	HOMEBOIN SG 55-15	SURAT SG 55-16

Scale 1:250,000

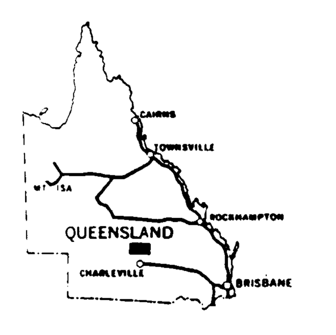
5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM



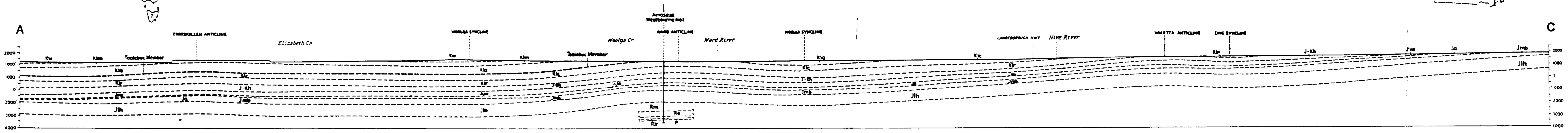
B Detailed reconnaissance - numerous traverses, air-photo interpretation



Section

Scale: $\frac{V}{H} = 4$

(Cainozoic omitted)

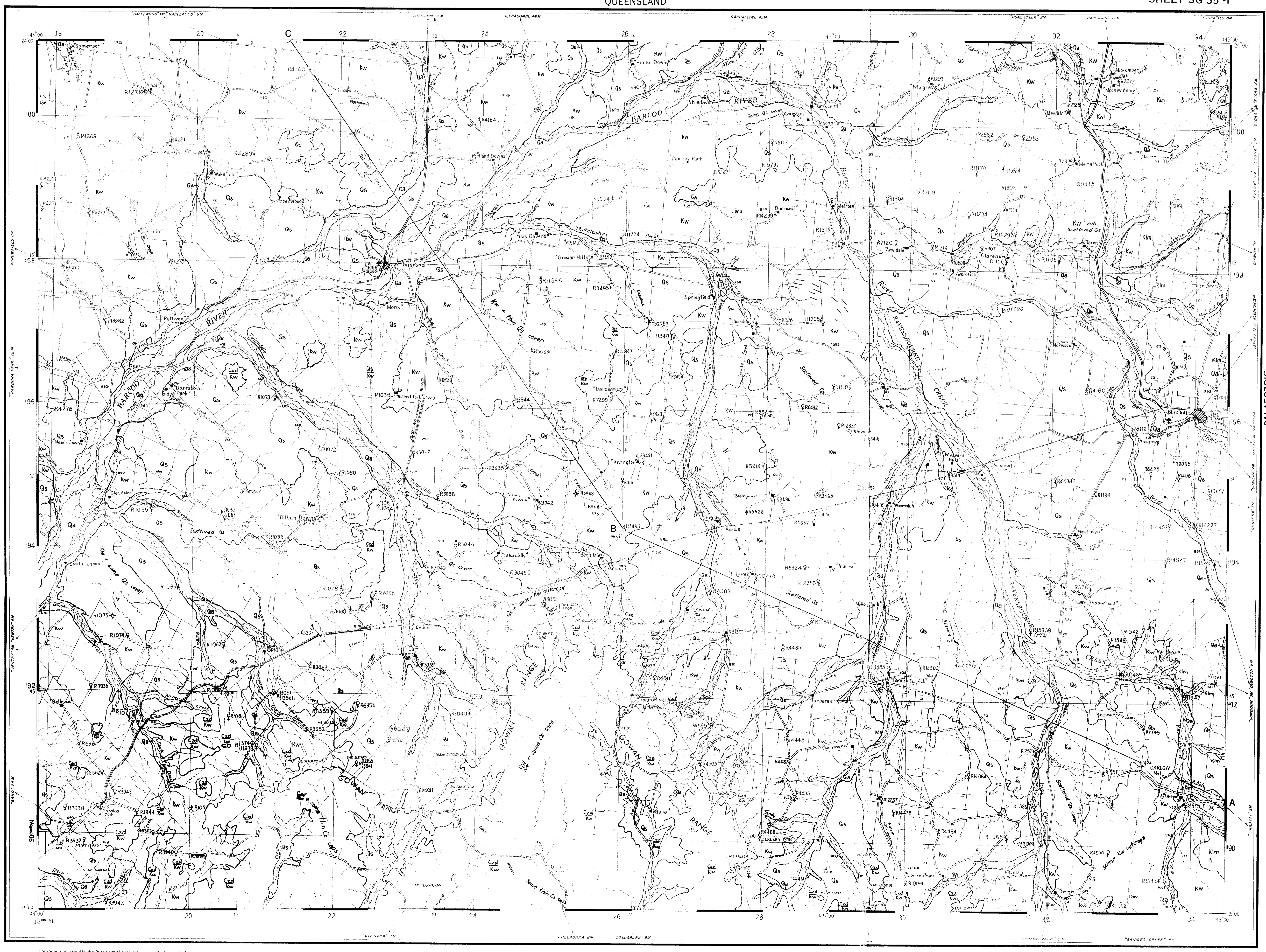


AUSTRALIA 1:250,000 GEOLOGICAL SERIES

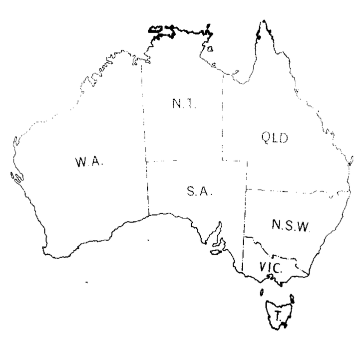
BLACKALL

QUEENSLAND

SHEET SG 55 -1



Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development, in conjunction with the Geological Survey of Queensland. Base map compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,000 scale. Transverse Mercator Projection.



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Showing Magnetic Declination

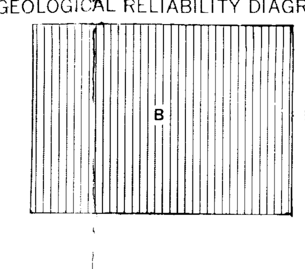
MACKUNDA SF 54-11	WINTON SF 54-12	MUTTABURRA SF 55-9	GALILEE SF 55-10	CLERMONT SF 55-11
BRIGHTON DOWNS SF 54-15	MANEROO SF 54-16	LONGREACH SF 55-13	JERICHO SF 55-14	EMERALD SF 55-15
CONNEMARA SG 54-3	JUNDAH SG 54-4	BLACKALL SG 55-1	TAMBO SG 55-2	SPRINGSURE SG 55-3
CANTERBURY SG 54-7	WINDORAH SG 54-8	ADAVALE SG 55-5	AUGATHELLA SG 55-6	EDDYSTONE SG 55-7
BARROLKA SG 54-11	EROMANGA SG 54-12	QUILPIE SG 55-9	CHARLEVILLE SG 55-10	MITCHELL SG 55-11

Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

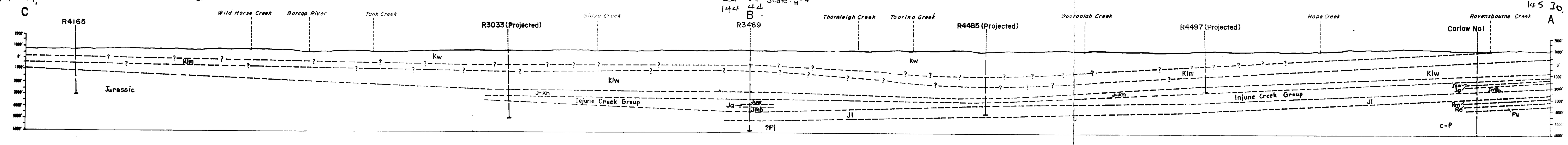
GEOLOGICAL RELIABILITY DIAGRAM



B Reconnaissance-traverse and air-photo interpretation

Geology by: D.J.Casey, (G.S.Q.).
Compilation by: D.J.Casey, N.F.Exon, E.H.J.Feeken, D.R.Williams.
Drawn by: D.R.Williams, E.H.J.Feeken.

Section
(Qa and Qs omitted)
Scale: $\frac{V}{H}=4$



PRELIMINARY EDITION, 1966

SUBJECT TO AMENDMENT

Reference

CAINOZOIC	QUATERNARY		Qa	*Alluvium*
			Qs	*Sand, gravel, soil*
	UNDIFFERENTIATED		Czd	*Duricrust (silcrete, laterite)*
	TERTIARY		T	*Well bedded clayey sandstone and conglomerate*
MESOZOIC	LOWER-UPPER (?) CRETACEOUS	Rolling Downs Group: Winton Formation	Kw	*Labile sandstone, in part calcareous, siltstone, mudstone, minor coal*
	LOWER CRETACEOUS	Rolling Downs Group: Mackunda Formation	Klm	*Labile sandstone, in part calcareous; siltstone, mudstone, coquinite*
		Rolling Downs Group: Wilgunya Formation	Klw	*Mudstone, siltstone, lithic sandstone, calcareous in part, minor limestone, coquinite*
		Allaru Member	Kla	*Mudstone: minor siltstone, in part calcareous; minor limestone*
	JURASSIC - CRETACEOUS	"Hooray Sandstone"	J-Kh	*Clayey quartzose to feldspathic sandstone, pebbly in part; conglomerate, siltstone*
	UPPER JURASSIC	Injune Creek Group: Westbourne Formation	Juw	*Siltstone, mudstone, very fine-grained quartz-rich sandstone*
	MIDDLE-UPPER JURASSIC	Injune Creek Group: Adori Sandstone	Ja	*Feldspathic to sublabile sandstone, pebbly in part; siltstone*
	MIDDLE JURASSIC	Injune Creek Group: Birkhead Formation	Jmb	*Sublabile to labile sandstone, calcareous in part; carbonaceous siltstone and mudstone; minor coal*
	LOWER JURASSIC		Jl	*Quartzose to sublabile sandstone; scattered pebbles; minor siltstone*
	MIDDLE-UPPER JURASSIC	Moolayember Formation	Rm	*Siltstone, mudstone, quartzose to sublabile sandstone, calcareous in part*
		Clematis Sandstone	Re	*Quartzose sandstone, some pebbly*
PALAEOZOIC	UPPER PERMIAN		Pu	*Shale; some interbedded sandstone toward base*
	? LOWER PERMIAN		Pl	*Shale, some carbonaceous; sandstone, claystone*
	CARBONIFEROUS - PERMIAN		C-P	*Shale; some very fine to very coarse-grained sandstone*

Section only (J-Kh to C-P)

Geological boundary, position approximate
Trend lines, air-photo interpretation

Dry hole, abandoned
Artesian bore
Sub-artesian bore
Artesian bore, ceased to flow
Abandoned bore
R1134 *I.W.S. registered water bore number*
E *Earth tank or dam*
Dam on stream
WH *Waterhole*
Sealed road
Formed road
Vehicle track
Railway with station
Fence
"Mons" *Homestead*
Building
Landing ground
yd *Yard*
·918 *Spot elevation, approximate*
(P.D.) *Position Doubtful*

BLACKALL
SHEET SG55-1

REFERENCE FOR COLUMNAR MEASURED SECTIONS AND SHALLOW DRILL HOLE LOGS

sandstone

symbol		grainsize (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

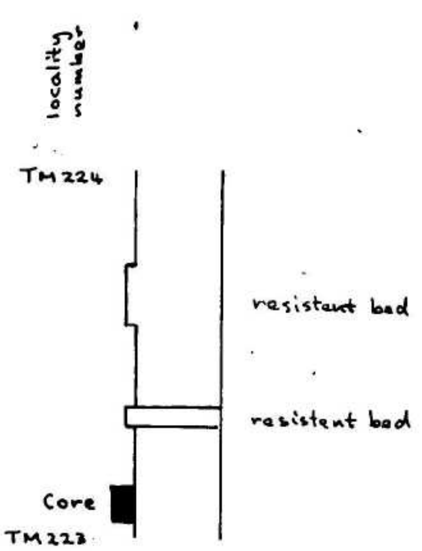
mudstone

claystone

limestone

coal band

gaps 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