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The Post-Palaeozoic Rocks on the Warwick 1:250,000 Sheet Area, Queensland and New South Wales

by

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SUMMARY

During 1968 the exposed Mesozoic and Palaeozoic rocks of the Warwick 1:250,000 Sheet area were mapped, and a brief subsurface study followed. This area forms part of the western side of the Mesozoic Clarence-Moreton Basin and is bounded on the west by the northern end of the Palaeozoic Texas High. Palaeozoic sediments floor the basin, and crop out on the eastern side of the basin.

The basement (Palaeozoic) surface dips very gently away from the Texas High to the north and east. A maximum of 2430 m of virtually flat-lying Mesozoic sediments has been drilled in exploratory wells in the central part of the basin, which lies along the eastern margin of the Sheet area.

The Clarence-Moreton Basin, is in general, a simple structure. However, there has been considerable post-depositional faulting and folding in the eastern part of the Sheet area. A major structure connects the South Moreton Anticline of the north, via the Grevillia and Toonumbar Anticlines, to the East Richmond Fault; there is a smaller parallel fault, the West Richmond Fault, in the Bonalbo area. The Mount Barney and Mount Alford anticlines are associated with Tertiary intrusions.

The Mesozoic sequence is essentially conformable, with continental sediments onlapping the Texas High. The Triassic sequence is largely coal measures and volcanics. The lower part of the Jurassic consists of fluviatile arkose (Ripley Road and Marburg Sandstones) derived from the Texas High. The Marburg Sandstone grades upwards into the Walloon Coal Measures, which contain considerable andesitic volcanic debris. This is overlain in the north by the labile sandstones of the Woodenbong Beds which grade laterally southwards into the quartzose Kangaroo Creek Sandstone; these may have been derived from the same source by southeast-flowing streams. The upper Jurassic Grafton Formation, which is similar to the Walloon Coal Measures, is the youngest Mesozoic unit preserved.

The basin, the axis of which plunges south in this Sheet area, probably developed in Cretaceous and early Tertiary times, and the faulting and folding in the east belongs to that period. The Miocene Main Range Volcanics and Lamington Volcanics, which are up to 1000 m thick, unconformably overlie the exposed Jurassic units. The volcanics are mainly basalt, but trachyte is common in the Main Range Volcanics, and rhyolite in the Lamington Volcanics. Since the Miocene, erosion has continued apace and much of the volcanic sequence has been stripped. In the area south of Boonah, erosion has exposed the underlying intrusive masses, which consist of acid to basic bosses, plugs, sills, and dykes. The Mount Barney and Mount Alford complexes, in particular, have a complicated development.

The great spread of Miocene volcanics has hampered petroleum exploration in this part of the Clarence-Moreton Basin and aeromagnetic and seismic surveys cover only part of the area. Four wells have been drilled and only small hydrocarbon shows were recorded. Poor permeability in most of the sandstone beds has been discouraging. The main targets are sandstone beds in the Triassic-Jurassic Bundamba Group.

INTRODUCTION

Most of the post-Palaeozoic rocks of the Warwick 1:250,000 Sheet area were mapped during the latter part of the 1968 field season by a combined Bureau of Mineral Resources - Geological Survey of Queensland geological party. N.F. Exon (party leader, BMR) and R.F. Reiser (GSQ) each spent about ten weeks, and A. Medvecky (BMR) three weeks, in the area. D.J. Casey (GSQ) mapped the northeastern part of the Sheet area from Brisbane. R. Brunker (GSNSW) spent some time compiling earlier work and two weeks mapping in the New South Wales part of the Sheet. His work and that of the BMR - GSQ geologists, were collated during a short field trip in early 1969. A photointerpretation of the Warwick Sheet area had been prepared by Maffi (1968) as a prelude to the field study.

The Mesozoic sediments of the Warwick Sheet area form part of the western marginal area of the Clarence-Moreton Basin. They onlap the Palaeozoic Texas High which occupies the southwestern half of the sheet area. Correlation of the basal units has been complicated by the effects of depositional conditions at the margin of the basin; folding and faulting have affected the sequence towards the centre of the basin in the east of the sheet area. Numerous Tertiary intrusives have invaded the Mesozoic sediments, while remnants of an extensive Tertiary basalt sheet cap much of the high country. The mapping has provided the opportunity to join the geology of the Queensland part of the Clarence-Moreton Basin to that of the New South Wales part (particularly as mapped in the classical work of McElroy (1962)).

The Darling Downs area is devoted to grain and mixed farming. Farms are generally small. Even smaller farms are the rule in the area to the east of the main Range in Queensland where dairying is the staple industry, with crops such as potatoes and onions grown on irrigated areas. Fodder crops are grown extensively, often for sale as hay. In the very rugged areas at the foot of the Main Range fat cattle raising is the main activity.

The main centres of population are Warwick (population 10,000), Allora, and Killarney on the Darling Downs, and Woodenbong and Kyogle in northern New South Wales. Small hamlets are common throughout most of the area.

Access is excellent, except for an area of forest west of Kyogle where tracks are lacking. Warwick lies on the Cunningham Highway, a sealed road linking Brisbane with southwestern Queensland. The Mount Lindsay Highway, also sealed, provides ready access to the eastern part of the Sheet area. Main roads are generally sealed and formed roads abound. Caution is required in forestry areas where main tracks are typically good, but some of the secondary tracks are suitable only for four-wheel-drive vehicles, even in dry weather.

Rainfall varies from 75 cm on the plains in the northwest to 150 cm in the McPherson Ranges near the coast. Water is largely stored in dams and earth tanks, but shallow water bores are abundant, especially in areas of deep alluvium.

Details of 5 shallow stratigraphic holes drilled during the season and their grid references are given in appendix 4. Graphic logs are shown in various figures (see Contents). Cores and cuttings are stored at the Bureau of Mineral Resources Core and Cuttings Laboratory, Fyshwick, A.C.T. Localities given in brackets thus (480420) refer to the 10,000 yard military grid shown on the Preliminary Edition of the Geological Sheet.

Nomenclature

Crook's (1960) classification of arenites is followed. 'Arenite' is used as the generalised non-genetic term for sand-sized clastic material. All the arenites described fall into his genetic subdivision of 'sandstone' - traction current deposits. The term 'quartzose' is applied where quartz forms 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 the qualifying terms 'feldspathic' or 'lithic' respectively can be used with 'sublabile sandstone'; and 'labile sandstone' can be 'feldspathic sandstone' or 'lithic sandstone'.

'Siltstone' is used as a grainsize term (1/16 mm to 1/56 mm). The term 'mudstone' is used as a general term for non-fissile sediments of the lutite class, and 'shale' is defined as a fissile mudstone. 'Claystone' is used for sediment consisting dominantly of clay minerals.

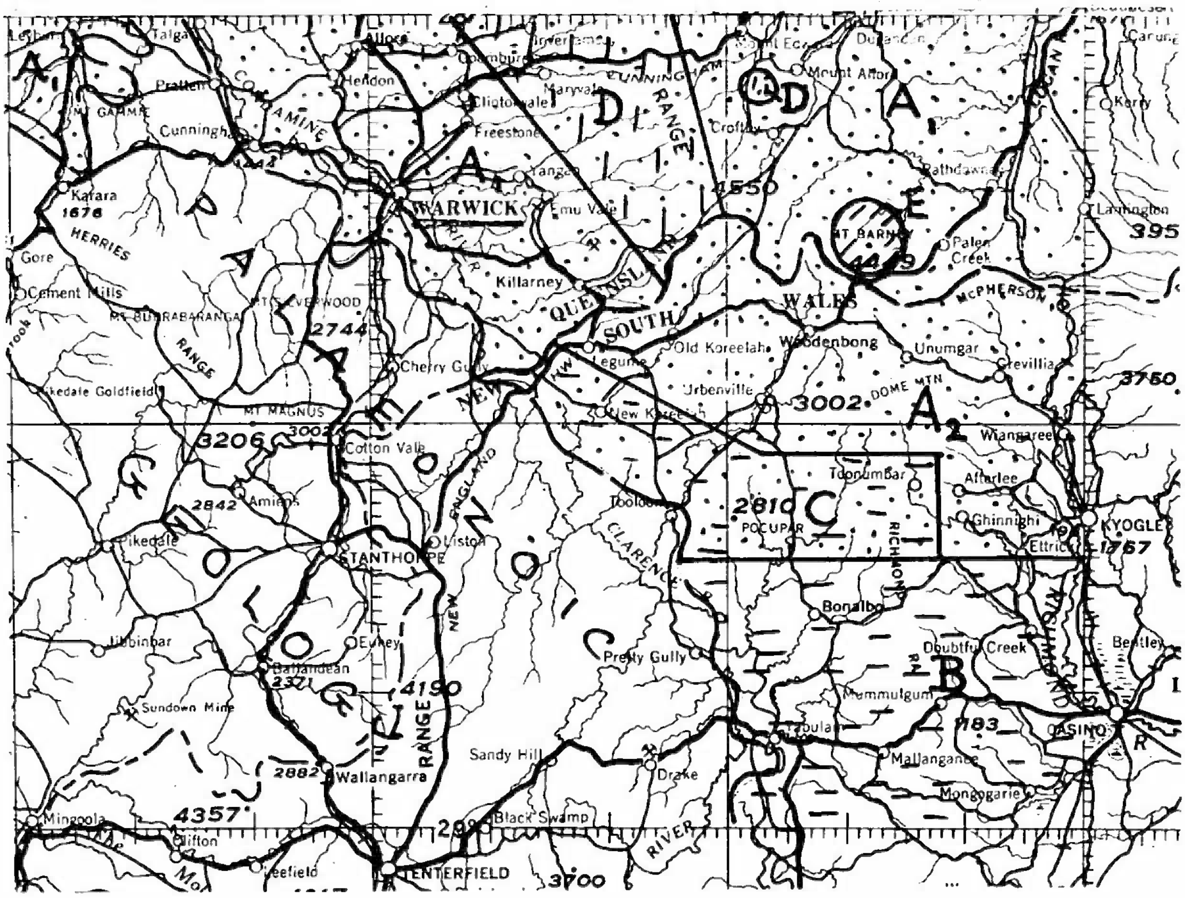
The Wentworth Scale has been followed for grain size terminology (Pettijohn, 1957).

PHYSIOGRAPHY

This area (see Fig. 1) lies across the Great Dividing Range, and subsidiary divides include the Herries Range, the McPherson Ranges and the Richmond Range. These separate the area into five drainage systems: the Condamine and Dumaresq-Macintyre Rivers join the Darling River and the Logan, Richmond and Clarence Rivers flow into the Pacific Ocean. The larger rivers and many of the creeks in this near-coastal area are perennial.

Fig 1

MAIN SOURCE OF GEOLOGY



A1	BMR - GSQ mapping
A2	BMR - GSQ mapping with some information from GSNSW
B	GSNSW mapping and compilation with some information from BMR - GSQ, Hanlon F.
C	BMR - GSQ and GSNSW mapping and compilation.
D	Mapping and compilation by BMR - GSQ and mapping by Stevens N.C. (U. of Q.)
E	Mapping and compilation by BMR - GSQ and mapping by Stephenson P.J. (U. of Q.).

0 10 20 30 miles

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The area has been divided into physiographic units as shown in Figure 2. It consists of two essentially independent provinces: the Palaeozoic massif in the southwest, and the rapidly eroding Mesozoic - Tertiary sequence in the northeast. The steeply dipping indurated sediments and the granite batholiths of the Texas High of the southwest form hilly country (maximum 1400 m) with radial drainage. The absence of Triassic sediments and the presence of Jurassic stream sediments in present-day valleys, but not at high levels, suggests that this is a mature area which has probably changed little since late Palaeozoic times.

A mass of more than 900 m of early Miocene Volcanics (volcanic plateaux) has completely transformed the topography of the Mesozoic Clarence-Moreton Basin, the land surface of which originally sloped steadily northeastwards away from the Texas High, parallel to the present-day dip of the sandstone mesa country. The Mount Warning shield volcano, just east of this area, poured out a mass of basalt and rhyolite which flowed away from the cone. Nearest the volcano, in the McPherson Ranges, the present-day elevation of the highest volcanics is 1200 m; at Beaudesert and Kyogle it is less than 150 m.

At much the same time intermediate and basic volcanics in the Main Range Volcanics forced their way through the soft sediments of the Walloon Coal Measures in the region between Boonah and Urbenville, where the surface sloped westward, presumably as a result of the easterly uplift which formed the south Moreton Anticline in late Mesozoic or early Tertiary times.

The highest point on the volcanic sequence is 1329 m at Mount Roberts in the east; the average elevation in the west is less than 900m.

Since the Miocene, the volcanics have been deeply dissected, and removed in some areas. Flows of differing resistance have given rise to spectacular cliffs. The Clarence and Richmond River systems were diverted to the south by the volcanic piles.

Erosion to the east of the Main Range has removed much of the soft Walloon sediments and exposed the resistant intermediate intrusive which form jagged pinnacles rising 300 m and more above the rolling Walloon plain, which has an average elevation of 300 m (rolling country with abundant volcanic plugs). Mount Barney is the highest of these intrusive peaks with an elevation of nearly 1500 m.

In the southeast, the shallow dipping, moderately resistant sandstone of the Kangaroo Creek Sandstone and the Marburg Sandstone has been eroded to form mesas and shallow dip slopes (sandstone mesa country), the land surface having an average elevation of 300 m. The outcrop area of the intervening Walloon Coal Measures, although of fairly low local relief, is more elevated as it was protected until recent times by a capping of Miocene basalt.

The elevation and relief on the Marburg Sandstone diminish northwestwards down the Condamine River, and the sandstone mesas give way to plains with scattered dip slopes (low relief sandy country). The Condamine alluvium is included with the unit.

The unresistant Grafton Formation in the far southeast has been strongly eroded and forms undulating country generally below 150 m (low relief clayey country).

PREVIOUS INVESTIGATIONS

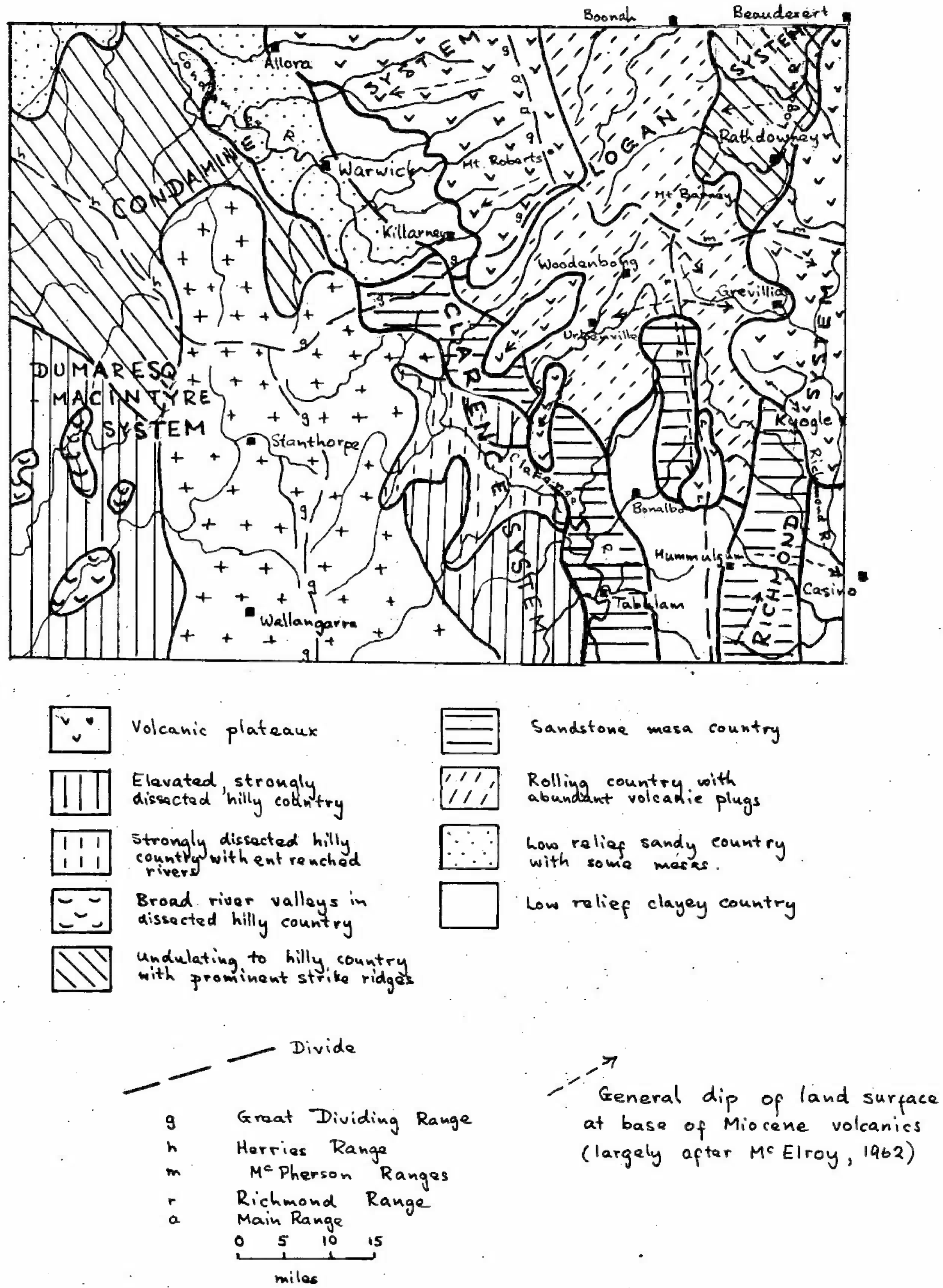
Geological

The first geological report dealing with the Warwick area was that of Aplin (1869), who mentioned the occurrence of coal at Talgai, northwest of Warwick. Gregory (1876) reported coal at Warwick and at Farm Creek east of that town; he stated that the occurrences were in 'the carbonaceous sandstone'; he mentioned 'erupted masses of felstone porphyry' at Cunninghams Gap. Gregory (1879) referred the basalts of southeastern Queensland to a 'very recent date in the Tertiary'. He recognized an older group of igneous rocks, the 'porphyritic rocks', which formed such intrusions as Mt Cordeaux, Mt Mitchel, and Spicers Peak near Cunninghams Gap, and Mt Barney, Mt Lindsay, and Mt Edwards. He subdivided the 'Carbonaceous series' into an upper part (soft thin-bedded sandstone and shale and hard cannel coal with remains of *Pecopteris*, *Taeniopteris*, and *Cycopteris*) and a lower part (thick-bedded sandstone and shale with thicker coal seams). The former is probably the Walloon Coal Measures of present usage, the latter equivalent to the interval Ipswich Coal Measures - Bundamba Group.

Feistmantel (1890) identified three plant fossils from the 'Carbonaceous Beds or Mesozoic Coal Beds' at Talgai:

Taeniopteris daintreei
Otozamites mandeslohi
Sagenopteris rhoifolia

PHYSIOGRAPHY



These identifications were quoted by Jack (1892). He placed the fossils in the Ipswich Coal Measures of Upper Triassic - Jurassic age. He reported other coal occurrences from Lower Swan Creek Railway Station. Emu Vale Railway Station, Tannymorel, and Killarney.

Ball (1903) reported on a supposed occurrence of gold at Mt Sturt. He described shale, sandstone and conglomerate 'believed to be of Trias-Jura age', with small seams of coal.

Andrews (1903) gave an account of the geology of Mt Lindsay; he saw the mountain as a mesa or flat-topped residual of a lofty plateau, and recognized a threefold vertical subdivision of rock types; trachyte overlain by basalt overlain by pitchstone.

Cameron (1907) provided a general stratigraphic framework for the Mesozoic of the Clarence-Moreton Basin, which has persisted with minor modification till the present day. He proposed a threefold subdivision of the 'Trias-Jura system' of south-eastern Queensland: the basal Ipswich beds; the coal-productive Bundamba beds, which he regarded as having either a faulted or unconformable upper contact with the overlying Walloon beds; and the coal-productive strata of the Walloon area. Cameron was the first to recognize the existence of the two separate coal measures, and the fact that the Darling Downs coal occurred in the upper coaly sequence. He also made the first reference to a southward-plunging anticline - the Trias-Jura Anticline - affecting the Mesozoic strata; this is now called the South Moreton Anticline.

Jensen (1909a) dealt with the alkaline rocks of eastern Queensland; he mentioned in particular Mt Edwards and Mt Greville. Jensen (1909b) described Mounts French, Edwards, Greville, and Alford as rhyolitic plugs of independent denuded volcanics, while the Mt Barney - Mt Maroon area was mapped as rhyolite; he advanced a theory of post-Cretaceous faulting to explain the Main Range Scarp.

Marks (1910) reported coal in Palen Creek south of Beaudesert. He suggested a Trias-Jura age for the older volcanic rocks of the area, while noting that geomorphology indicated a much younger age. Marks (1911) discussed the various theories then current on the age of igneous activity in the area. He concluded that there were rocks younger than Trias-Jura at Clifton, and that the eastern part of the McPherson Range was undoubtedly Trias-Jura. Jensen (1911) mentioned the area in a general discussion of the structural evolution of eastern Australia.

On the basis of geomorphology, Wearne & Woolnough (1911) concluded that the peculiar contour of the Main Range around Cunninghams Gap was explicable only by invoking two-stage uplift of a basaltic peneplain. They also suggested two periods of igneous activity in the area: the first, in the Trias-Jura, gave rise to the normal trachytes of the Main Range, Mount Edwards, and Mount Flinders, and to the basalts of the Main Range near Cunninghams Gap; the second, in the Tertiary, gave rise to the more alkaline trachytes of Mounts French and Greville, to the rhyolites of Mounts Maroon and Barney, and to the basalts of the Toowoomba Range.

Marks (1912) reported on the Tannymorel Coal Mine, and noted that coal of excellent quality occurred in narrow seams; he described basalt at the site as a sill intruding the strata. Dunstan (1913) mentioned the Darling Downs coalfields in a general survey of coal resources in the state.

Richards (1916) recognized three major subdivisions of the volcanic rocks of southeastern Queensland: a lower unit, comprising widespread basic and sub-basic rocks, a middle unit comprising rhyolite, trachyte, and their glassy and fragmental representatives, and an upper unit of basic and sub-basic rocks. He adduced a post-Walloon age for these rocks, and suggested correlation with the Cainozoic rocks of Victoria and New South Wales. Richards (1918) discussed the building stones of Queensland; from the area mapped, he mentioned the Swan Creek or Mt Sturt sandstone, used, for example, in the Warwick Town Hall, and the Warwick sandstone.

Morton (1923) mapped the northeastern part of the Warwick Sheet area as part of a larger survey, and his conclusions agree closely with those of the present investigation. He was the first to detail the position and form of the South Moreton Anticline, noting its asymmetry and plunge to the south. His description of the Bundamba Series, and the areal extent shown, correspond with those of the Marburg Sandstone of present mapping, while his Walloon Series is the same as our Walloon Coal Measures.

Bryan (1925) mentioned the South Moreton Anticline in a discussion of earth movements in Queensland. Jensen (1926) considered the Walloon Series as a possible oil producer in southern Queensland; he mentioned particularly oil shale of the Lower Walloon Series encountered in bores in the Warwick-Killarney district, and similar shale associated with bituminous coals near Boonah. The Boonah district was the subject of a report by Ball (1928), who reported, unfavourably, on various reported oil and gas occurrences in the area. Denmead (1929) recorded the occurrence at Tannymorel coal mine of refractory clay underlying the basalt which was suitable for pottery.

Richards, Bryan, & Whitehouse (1932), in a note on the geology of the Mt Barney complex, recorded the presence of two series of sedimentary strata: an older, steeply dipping, marine series, tentatively correlated with the Pustula beds of the uppermost Lower Carboniferous of central Queensland and a younger, gently dipping series containing fossil wood.

Marks (1932) mentioned briefly the area mapped in a physiographic paper; he supported the erosional theory of the origin of the Main Range scarp. In a more detailed and wider-ranging paper, Sussmilch (1932) discussed the geomorphology of the Moreton district, including all of the Queensland part of the Sheet area east of Warwick. On geomorphological grounds he advocated faulting as an explanation of the Main Range scarp. In contrast with Wearne & Woolnough (1911), he regarded the lava and tuff peaks of the Cunninghams Gap area as mountains of accumulation along a north-south line of fracture. The most important part of the paper was a subdivision of the area into geomorphological regions.

Reeves (1936) considered the South Moreton Anticline as a possible structural trap for oil or gas. He concluded that the numerous intrusions, and the consequent highly disturbed nature of the beds along the crest of the fold would militate against the effective sealing of reservoir beds. Reeves's (1936) treatment of general geology follows that of Morton (1923), except that he reported tuffaceous sediments in the upper part of the Walloon Series. He deduced that much of the sediment from this part of the Walloon Series was derived from volcanic rocks, and that therefore volcanic activity referred to as Tertiary was initiated in Jurassic times.

Shepherd and Connah (1948) recorded bauxite nodules from a road metal quarry near Warwick. They noted that lateritization was scattered and hence the bauxite was of no commercial interest. In a summary of data about Queensland coal fields, the Geological Survey of Queensland (1951) described the Tannymorel coal mine as a working mine with an uncertain future.

The Science Students' Association in the University of Queensland (1951) mapped in detail igneous and sedimentary rocks in the Mount Ballow and Burnett Creek area. They also provided determinations of Jurassic plant fossils collected from numerous plant localities in the area.

Stephenson (1954, unpubl. hons. thesis) studied the geology of the Mount Barney complex. He dealt mainly with the igneous rocks but also gave the first detailed account of the sedimentary section. He proposed the same Ballow Group for all the Mesozoic rocks of the area. The lowest units, the basal Yamahra Conglomerate and the associated Portal Creek Volcanics, were assigned by Stephenson, on floral evidence, to the Triassic. A Triassic age was also implied by Hill (1960) when she suggested the possible correlation of these units with the Ipswich Coal Measures. Present evidence suggests lithological correlation, at least, of the Portal Creek Volcanics with undoubted Triassic volcanics encountered in The Overflow No. 1 well. The other members of his Group can be correlated with the Ripley Road - Marburg sequence elsewhere. Stephenson later presented a Ph.D. thesis on the complex (Stephenson, 1956) and published a summary of some of his findings (Stephenson, 1959).

Mott (1954) and Jensen (1954) both reviewed the geology of the South Moreton Anticline; Siller (1959) dealt specifically with oil and gas prospects in the same area, having given a general account of the geology which followed accepted lines. Siller concluded that there could be accumulations of gas from the Walloon Coal Measures, but that absence of marine sediments ruled out the possibility of finding oil.

Green & Irving (1958) found that palaeomagnetism provided a basis for differentiating the Older and Newer Volcanics of Victoria and used the method to correlate other Cainozoic volcanics. They correlated the Toowoomba basalts (continuous with those of the Cunninghams Gap area) with the Newer Volcanics of Upper Tertiary or Quaternary age, in contrast with David's (1950) correlation with the Older Volcanics. David (op. cit.) gave the age of the basalts both at Toowoomba and in the McPherson Range as probably Oligocene.

Webb, Stevens, & McDougall (1967) obtained potassium/argon ages of whole-rock and mineral samples from the extrusives and near-surface intrusions of the Moreton District. They showed that local volcanic activity occurred during the early Miocene and late Oligocene, but the most widespread phase occurred in the early Miocene between 26and 22 million years ago. During this interval the lavas of the Main Range and Mt Warning area were extruded and the rhyolite and trachyte intrusions of the southwest Moreton District were emplaced. Potassium/argon dating on three samples from the Tweed volcanic sequence in New South Wales (McDougall & Wilkinson, 1967) indicated an early Miocene age for the Lismore Basalt of McElroy (1962).

Stevens (1959) described ring-dykes at Mt Alford and at Minto Crags. He proposed the name Mooggerah Sandstone for a unit underlying the Walloon Coal Measures which has been dragged up by the Alford intrusion; the unit is here correlated with the Marburg Formation. Stevens (1962) gave more details of the petrology and geochemistry of the Mt Alford complex.

Pearce (1964, unpubl. M.Sc. thesis) mapped the northeastern part of the Warwick Sheet area and provided a detailed study of the form and extent of the South Moreton Anticline; his subdivision of the Marburg Formation was not mappable on a regional scale.

McTaggart (1961) discussed the volcanic rocks from Mt Warning as far west as Mt Barney. Although parts of his accompanying map were confirmed by the present mapping, his correlations were based on little evidence and are unreliable.

Stevens (1965) discussed the volcanic rocks of southeast Queensland. He proposed the name Main Range Volcanics for the near-horizontal Tertiary volcanic rocks in the area and described three members within the formation: Spicers Gap Trachyte Member, Swanfels Trachyte Member, and Steamers Trachyte Member. His boundaries have been used in part on the accompanying map. Russel (1965) dealt in detail with the volcanic rocks of the Spicers Peak area.

Ellis (1966) edited a handbook on the geology of southeastern Queensland in which Staines summarised Mesozoic stratigraphic nomenclature, Stevens the igneous geology, and Thomson & Hubble the soils of the area.

Jorgenson & Barton (1966) published a photo interpretation of the Moreton Basin, and extended the Surat Basin Jurassic units into the Moreton Basin. The areal extent of their Walloon Coal Measures agrees fairly closely with that shown here. In general, the Hutton Sandstone, Evergreen Formation, and Precipice Sandstone correspond with the Bundamba Group of present usage, but the detailed correlation (for instance, of the Precipice Sandstone with the Ripley Road Formation) cannot at present be justified.

Geophysical

Only two geophysical surveys have been carried out in the area, both in New South Wales and for Mid-Eastern Oil. The first was a reconnaissance seismic reflection survey in the area south and east of Bonalbo (Warner, 1963). The location of lines was severely hampered by the presence of basalt in many areas. Reflection quality varied and reflectors contoured were a 'Basal Mesozoic Phantom Horizon' and a 'Shallow Mesozoic Phantom Horizon'. The presence of at least 2500 m of Mesozoic section northwest of Casino was suggested by the data, and this led to the drilling of mid-eastern Kyogle No. 1 and Sextonville No. 1 wells which confirmed the thick section.

An aeromagnetic survey (Zarzavatjian, 1965) was carried out over almost the whole of the Mesozoic sequence in N.S.W. By flying at 3000 m the distorting effect of the basalts was minimized and acceptable depth-to-basement data obtained. The data suggest a maximum depth to basement of 3200 m immediately east of Mummulgum.

Exploratory drilling for petroleum

Exploratory drilling in and near the Warwick Sheet area is summarized in Table 1.

PALAEOZOIC ROCKS

The Texas High was elevated throughout the Mesozoic, and streams carried the erosion products into the surrounding low areas where they were deposited. Local valley-fill Mesozoic deposits have been preserved on the Texas High. Most of the sedimentary and volcanic rock types of the Texas High occur as pebbles in the lower part of the Mesozoic sequence, and granitic debris forms the matrix of these sediments. The following discussion of the rocks is taken from Olgers & Flood (1969).

Granite of Texas High

The Granite Belt of southern Queensland and northern New South Wales extends from west of Warwick south through Stanthorpe to Wallangarra and beyond. In general it is separated from the Mesozoic sediments by an intervening tract of Palaeozoic sediments or volcanics. However, modern streams near the edge of the Texas High are dominated by granitic debris and it can be assumed that the ancient streams were also; this supposition is born out by the composition of the Mesozoic sediments.

The granites are largely normal massive granites and granodiorites of Permian age. They intrude Devonian, Carboniferous, and Permian sediments.

Palaeozoic sediments and volcanics

These generally tough and resistant rocks are of Devonian, Carboniferous, and Permian age. They break down to give debris of cobble and pebble size, which was incorporated in the Mesozoic sediments deposited near the Texas High.

Devonian intermediate volcanics, limestone, chert, and shale crop out near Silverwood, south of Warwick. Carboniferous sandstone, mudstone, limestone, and minor volcanics crop out extensively in the northwest and west, and there is a smaller body north of Drake. The sandstone and mudstone

TABLE 1: EXPLORATORY DRILLING

WELL (all were subsidized)	YEAR COMPLETED	SHEET AREA	TOTAL DEPTH (feet)	HYDROCARBON SHOWS	INTERVAL	STATUS	REFERENCE
Queensland Americn The Overflow No. 1	1960	Ipswich	2993	Minor hydrocarbon shows related to coal seams		Abandoned	Queensland American Oil Company (1963)
Mid-Eastern Kyogle No. 1	1963	Warwick	8170	Oil in SWC. from 2770' Oil in D.S.T. between 3735' and 3752'	Upper and lower parts of Bundamba Group	Abandoned	Relph (1963)
Burmah Oil Co. Clifden No. 3	1963	Grafton	7505	No shows		Abandoned	Burmah Oil Co. (1963)
Mid-Eastern Sextonville No. 1	1964	Warwick	7315	Minor gas shows	Bundamba Group	Abandoned	Perryman (1964)
Phillips-Sunray Swan Creek No. 1	1965	Warwick	1662	No shows		Abandoned	Kyranis & Patterson (1966)
Australia Cities Service Tullymorgan No. 1	1965	McLean	7582	Some higher hydrocarbons in D.S.T. No. 2 (3641' - 3741')	Bundamba Group	Abandoned	Boisvert & Williams (1965)
Clarence River Basin Hogarth No. 1	1968	Warwick	3996	No shows		Abandoned	Hanlon (1968)

are siliceous and the mudstone often resembles chert. These steeply dipping beds form strike ridges and are deeply incised. Highly sheared zones are phyllitic and unresistant and have aided erosion.

Permian agglomerate, tuff, rhyolite, mudstone, sandstone, and conglomerate are widespread in the Drake area of New South Wales, and there are some small Permian fault blocks in the Silverwood area.

Neranleigh-Fernvale Group

The Neranleigh-Fernvale Group, which forms the upper part of the Brisbane Metamorphics, crops out widely in the Moreton District (Hill & Tweedale, 1955) and along the New South Wales coast (McElroy, 1962). The group forms a major part of the basement on the northern and eastern side of the Clarence-Moreton Basin, although it does not crop out in the Warwick sheet area.

The group is very heterogeneous, containing banded shale and chert, radiolarian jasper, siltstone, massive greywacke, and impure limestone. Phyllitic siltstone and shale and siliceous sandstone are common in New South Wales. Its age is unknown, apart from the fact that it is pre-Triassic.

Palaeozoic of Sextonville No. 1 well

The basal indurated sequence in Mid-Eastern Sextonville No. 1 was tentatively assigned to the Carboniferous in the well completion report (Perryman, 1964). The upper 15 m of the sequence is tight, hard pebbly sandstone. This is underlain by 60 m of very fine grained quartz keratophyre which is interpreted as a flow. The remaining 120 m consists of tough, dark grey to black siltstone and shale. This is generally laminated and somewhat deformed but the average dip is shallow. It contains scattered well-rounded pebbles and small cobbles of volcanic and siliceous rocks. A core sample submitted for palynological work yielded no spores.

This sequence is probably best regarded as part of the Texas High sequence, which is less than 32 km away; it is lithologically most similar to Permian rocks.

MESOZOIC ROCKS

Ipswich Coal Measures (including Triassic volcanics)

The Ipswich Coal Measures consist of about 1300 m of freshwater shale and sandstone, some coal-bearing, together with conglomerate, breccia, tuff, and basalt (Denmead, 1955). They do not crop out in this area but are widespread in the subsurface (Fig. 3). They can be readily correlated with the Nymboida Coal Measures of New South Wales, but the older Queensland name is used here.

Figure 3 shows the coal measures to consist largely of a mixture of shale, siltstone, sandstone, conglomerate and coal. The lower part of the sequence contains abundant volcanics in some wells; in B.O.C. Clifden No. 1 volcanics are abundant throughout the sequence. These volcanic sequences are presumably correlates of the Brisbane Tuff and the Chillingham Volcanics of outcrop. They consist of altered red and green basalt, andesite, trachyte, and tuff in Queensland American No. 1 (The Overflow) where they are well developed. The volcanics in Mid-Eastern Sextonville No. 1 well are probably Tertiary sills rather than Triassic volcanics. The volcanic sequence in Phillips Swan Creek No. 1 to the west is largely dark green grey and orange hard massive tuff grading to agglomerate, with varicoloured volcanic rock fragment, quartz, feldspar and mafic minerals, in an ashy, in places siliceous, matrix. There is also some shale and tuffaceous sandstone in the sequence.

In outcrop the Ipswich Coal Measures contain a rich fossil flora of Middle and Upper Triassic age (e.g. Jones & de Jersey, 1947; Hill, Playford & Woods, 1965) and two prolific insect horizons.

Triassic Rocks of Mt Barney

In the northern flank of Mt Barney there is a Triassic sequence dipping northwards at an average of 30°. In the eastern flank the corresponding sequence is overturned and dips westwards. The area was mapped by Stephenson (1959, 1960) and his boundaries have been generalized on the accompanying maps. The following discussion is based on his work.

Two sedimentary sequences are involved, and both contain the Middle to Upper Triassic plant Dicroidium odontopteroides. They were included in his 'Ballow Group', the upper, Jurassic part of which we include in the Marburg Sandstone and Walloon Coal Measures. The lower sequence is the Yamahra Conglomerate, which is more than 150 m thick and rests unconformably on Carboniferous rocks. It consists of quartzose sandstone and conglomerate with boulders of metaquartzite and chert up to 0.3 m across.

Overlying the Yamahra Conglomerate is 15 to 90 m of basic lava and tuff. The sequence is then interrupted by a trachytic sill of Tertiary age. Overlying this is the upper sedimentary sequence, which consists of 150 m of quartzose sandstone, light in colour, with clay cement, and black carbonaceous shale.

B. Houston (GSQ, pers. comm.) has suggested that the Triassic volcanics in the middle of this sequence are similar to those penetrated low in Queensland American No. 1 (The Overflow), which lies some 40 km to the north. They can probably be correlated with the Brisbane Tuff of the Ipswich Coal Measures.

Bundamba Group

Cameron (1907) defined the Bundamba Grits as a series of unproductive sandstones overlying the coal-bearing Ipswich Beds and overlain by an upper productive series, the Walloon Beds. Later workers have shown that several mappable units could be recognized in this interval. This was apparently the reason for the use of the term 'Bundamba Group' on the Geological Map of Queensland (Hill, 1953).

The name Bundamba has been misused by many geologists, who restricted it to a particular type of sandstone (massive, cross-bedded, quartzose, light-coloured). This makes up only a part of the interval between the Ipswich and Walloon Caol Measures. Staines (1964) formally defined the lowest three formations in the Bundamba Group - the Aberdare Conglomerate, the silty Raceview Formation, and the massive Ripley Road Sandstone. He also pointed out the difficulty in fixing the upper limit of the Bundamba Group: 'In the Rosewood area, "the Walloon Coal Measures conformably succeed the Marburg Sandstone, the junction being taken as the top of the highest bed of conglomerate or pebbly sandstone in the latter formation" (Cameron & de Jersey, 1960, p. 291). The top of the Marburg Sandstone is thus explicitly defined. It might then appear that the upper limit of the Marburg Sanstone, being contiguous with the base of the Walloon Coal Measures, is also the upper limit of the Bundamba Group. This conclusion is open to doubt as it is now suspected (J.B. Cameron pers. comm.) that W.E. Cameron (1907, 1923) may have included in his "Walloon Series" a section of strata which in fact belongs to the Marburg Sandstone.'

However, no further evidence has been published to amplify this idea, and in this report Cameron's definition of the Bundamba Group as the interval between the Ipswich and Walloon Coal Measures is accepted. Hence the Marburg Sandstone is treated as a formation of the Bundamba Group. The doubts over the Walloon-Marburg boundary will probably not be resolved until regional mapping of the Ipswich-Marburg area is undertaken.

The terms 'Tabulam Beds' and 'Tabulam Group' were initially used (Lloyd & Whiting, 1940; Lloyd & Rayner, 1946; David, 1950; McElroy 1962) for a Triassic-Jurassic sedimentary sequence lying between Triassic and Jurassic Coal Measures in the Clarence-Moreton Basin in New South Wales. McElroy (1962) divided the Tabulam Group into the Bundamba Group and Marburg Formation, correlating them with similar sequences in Queensland. With more recent mapping in Queensland (Ipswich Basin), new results have indicated that the Bundamba Group and Marburg Formation of New South Wales as used by McElroy are not equivalent to the same named units in Queensland.

The two upper formations of the Bundamba Group which crop out in this area are discussed below. Neither the Aberdare Conglomerate nor the Raceview Formation is exposed in the area but both probably occur in Queensland American. The Overflow No. 1, 8 km north of the Sheet boundary (see Fig. 3).

In the type area the Aberdare Conglomerate consists of polymicitic conglomerate, sandstone, siltstone, and thin carbonaceous shale beds. The Raceview Formation consists of sandstone, siltstone, shale (some carbonaceous), and a few thin coal seams. The Aberdare Conglomerate varies between 1.5 and 35 m thick and the Raceview Formation between 95 and 160 m thick (Staines, 1964).

Recent palynological work based on the Geological Survey of Queensland's core drilling programme in the Ipswich area suggests that the Triassic-Jurassic boundary lies at or near the base of the Ripley Road Sandstone. Thus the Aberdare Conglomerate and Raceview Formation are probably late Triassic and the Ripley Road Sandstone Lower Jurassic in age.

In the subsurface in the Clarence Basin (Fig. 3), the Bundamba Group can be separated from the Walloon and Ipswich Coal Measures, but it is difficult to relate subdivisions in the group to the outcrop formations. This is also the situation in outcrop on the eastern side of the basin in the Tweed Heads Sheet area (G. Tweedale, pers. comm.).

In all the wells a subdivision into an upper finer grained part and a lower coarser grained part can be made. It is possible that these correlate with the Marburg Sandstone and the Ripley Road Sandstone of outcrop. It could also be argued that the lowermost fine-grained part of the group in the Tullymorgan No. 1 and Clifden No. 3 wells near Grafton is an equivalent of the Aberdare - Raceview sequence in the Ipswich area.

Unfortunately the density of drilling is not great enough to be sure and the outcrop picture on the western side of the basin in the Grevillia and Toonumbar Anticlines has to be taken into account. There the sequence mapped as Marburg Sandstone consists of an upper better bedded and finer grained sequence and a lower poorly bedded, coarser grained sequence. On the western side of the basin the lower sequence is arkosic sandstone, but in the two anticlines it is quartzose to feldspathic sublabile sandstone. It is tempting to regard the lower sequence in the anticlines as Ripley Road Sandstone, but it is too well bedded to be typical of that unit. Similar sandstones occur in the lower part of the Marburg Sandstone in outcrop in the northern part of the Sheet area. R. Helby (GSNSW) has described microfloras from the Toonumbar sandstone as of Marburg age (R. Brunker, pers. comm.).

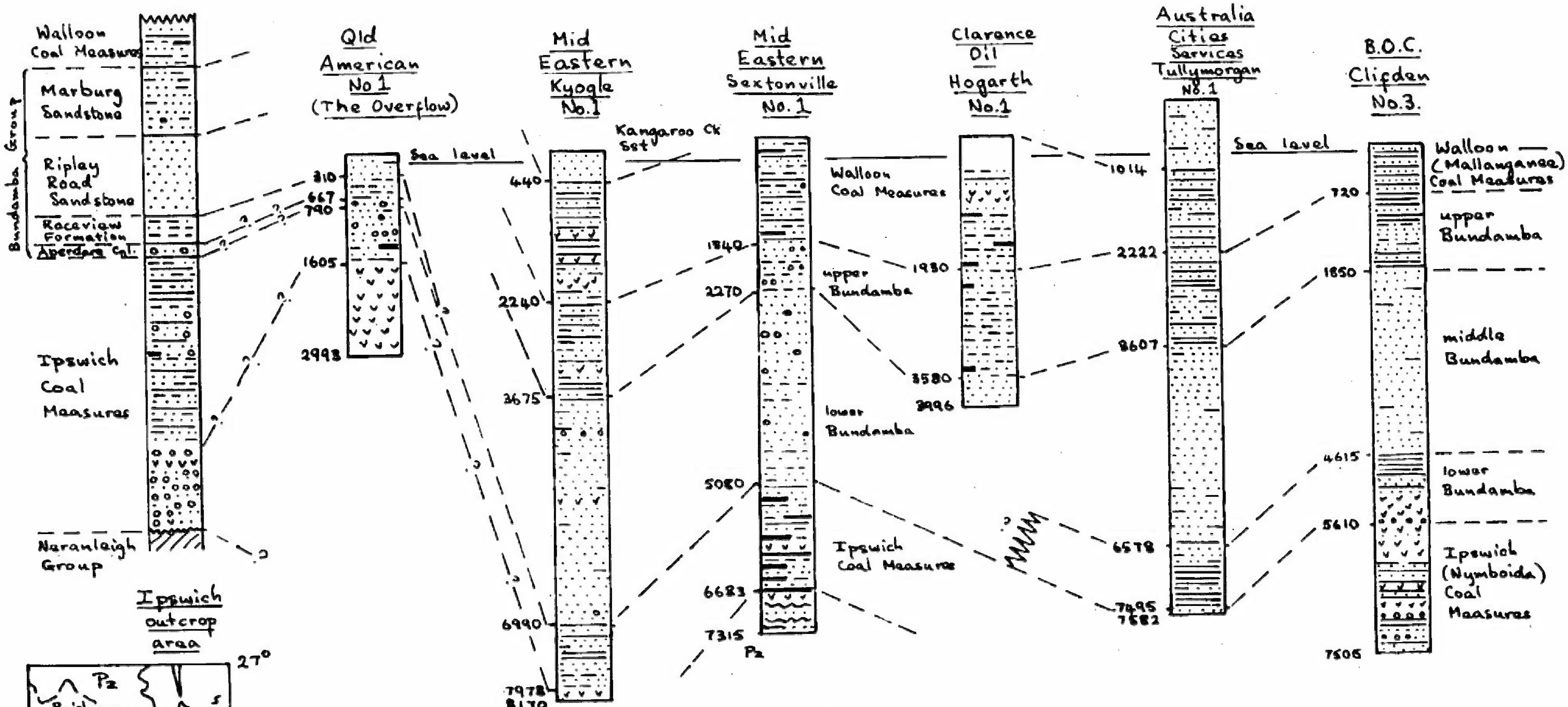
Thus, although the subdivision in the wells (and the anticlines) may represent Marburg - Ripley Road, it is possible that the true boundary is somewhat lower. On the western side of the basin the arkosic sequence is unlike either sandstone. As similar rock types occur interbedded with definite Marburg sediments higher in the sequence, and as the Ripley Road Sandstone is generally less feldspathic than the Marburg Sandstone, it was decided to include the arkosic sequence in the Marburg Sandstone. With more work the arkosic sequence could be mapped as a separate unit.

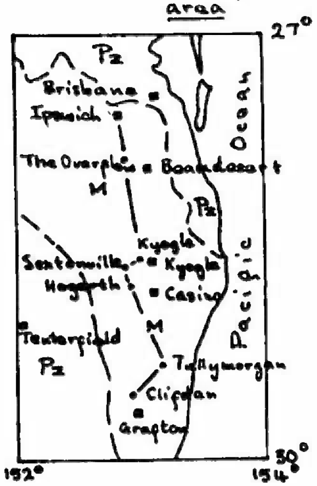
Ripley Road Sandstone (Staines, 1964)

In its outcrop type area the Ripley Road Sandstone is a white, fine to coarse-grained, massive sandstone, composed mainly of quartz with some weathered feldspar and a kaolin matrix. However, continuous coring in the type area has shown that it is, in fact, a feldspathic sandstone.

In the Warwick Sheet area, the Ripley Road Sandstone crops out in a narrow belt about a kilometre wide, in the axis of the South Moreton Anticline. There is another exposure west of the axial portion of the South Moreton Anticline in a valley along Allans Creek.

The Ripley Road Sandstone, as exposed in weathered outcrop, is dominantly a massive, friable, medium to coarse grained, white to light brown, quartzose to feldspathic sublabile sandstone with a clayey matrix. Subordinate beds of fine-grained sandstone and a few thin pebble beds with acid and basic volcanics and quartz pebbles occur. Planar cross-bedding with large sets is very common; current directions are consistent to the north. There is some gradation within the sets from very coarse to fine grained.





CORRELATION OF OIL WELLS

Vertical scale 1" = 2000'

Numbers are feet below Kelly bushing

Note : Volcanics in Walloon are Tertiary sills .

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Fig.3

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In Qld American The Overflow No. 1 (Fig. 3) an incomplete section of 90 m of the Ripley Road Sandstone was penetrated whereas in the type area a thickness of up to 370 m has been estimated (Freytag, 1963).

The boundary between the Ripley Road Sandstone and the Raceview Formation was not observed in the Warwick Sheet area. Staines noted that the Marburg - Ripley Road boundary is vague in the Ipswich area and described several geologists' mapping of the contact. Freytag (1963) encountered sandstones transitional between the Ripley Road and Marburg and so was unable to draw a boundary between them. Pearce (1964) did not recognize the presence of the Ripley Road Sandstone.

No macrofossils were collected in the area. Two continuously cored stratigraphic holes have been drilled in the Bundamba Group by the Geological Survey of Queensland, near the type section of the Ripley Road Sandstone. A detailed palynological study will be carried out on material from these holes.

Previously the Ripley Road Sandstone has been regarded as Upper Triassic, but the latest palynological study shows that at least the upper part is basal Jurassic. The Triassic-Jurassic boundary has not been precisely determined; the incoming of Classopollis is arbitrarily regarded as the start of the Jurassic. Definite Upper Triassic spores have been obtained from the underlying Raceview Formation in GSQ Ripley Road No. 1.

Marburg Sandstone (Reid, 1921; Hill, 1953)

The Marburg Sandstone crops out extensively in the Warwick Sheet area. It conformably overlies the Ripley Road Sandstone around the South Moreton Anticline, and unconformably overlies Palaeozoic basement around the Texas High. It is also present in the faulted Swan Creek Anticline and in several small culminations north of this anticline.

It is also present in the Grevillia and Toonumbar Anticlines south of the South Moreton Anticline. It forms a fairly rugged topography of dip-slopes around the South Moreton Anticline, and a more subdued topography elsewhere.

South Moreton Anticline Area

In the northeast, which is near the type area, the Marburg Sandstone, consists dominantly of fine to very fine grained, feldspathic sublabile to labile sandstone, which is thickly to very thickly bedded. It is commonly hard and well-bedded. Locally, massive medium to coarse-grained sandstone occurs, ranging in composition from quartzose to labile. Pebble lenses are common and in places isolated pebbles are scattered through the fine-grained sediments. The pebbles include acid and basic volcanics, low-grade metamorphics, and quartz. Although sandstone is the characteristic lithology, significant amounts of finer sediments are present, especially in the upper part of the formation.

Pearce (1964) divided the Marburg into upper (Innisplain) and lower (Kooralbyn) members. He defined the Innisplain as an interbedded sequence of very fine grained sandstone, siltstone and mudstone up to 240 m thick, the sandstone being the most common. In the present regional survey it was not possible to map these divisions of the Marburg, although the finer upper section was noted. The siltstone is mainly thin bedded, with some very resistant beds of ironstone. Olive brown thin-bedded mudstone is mainly very weathered.

Because of the variations in dip across the section in the northeast it was not possible to estimate the thickness accurately. Pearce (1964), Morton (1923), and Reid (1922) all suggested a minimum thickness of 1200 m and this was confirmed by the present survey. If these estimates are correct, it is quite possible that most of the subsurface Bundamba Group in the south of this area is in fact the Marburg Sandstone. The thickness in the type area is generally estimated to be 300 m which suggests the unit could be thickening markedly southwards.

A reconnaissance of the type area carried out with the help of A. Carr (Coal Section, GSQ) revealed criteria for differentiating the Ripley Road from the Marburg in outcrop. The Marburg is generally finer grained than the Ripley Road; it is generally dark brown compared with the white to light brown Ripley Road; it is usually thick-bedded with some resistant well developed bedding. The Ripley Road is massive and friable and contains patches of assorted pebbles generally in very hard dark brown rock. Near the base of the Marburg there is a distinctive fine grained, greenish-brown silty sandstone with feldspar grains.

These criteria were applied in the Warwick area to define the boundary. However, only in one outcrop was the contact visible. In addition, the Ripley Road Sandstone has weathered more readily than Marburg and produced reasonably gentle slopes, whereas the overlying Marburg has resisted erosion and formed a rugged topography.

An examination of cores from the G.S.Q. type-area drilling showed that the differences between the Ripley Road and Marburg Sandstones are much more apparent in weathered outcrop than in the subsurface. In the subsurface the Ripley Road Sandstone is generally medium to coarse grained feldspathic sandstone. Similar but generally finer grained sandstone predominates in the Marburg Sandstone. The presence of siltstone and pebbly beds helps to differentiate the Marburg Sandstone. The boundary between the two units is transitional over about a hundred metres.

Texas High area

In the Warwick Sheet area and to the west of the Texas High in the adjacent Goondiwindi Sheet area the oldest Mesozoic sediments have been assigned to the Marburg Sandstone.

On the eastern side of the Texas High there is an arkosic sequence up to 150 m thick which sits directly on basement. This sequence consists of thickly bedded to massive sandstone and conglomerate with high-angle cross-bedding very prominent in some beds. The sandstone, and the matrix of the conglomerate, is largely medium to coarse grained and feldspathic, indicating derivation from the granites to the west.

The angular feldspars suggest rapid erosion of the hinterland and deposition from streams (Photo Plate 1).

The polymictic conglomerates are most abundant in present-day valleys and are mostly valley-fill deposits. They are particularly well exposed in cuttings on the New England Highway south of Warwick. There the clasts are mostly comparable with nearby Palaeozoic rocks and consist of black, grey, and green chert, silicified sandstone, carbonaceous siltstone, quartz, porphyritic acid volcanics, and minor granite. The conglomerates are interbedded with fine to coarse grained arkosic sandstone. These are point-bar deposits, and soft siltstone beds and pods (Photo Plate 2) represent quieter deposition on top of the point bar.

In the Leyburn area in the north, deposition was less rapid and true conglomerates are rare, although polymictic arkosic pebbly sandstone is quite common (Photo Plate 3 and Fig. 4). The basal deposits in areas of phyllitic Palaeozoic rocks south of Leyburn are virtually unworked lithic sandstones consisting almost entirely of phyllite and quartz fragments (from veins in the Palaeozoics). These are commonly overlain by well bedded, fine grained quartzose sandstone, very reminiscent of the typical Boxvale Sandstone. These beds contain plant roots in situ and well preserved fronds (see Appendix 3). The dominant rock type is, however, thickly bedded crossbedded feldspathic sandstone.

In the area between Warwick and Tabulam the conglomeratic arkosic sequence is well developed. Southwest of Waterdale Homestead there are particularly fine outcrops of massive conglomerate with a maximum thickness of 100 m. The clasts (e.g. Photo Plate 1) are dominated by Palaeozoic sediments and acid porphyries. The sediments include quartzite and silicified fine-grained labile sandstone and finer sediments. Other rock types include basalt, crystalline tuff, schist, ironstone, and intraformational arkose blocks. Fossil logs some replaced by clay, others by ironstone, are common.

The maximum cobble size noted is 30 cm, but the average size for the largest deposit (45 m thick) is approximately 15 cm. The average size for all deposits is about 5 cm. Most clasts are angular, but sharply rectangular blocks are not common.

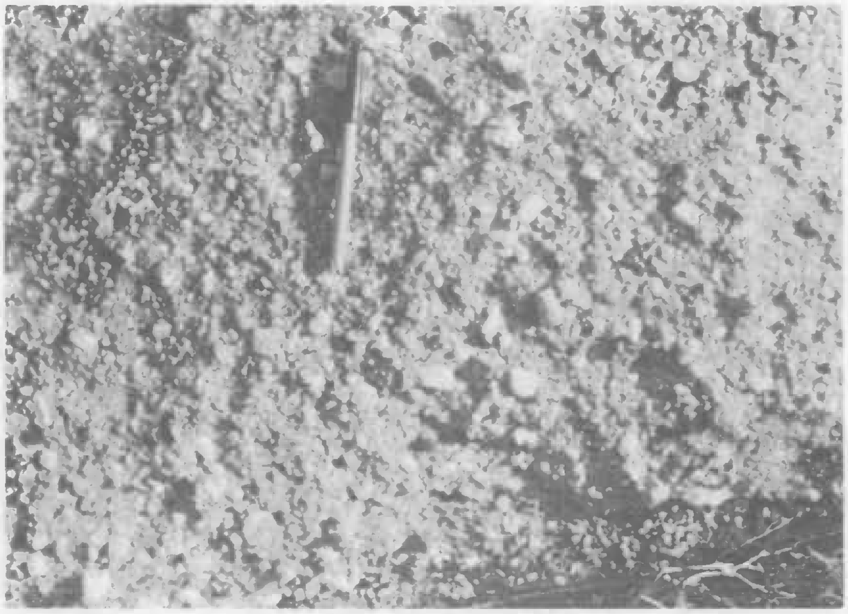
These basal deposits were laid down by streams draining the Texas High. Their matrix was derived largely from the granitic hinterland but the high relief Palaeozoic areas, crossed by the streams, shed coarser material. The very coarse sediments were probably deposited during major floods. Massive tree trunks are found in places in the sequence, especially in the general Warwick area; some are 10 m long and 1 m in diameter.

The period of coarse clastic deposition was followed by deposition of about 250 m of fine to coarse generally labile sandstone, and lesser siltstone especially towards the top. This sequence is very similar to the Marburg Sandstone in the type area. The sandstones vary from greenish grey to yellowish grey when labile to buff when sublabile to quartzose. They average about 35% quartz, 20% orthoclast and albite, 25% rock fragments (fine grained sediments and volcanics), 15% clay matrix, and also contain minor iron minerals, muscovite, and biotite. This composition suggests a more mature type of sediment but with the same origin as the arkoses as the resistant rock fragments have increased in proportion. Mudclasts and small pieces of fossil wood are common.

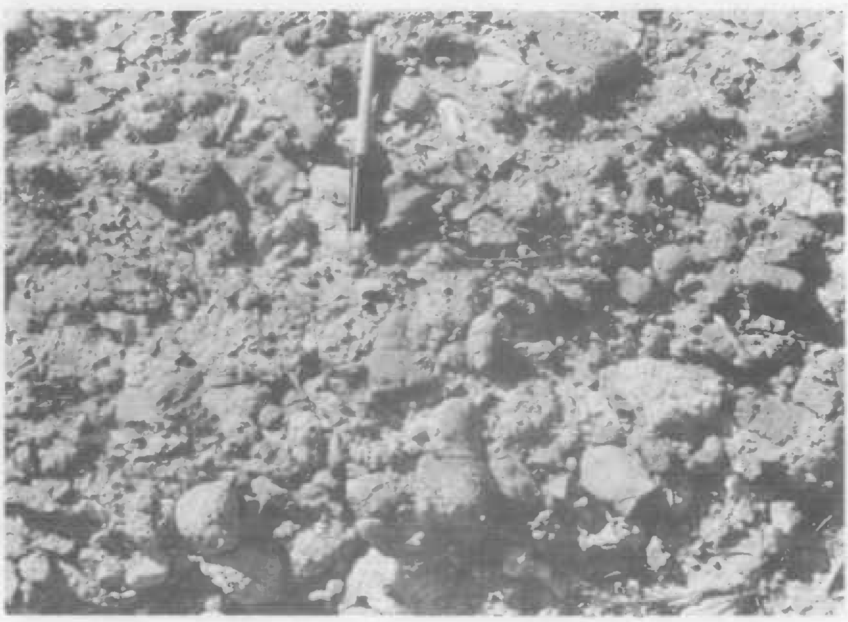
One particularly massive sandstone sequence, which serves as a marker, can be identified from south of Tabulam north to the state border; it is generally associated with fossil logs and pebbles and cobbles, and presumably represents a widespread flood.

The upper sequence varies from very well bedded (Photo Plates 3, 4) to poorly bedded. Cross-bedding varies from low-angled and minor to torrential and dominant (Photo Plates 3, 4). The more quartz-rich sandstone from the upper sequence near Warwick has been used for ornamental stone.

Basal Marburg Sandstone



a. Feldspathic grit in creek crossing south of Lower Acacia Creek (grid ref. 536470)



b. Polymictic conglomerate in creek near a, south of Lower Acacia Creek.

Basal Marburg Sandstone

a. Coarse sandstone in lower point bar with siltstone in upper point bar. Road cutting on New England Highway south of Warwick (grid ref. 505512)

b. Close-up of siltstone fragments included in sandstone at same locality.

a. Pebbly sandstone with diverse pebbles, in basal Marburg Sandstone east of Leyburn (grid ref. 467527)

b. Low-angled cross-bedding in well bedded sandstone in upper Marburg Sandstone. In quarry north of Warwick (grid ref. 506515)

Marburg Sandstone

a. Well bedded sandstone in eastern flank of South Moreton Anticline. In railway cutting (grid ref. 605506)

b. Well bedded sandstone, with low-angled cross-bedding, in upper Marburg Sandstone in quarry near Warwick (grid ref. 512504)

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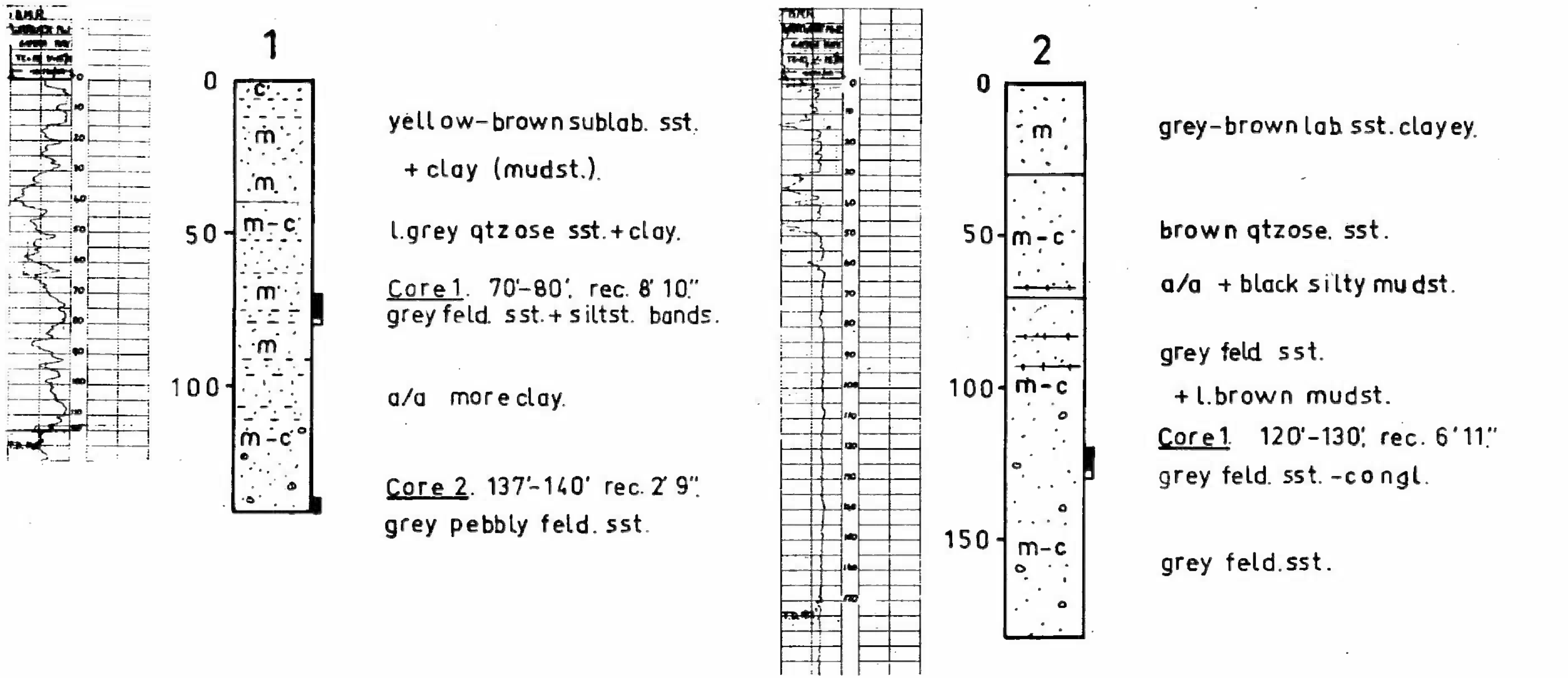
LOWER MARBURG SANDSTONE.

Fig 4.



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In the southern part of the area, the sequence is generally thickly bedded and cross-bedded, although there are some thinner and better bedded sandstones. The sandstone is generally greenish brown and labile. Siltstone beds up to 10 m thick are also present. Polymictic pebbles are abundant at the bases of some sandstone beds.

Grevillia and Toonumbar Anticlines

The Marburg Sandstone present in these anticlines is a considerable distance from the Texas High. The upper 150 m of the sequence in the Grevillia Anticline consists of well bedded greenish brown fine to medium labile sandstone and siltstone. The lower 150 m consists of thickly bedded and strongly cross-bedded fine to very coarse feldspathic sublabile sandstone, which is pebbly in part. The sand grains are angular, and the pebbles consist of quartz, quartzite, and acid volcanics, with some fossil wood.

The bottom of the lower sequence is not exposed; it is very similar to the 150 m-thick sandstone sequence at Toonumbar (Bell, 1968), which consists of very thickly bedded fine to coarse grained feldspathic sublabile sandstone grading to quartz pebble conglomerate, and some siltstone. The sandstone contains red fragments, which may be garnet. The Toonumbar sequence was identified by R. Helby (G.S. N.S.W., pers. comm.), on the basis of palynology, as of Marburg age, and his interpretation is supported by lithologic correlation.

Environment of Deposition

The formation was deposited by streams radiating from the Texas High; even in the northern part of the Moreton Basin the derivation is from the south (Swindon, p. 290 in Hill & Denmead, 1960). Lack of marine organisms suggests that it is a freshwater unit, although it is possible that it could be marine or deltaic in part. The presence of Hystrichosphaeridium in the upper part of the formation in BMR Warwick No. 4 (Fig. 5), associated with carbonaceous and pyritic sandstone, suggests a period of quiet marine deposition. It is obvious that there was a marked change in the hinterland in early Jurassic times to give the high-energy deposition of the basal sequence around the Texas High, when there had been only very slow Triassic deposition farther into the basin. This could have been related to a change of climate, or to uplift of the Texas High. As time passed the streams approached equilibrium and fine-grained sediments were laid down as point bar and backswamp deposits.

Thickness

No reliable thickness data exist in the area but thicknesses between 300 m and 600 m around the Texas High are suggested from outcrop information; it is probably thicker in the subsurface and in outcrop in the northeast.

Age

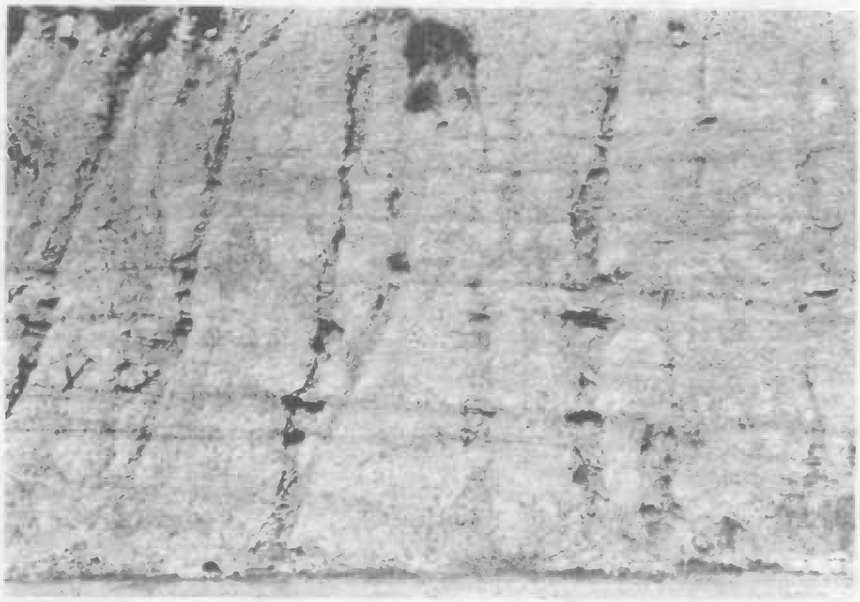
Whitehouse (1955) suggested an Upper Triassic age for the formation, based on the identification of a jawbone fragment as a labryinthodont, Austropelor wadleyi, by Longman (1941). However, palynological studies of samples from the Marburg in the Ipswich area have shown that it is Lower Jurassic in age (de Jersey, 1963). De Jersey suggested that the bone fragments could be a reworked fossil from the Triassic.

Plants collected by the present party from the Marburg Sandstone (White, 1969) suggested a Jurassic to Lower Cretaceous age for sediments south of Warwick (505491), a Triassic or Jurassic age for sediments south of Mt Barney (581489) and a Jurassic age for sediments from the well-known Durikai locality (466503). This locality is fully documented Gould (Appendix 3). He suggests an upper Liassic age for the flora. A J4 spore assemblage (Lower or Middle Jurassic) and a post J2 spore assemblage (Lower Jurassic or younger) were obtained from BMR Warwick No. 4 in the uppermost part of the formation (Burger, Appendix 2). Thus the unit is probably almost entirely Lower Jurassic.

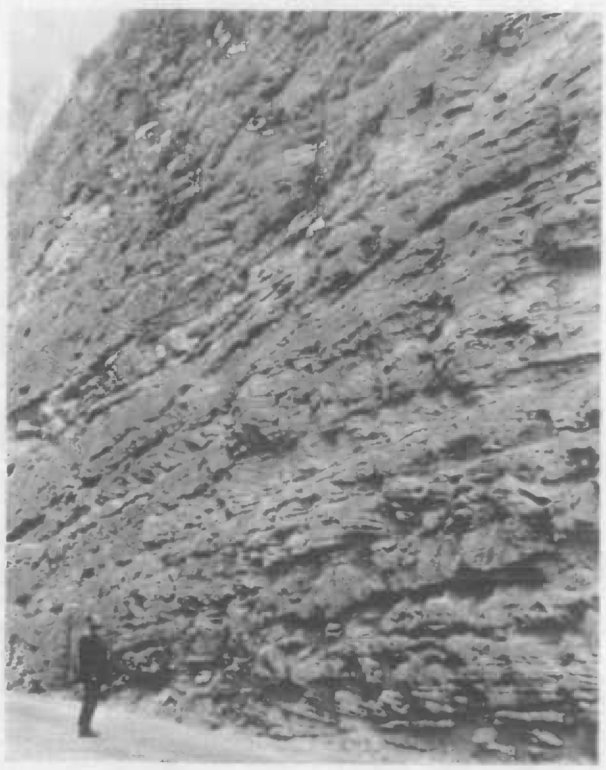
Walloon Coal Measures

Gregory (1876) described coal measures near Walloon, but the name Walloon Beds was first proposed by Cameron (1907). Reid (1921) renamed them the Walloon Coal Measures. The history of the unit is discussed in some detail by Whitehouse (1955), Cameron, de Jersey & Swindon (pp. 287-8 in Hill & Denmead, 1960), and Gould (1968). Whitehouse (1955) designated a type area near the town of Walloon. The coal measures are about 200 m thick in the type area, where drilling shows them to consist of light grey mudstone, siltstone, fine-grained clayey lithic sandstone and thin coal seams.

When exposed to the weather the sandstone, which has a montmorillonitic matrix, disintegrates rapidly, and sandstone is rare in outcrop. In the subsurface the sandstone proportion varies greatly from hole to hole. The recent GSQ stratigraphic drilling program has shown that an upper sequence of medium-grained sandstone, more than 30 m thick, is present in the type area.



a. Well bedded fine grained soft sediments in upper Ma Ma Creek Sandstone (Ipswich 1:250,000 Sheet, grid ref. 521561)



b. Well bedded cross-bedded moderately resistant sandstone in road cutting in lower Ma Ma Creek Sandstone (Ipswich 1:250,000 Sheet, grid ref. 523563)

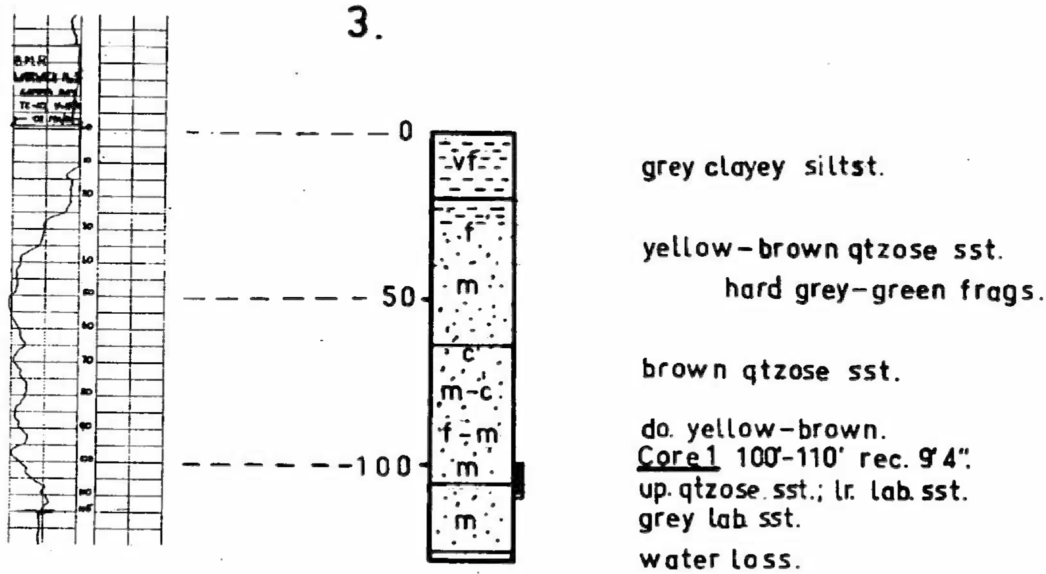
Fig. 5

DRILL HOLES B.M.R. WARWICK Nos. 3+4.

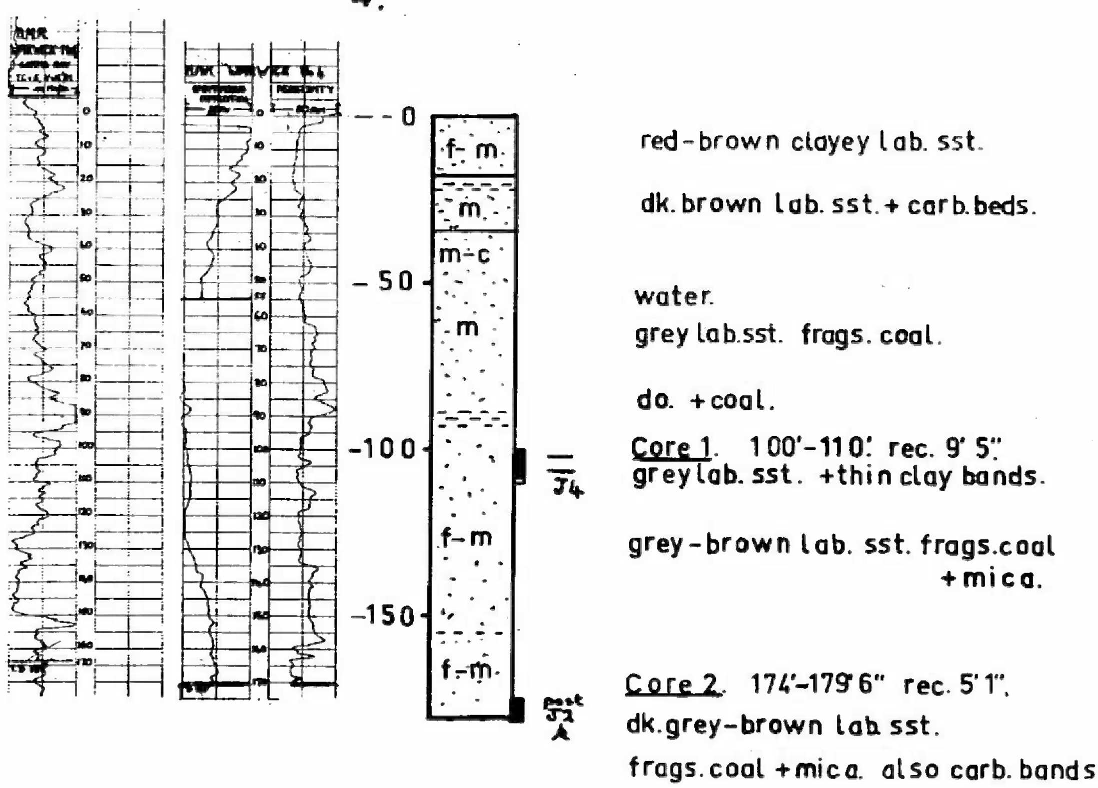
KANGAROO CREEK SANDSTONE (No 3).

UPPER MARBURG SST (No 4).

3.



4.



To accompany Record 1969/80

H56/A2/6

In the eastern half of this Sheet area the Walloon Coal Measures cover a large area within the Clarence-Moreton Basin. Where undisturbed and unprotected they form rolling country with virtually no outcrop. In the northeast they are intruded by sills, dykes, and plugs of Tertiary igneous rocks which dominate the landscape and increase the relief; very few of these intrusions appreciably affect the dip of the Walloon. Elsewhere the coal measures are commonly overlain by Tertiary flows which form a hard capping.

The rock types in this area are essentially similar to those in the type area, although the greater relief means that outcrop, particularly of the sandstone, is better. The matrix of the sandstone, although generally very clayey, is often calcareous, and calcareous concretions are common; when not originally calcareous, or when leached, the sandstone is very friable.

In the northeast (e.g. Mt Barney area) the lower 400 m of section consists largely of well bedded carbonaceous mudstone and siltstone, and lesser thinly bedded fine-grained greenish-brown lithic sandstone, coaly mudstone, and coal. Sandstone is more common in the upper 200 m of the sequence. It is medium grained, thickly bedded, crossbedded, greenish-grey and contains abundant andesitic rock fragments and subordinate feldspar; coaly grains and lenses are common in some beds. In the southeast the sequence is essentially similar. Volcanic and sedimentary pebbles and small pieces of fossil wood are scattered through some sandstone beds.

West of the Main Range Volcanics, siltstone and mudstone still predominate, but thick sandstone sequences are exposed in places. There is particularly good outcrop of some 20 m of sandstone in a small creek north of Warwick (512507). The exposure varies from medium grained sandstone to lithic grit; it is poorly thickly bedded and crossbedded in part. It is generally calcareous with calcite concentrated in more resistant lenses and concretions (Photo Plate 6), and is generally brown or greenish-brown. There are clay clasts in some beds.

In thin section the sandstone consists of largely andesitic rock fragments with less than 10% of quartz, albite, and sedimentary rock fragments, and with abundant clay matrix or calcareous cement. The clay matrix has broken down, in part at least, from rock fragments. Minor constituents may include iron ore, muscovite, and biotite.

The Walloon Coal Measures conformably overlie the Marburg Sandstone. The contact is transitional; in the type area the top of the highest bed of conglomerate or pebbly sandstone is taken as the top of the Marburg Sandstone. Marburg-type sandstone persists in the basal Walloon Coal Measures, and abundant carbonaceous siltstone and mudstone are present in the upper part of the Marburg Sandstone.

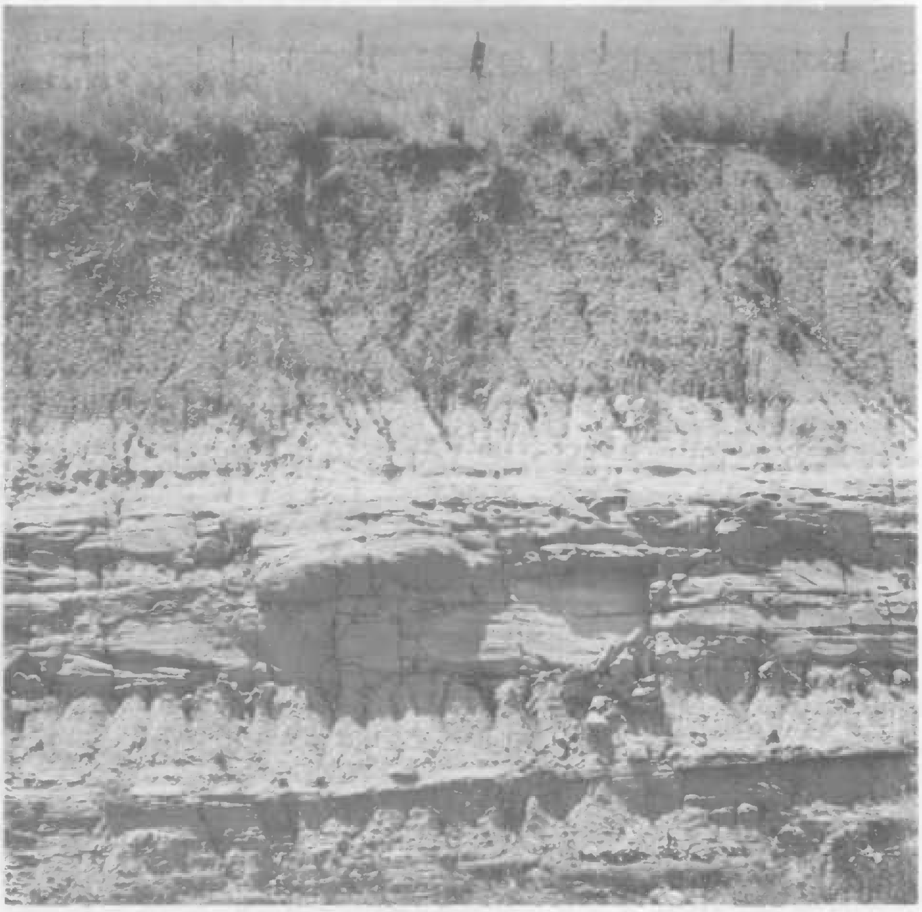
In the northeastern part of the Warwick Sheet the boundary is quite distinct. The resistant sandstone beds in the Marburg form the high country around the South Moreton Anticline, and contrast with the flat lands developed on the Walloon Coal Measures. Lithological distinctions in outcrop may be more apparent than real as the benches of resistant sandstone in the Marburg are separated by intervals of poor or no outcrop, reflecting less resistant, more Walloon-like, sediments. The Marburg sandstone beds are typically deep green very fine to fine-grained feldspathic sublabile to feldspathic, with minor lithic fragments; whereas Walloon sandstone is typically very lithic, commonly with a high percentage of coaly fragments, and with subordinate feldspar.

In the southeastern part of the Warwick Sheet the boundary is transitional, generally without major changes in topography or lithology.

West of the Main Range Volcanics, the boundary can be mapped relatively easily: the Walloon gives black soil whereas the Marburg gives orange or brown clayey sandy soil. This change coincides with the change from the Marburg Sandstone, to the very poorly outcropping calcareous mudstone, siltstone, and fine-grained sandstone of the Walloon Coal Measures. Walloon sandstone generally contains black lithic fragments whereas Marburg sandstone generally does not. There is frequently a photo-break at the boundary, but this can be obscured by black soil moving downslope.

The Walloon Coal Measures were deposited in swamps by low-energy streams and in lakes. Coals accumulated in backswamp areas. The abundance of fresh andesitic rock fragments, and the presence of montmorillonite as matrix and in discrete beds, indicate that there was andesitic vulcanism in the hinterland which provided much of the debris. There are tuffs and similar sediments of the same age in the Surat Basin (Exon & Duff, 1968), suggesting widespread volcanic influence at the time. In the type area (Hill & Denmead, 1960; p. 290) deposition was from north-flowing currents. It is assumed that, as in Marburg times, the Texas High was the main source of streams in the area, and that they radiated from it; the few crossbedding readings we have taken tend to confirm this assumption.

Walloon Coal Measures



a. Typical sandstone and siltstone in railway cutting near Beaudesert (Ipswich 1:250,000 Sheet, grid ref. 607527)

b. Poorly bedded crossbedded sandstone with some calcareous lenses in creek north of Warwick (grid ref. 512506)

PHOTO PLATE 7

Road cutting on the Cunningham Highway through steeply dipping Walloon Coal Measures; note disrupted coal bands and Tertiary basic sills (grid ref. 554520)

Coal has been mined at Bonalbo and Tannymorel, but these mines have closed. Working seams are generally 1-4 metres thick (Gould, 1968) but seam thicknesses can be greater. The coal is a high volatile bituminous type and is generally non-coking.

The sequence in this area is thicker than the 200 m of the type area in the north. We estimate a thickness of 450 m at Mt Barney, and the formation is 550 m thick in Mid Eastern Kyogle No. 1 well (Fig. 3) in the middle of the basin. It thins southwards to 360 m in Australia Cities Services Tullymorgan No. 1 near Maclean and in the far south near Nymboida (McElroy, 1962) it is between 120 m and 200 m thick. Thus, the formation thickens towards the centre of the basin.

Plant leaves and stems are very abundant. Plants collected during the present survey are of Jurassic to Lower Cretaceous age (White, 1969). R.E. Gould has recently completed an exhaustive survey of the Walloon Flora. De Jersey & Paten (1964) assign a Middle Jurassic age to the sequence in the type area. McElroy (1962) records two spore assemblages from the Bonalbo Colliery which were identified by J.P.F. Hennelly as of Upper Jurassic age. Burger (Appendix 2) obtained a typically Jurassic flora of Evans' (1966) division J4, which is of Middle Jurassic age. Thus most of the unit is Middle Jurassic but it may range up into the Upper Jurassic.

Woodenbong Beds

This name is proposed for the feldspathic sandstone sequence which overlies the Walloon Coal Measures northwest of Woodenbong, around Capeen, and west of Kyogle. A typical section is exposed on the Forestry road leading up to the Queensland border, between points 572485 and 569485; the sequence continues to the base of the basalt at Mt Clunie to the west. As is generally the case, there is a break of slope at the foot of the lowermost sandstone of this unit, which is more resistant than the underlying Walloon Coal Measures. The estimated thickness of the sequence on the road north of Woodenbong is about 400 m. The lower part of the Beds consist largely of massive to medium bedded, pale grey, fine to coarsegrained, crossbedded feldspathic sandstone with minor dark lithic grains, and some carbonaceous partings. Granule and pebble bands contain clasts derived from the Palaeozoic sequence, including acid porphyries. Small pieces of fossil wood occur in some beds. Thinly bedded ripple-marked siltstone lenses are common. The ripple marks and crossbedding suggest current flow to the east. Above the basal section outcrop is poor, but the beds appear to consist of more than 50% fine to medium grained feldspathic sandstone; siltstone, carbonaceous mudstone, and minor coal make up the rest of the sequence.

Other good exposures are southwest of Mt Barney, where the beds form high country above the Walloons, and in the hills around Capeen, including the Richmond Range. They are essentially similar everywhere although they contain more lithic grains and more feldspar in the north than in the south. Southwards they grade laterally into the more quartzose Kangaroo Creek Sandstone. Northwards they have been eroded away and the Walloon Coal Measures are overlain by Tertiary basalt; these are the youngest Moreton Basin sediments in Queensland. Southwest of Mt Barney the beds are heavily leached and appear superficially to be sublabile; fresher outcrops show that they are feldspathic. In the hills around Capeen (e.g. road towards Dome Mountain, road over Richmond Range) outcrop is particularly good and shows that the sequence is predominantly sandstone. Near the southern limit of the Woodenbong Beds there is a basal medium to coarse sandstone sequence perhaps 15 m thick (e.g. 577457) which varies to sublabile and apparently to quartzose and is transitional to the Kangaroo Creek Sandstone. McElroy (1962) mapped the beds in this area as part of the Kangaroo Creek Sandstone, although he included those near Woodenbong in the Walloon Coal Measures. However, overlying the basal sequence there is about 150 m of unresistant feldspathic sandstone which is distinct from the Kangaroo Creek Sandstone. Some is greenish and contains a sizeable fraction of lithic grains. Minor pebbly and gritty bands persist throughout the sequence.

It is suggested that derivation was from the north and west and that this sequence cleans up gradually to produce the Kangaroo Creek Sandstone, which is quartzose in its type section to the south. Certainly the boundary between the two units is gradational, and the boundary shown on the map is arbitrary. It is possible that the uppermost part of the Woodenbong Beds equates with the Grafton Formation, but there is no continuity of outcrop. As the Grafton Formation is lithic and generally fine grained correlation is highly speculative.

The conformable contact with the underlying Walloon Coal Measures is very obvious in most areas. The sequence is comparable with that in the eastern part of the Surat Basin where the Springbok Sandstone overlies the Birkhead Formation. It is possible that the Woodenbong Beds were originally continuous with the Springbok Sandstone, but structural movements and erosion have left a gap of 125 m to the Springbok Sandstone in the Millmerran area. Alternatively there may have been no deposition between the Yarraman Block and the Texas High. Unfortunately we have no palynological data from the Woodenbong Beds as a basis for comparison with any other sequence.

The formation is a freshwater unit laid down by streams and in lakes. Its provenance is probably largely granitic and from the Texas High area. The intermediate volcanic grains probably represent contemporary andesitic vulcanism in the north; alternatively they might be derived from earlier Jurassic sediments. Crossbedding readings suggest deposition from a stream flowing to the east and southeast, which is somewhat different to the situation in Walloon times.

The beds are underlain by the Middle to Upper Jurassic Walloon Formation, and overlain by Miocene volcanics. As they are equivalent to the Kangaroo Creek Sandstone, and possibly the lower part of the Grafton Formation, which is of Upper Jurassic age (Burger, Appendix 2), the beds are probably entirely of Upper Jurassic age.

Kangaroo Creek Sandstone

The names 'Kangaroo Creek Series' and 'Kangaroo Creek Stage' were proposed (Lloyd & Whiting, 1940, unpublished; Lloyd, 1950) for the sandstone which forms escarpments up to 90 m high along Kangaroo Creek. The unit was redefined by McElroy (1962) as Kangaroo Creek Sandstone.

The following description of typical Kangaroo Creek Sandstone is drawn from McElroy (1962). He says (p. 45) 'The dominant rock type (indeed, almost the only rock type) of the formation typically consists of medium to coarse, glistening white and cream sandstone of saccharoidal texture. Thin bands and lines of quartz pebbles are distributed sparsely throughout the formation'. In thin section quartz comprise 80 to 85 percent of the rock, silty rock fragments, chert, and feldspar 3 to 4 percent, and clay matrix the remainder. Thus by Crook's (1960) classification it is quartzose sandstone. Zircon, rutile, garnet, tourmaline, and monazite are present in small quantities.

McElroy (1962) mapped the formation right around the basin from just south of Woodenbong to the Grafton area, and thence north to the Numbin area, but we have mapped the feldspathic sandstone around Woodenbong separately as the Woodenbong Beds. The facies boundary shown on the geological map is quite arbitrary. It marks roughly the southernmost extent of dominantly feldspathic sandstone. South of it quartzose and feldspathic sublabile sandstone predominates.

The Kangaroo Creek Sandstone is a cliff-forming unit, at least in the lower part. It is typically exposed along the Mallanganee-Casino road where it is about 180 m thick. The lower third of the sequence consists of thickly bedded, crossbedded, fine to coarse grained, white to buff, quartzose to feldspathic sublabile sandstone. There are minor dark lithic grains, and isolated potash feldspar grains are characteristic; quartz grains display crystal faces. The rather rare pebble bands consist largely of quartz, quartzite, phyllite, chert, and acid porphyry. Non-outcropping bands may represent more labile sandstone. The upper part of the sequence is much less resistant and consists largely of fine-grained feldspathic sublabile sandstone, which grades to feldspathic sandstone in some beds.

The Kangaroo Creek Sandstone overlies the Walloon Coal Measures with apparent conformity in this area, although McElroy (1962, p. 42) believes that there is an angular unconformity of several degrees to the south. The east Richmond Fault, which follows the contact in the Mummulgum area, confuses the relationship in one of the best outcrop areas.

The Kangaroo Creek Sandstone is a fluviatile deposit. No doubt the Texas High remained the source of the detritus, and variations in the rocks in the headwaters of the streams had an effect. However, the steady bulk change southwards to a thinner and more quartzose deposit indicated deposition from southeasterly flowing streams.

The unit thins southward as it becomes more quartzose. The Woodenbong Beds are more than 300 m thick. In Mid Eastern Kyogle No. 1 135 m of the Kangaroo Creek Sandstone was penetrated and there is a considerable thickness of the unit above the well head; 250 m is a reasonable thickness estimate. In the south of the Warwick Sheet, Hanlon (1968) estimated a thickness of 180 m. In the type area it is about 150 m thick.

A core sample from Kyogle No. 1 yielded the spore Lycopodiamsporites rosewoodensis which indicates a post-Middle Triassic age. This is the only recorded identified fossil. The Kangaroo Creek Sandstone overlies the Middle to Upper Jurassic Walloon Coal Measures and underlies the Upper Jurassic Grafton Formation; thus its age is Upper Jurassic.

Grafton Formation

The terms 'Grafton Beds' (Lloyd & Rayner, 1946) and 'Grafton Stage' (in David, 1950) were proposed for a sequence of poorly outcropping sandstone, siltstone, and mudstone extending along the axial zone of the Clarence Basin from south of Grafton to north of Casino. These are the youngest rocks of the Clarence-Moreton sequence. McElroy (1962, p. 45) renamed the unit Grafton Formation.

The formation, which has no designated type section, was described by McElroy (1962) from a brick pit near Grafton and a section in a road cutting south of Casino, as largely siltstone and claystone with lesser soft sandstone which is poorly crossbedded. In thin section (p. 47) the clayey lithic sandstone contains quartz and rounded chert, with minor feldspar, and abundant clay matrix. Subrounded zircon predominates over rutile in the heavy mineral fraction.

Most of the outcrop consists of greenish lithic sandstone, or pale grey feldspathic sandstone, both of which are calcareous in part. The lithic sandstones are medium to thickly bedded. Some beds contain green and pink clay clasts, and some are very tough. These sandstones average about 30% quartz, 40% rock fragments (both andesitic and sedimentary), 10% feldspar, and about 20% chloritic clay matrix. Muscovite, biotite, and detrital iron ore are minor constituents of some beds. The feldspathic sandstones, which crop out under the bridge at Casino, are thickly crossbedded.

BMR Warwick No. 5 stratigraphic hole (Fig. 6) penetrated 95 m of a monotonous sequence consisting largely of fine to coarse grained grey sublabile to labile sandstone with angular clasts. Garnet and coal grains and clay clasts are abundant in some beds. Minor siltstone and clay are also present.

The formation conformably overlies the Kangaroo Creek Sandstone. Although the contact is gradational, the generally quartzose to feldspathic sublabile Kangaroo Creek Sandstone is quite distinctive, in bulk, from labile Grafton Formation sandstone.

It is possible that the upper part of the Woodenbong Beds is equivalent to the Grafton Formation - the grey sandstone in BMR Warwick No. 5 are not unlike sandstones high in the Woodenbong Beds. However, the feldspathic Woodenbong Beds contain very few lithic sandstones, and none of the tough green sandstones that typify the Grafton Formation in outcrop. There is no continuity of outcrop and correlation is open to doubt.

This is apparently a fluviatile unit in this area. As the siltstone and mudstone sequence farther south suggests lake deposits, derivation from a northerly source is likely. Much of the detritus probably came from the Texas High to the northwest, but the presence of abundant andesitic rock fragments may indicate some contemporary vulcanism. The presence of *Hystrichosphaeridium* in BMR Warwick No. 5 suggests marine influence.

The maximum thickness of the unit is probably approached in Clarence Grafton No. 2 bore (McElroy, 1962, p. 45) where it is 270 m thick. In this area it is probably less than 150 m thick.

The Grafton Formation is unconformably overlain by Miocene basalts and is often exceedingly hard near the contact, suggesting heat-induced recrystallization of the calcareous matrix. It contains Taeniopteris spatulata, a Jurassic to Lower Cretaceous plant (McElroy, 1962). From cuttings in BMR Warwick No. 5 Burger (Appendix 2) has obtained a microflora which favours an Upper Jurassic age over a Lower Cretaceous one, and which he has assigned to Evans' (1966) spore unit J5-6. Its age is thus probably Upper Jurassic.

MIOCENE IGNEOUS ROCKS

There was a great deal of igneous activity in southeastern Queensland and northeastern New South Wales in early Miocene time. In the Main Range and McPherson Range areas, the products of this vulcanism still dominate the landscape. Many types of igneous rocks occur as bosses, plugs, sills, and dykes, between Boonah and Woodenbong. The Main Range Volcanics, which consist of alkali-olivine basalt and lesser trachyte, were fed from vents in this area, and were largely deposited to the west on a westerly slope. The subalkaline basalts of the Lamington Volcanics were extruded from vents at Mt Warning, and the associated rhyolites were extruded from local vents through the basalts and form discontinued lenses. Later erosion has stripped the basalts from the centre of the area, and revealed the intrusions, which are confined to the outcrop area of the Walloon Coal Measures. It is probable that numerous intrusions underlie the basalts in the remainder of the area.

The results of potassium - argon dating of the igneous rocks are tabulated in Table 2.

Miocene Intrusions

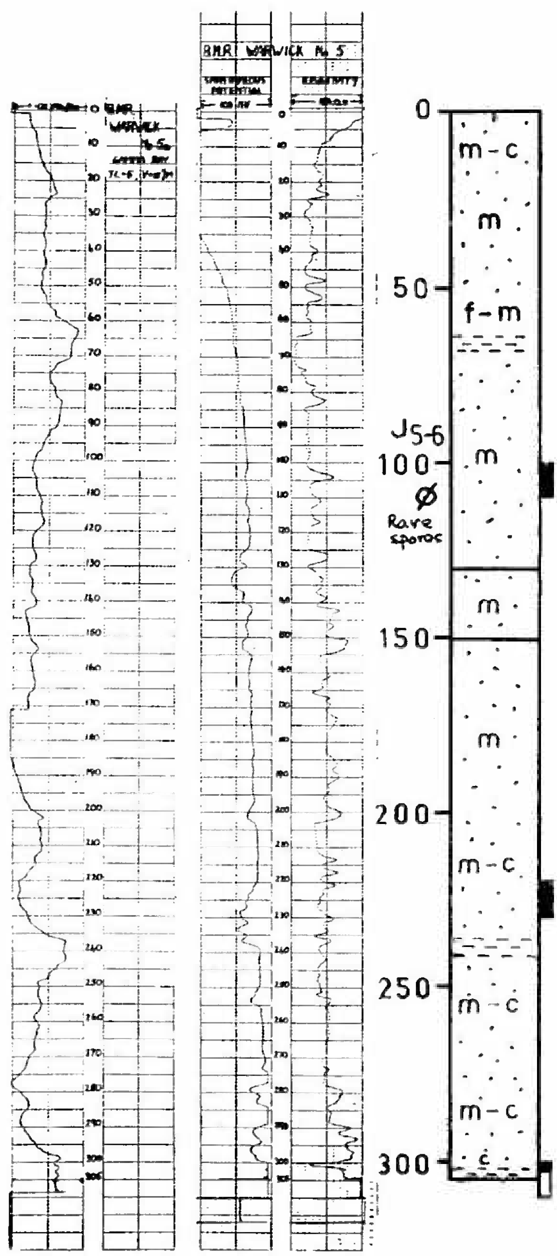
Numerous intrusive masses, mostly plugs, dykes, and sills, are present in the northeastern part of the Sheet area. These rocks and their relationship to the pre-Tertiary rocks are shown on the general geological map.

Most of the rocks in the Queensland part have been described by Richards (1916); the Mount Barney Complex have been described in detail by Stephenson (1954, 1956, 1959, 1960) and the Mt Alford Ring Complex by Stevens (1959, 1960, 1962). Many other authors have mentioned them in passing. In the New South Wales part work has been far less intensive and little has been written apart from the general discussions in McElroy (1962).

Fig 6

DRILL HOLE B.M.R. WARWICK Nos. 5 & 5A.

GRAFTON FORMATION.



brown fe sst.

grey lab. sst. frags. coal.

grey, brown, red-brown sst.

grey lab. sst.

Core 1. 100'-110' rec. 9' 4".
grey, m.gr. sublab sst. frags. coal + clay. some clayey bands, up to 1".

grey-brown qtzose. sst. some fe.

grey-brown lab. sst. frags. coal+fe.

do. less lithics.

Core 2. 220'-230'. rec. 9' 7".
grey, m.gr. sublab. sst. frags. coal + garnet.

grey, lab. sst. frags. coal + garnet.

Core 3. 300'-310'. rec. 2' 6".
grey sublab. sst. frags. coal.
fe. in lower part.
bedding inclined 5°

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The distribution of rock types and the dating evidence (Table 2) suggest that emplacement of the alkali suite of trachyte, comendite, and microsyenite in the area west of Rathdowney, commenced slightly before that of the acid rhyolites and granophyres related to the Mount Barney and Mount Alford Complexes. However, both the time of emplacement and the rock type probably overlapped. Intrusion of dolerite, basalt and teschenite, on the evidence of the extrusives in the Main Range Volcanics, probably continued longer than that of the more acid suites and started sooner. The extrusive equivalents of the microdiorite, diorite, and andesite cannot be separated from the basalt in the field, and the period of their intrusion remains speculative, although it is certainly confined to the general period of vulcanism.

An interesting and virtually unexplained phenomenon is that the intrusions are largely confined to the outcrop area of the unresistant Walloon Coal Measures, although the main acid complexes (Barney and Alford) dragged the more resistant Marburg Sandstone to the surface.

The Mount Barney Central Complex (Stephenson, 1959, 1960)

The complex has updomed the Walloon Coal Measures and exposed the underlying Jurassic Marburg Sandstone and Triassic and Carboniferous sediments (see geological map). Inside a circular line of flexure, dips of 20-40° away from the intrusions are common; outside the line dips are normally shallow.

The intrusive history of the complex can be related to five successive centres of activity, aligned east-west. The intrusive rocks range from acid granophyres to tholeiitic dolerites (see Stephenson, 1959, 1960).

The Mount Alford Ring Complex (Stevens, 1959, 1960, 1962)

The situation is greatly generalized in the geological map. The ring complex consists of a central boss of porphyritic microdiorite, with closely associated granophyre, intrusive into steeply dipping Marburg and Walloon sediments which were dragged up during intrusion. Ring dykes of rhyolite and trachyte have intruded the upturned Marburg sediments, and andesite has invaded the boss. Sills of rhyolite extend northwards from the outermost ring dyke. The central boss and the outer zone of ring dykes have been pierced by later dykes of rhyolite and trachyte. At about the same time breccia necks formed within and on the margin of the boss by explosive action. The latest phase of activity is represented by a basaltic dyke swarm, which is restricted to the ring complex.

TABLE 2 - POTASSIUM-ARGON DATING

Subdivision	Age (m.y.)	Comments
Alkali trachyte intrusives of central area	25-24*	Mount Edwards only one dated within area of Fig. 1
Acid intrusions of central area	23.5 - 22.5*	One sample from each of Mts Alford, French, Barney, Gillies
Main Range basalts	24-22*	Consistent decrease up sequence from basal flow. Four samples in Mount Mitchell area
Gabbro, Mount Warning Volcano	22.4*	One sample
Basalts, Mount Warning Volcano	22-20*	Weathered, internally inconsistent; probably too young. Four samples
Basalts, Mount Warning Volcano	22.9,22.6+	More reliable, 2 samples
Tabulum basalt	23.6+	Not known whether part of Main Range or Lamington sequence, or neither

* Webb, Stevens, & McDougall, 1967

\+ McDougall & Wilkinson, 1967.

Other ring dykes

An almost complete ring dyke of alkaline rhyolite forms Minto Crags, southeast of the Mount Alford complex. Two other partial ring dykes of presumed trachytic nature occur southwest of Urbenville and near Capeen. These were identified as ring dykes largely on the basis of their photo-pattern.

Trachytic plugs and related sills

In places trachytic plugs are surrounded by sills of similar composition. Possibly the sills were intruded into the Jurassic sediments during injection of the plugs before the final vertical break-through which formed volcanic vents.

MIOCENE VOLCANICS

Most of the volcanics can be assigned to the Main Range Volcanics (Stevens, 1965) west of a line connecting the Main Range and Woodenbong, and the Lamington Volcanics (after Bryan & Jones, 1945) east of Mt Barney. A longitudinal line through Bonalbo and Capeen may separate the two units in the south. The affinities of the small basalt cappings in the Mt Barney/ Boonah area are not known with any certainty. Some may be late-stage products of the Mt Barney and Mt Alford complexes.

Main Range Volcanics

The Main Range Volcanics have been discussed by many workers including Richards (1916) and Stevens (1960, 1965). They form a north-northwesterly belt of country sloping gently westwards from the main Range to Allora and Killarney. Up to 1000 m of volcanics are exposed in the east. The flows dip gently westwards, and thin in that direction. The area has been cut into ridges, with valleys more than 300 m deep, by westerly flowing streams.

The fairly straight scarp led early workers to postulate a major fault along the escarpment, but Reid (1922) and Marks (1932) showed that there is no evidence of such a fault and suggested that the scarp is due to normal stream erosion, which is more active east of the divide.

The volcanics were largely extruded from fissures along and just east of the line of the main Range; the fissures are represented by a multitude of basalt dykes, and many trachytic sills and plugs. Stevens (1965) states that the volcanics dip easterly and westerly at low angles away from a line which is very close to the present divide. The pre-volcanic surface was quite irregular and the base of the volcanics varies greatly in elevation.

Stevens (1965) showed that the sequence is complex in detail. The lower 300 m contains numerous trachyte sills up to 165 m thick, but the oldest flow is always basalt. The upper 600 m of the sequence is entirely basaltic. The trachytes are discontinuous and lenticular, and occur at various levels. Each flow had a local vent, some of which are represented by exposed plugs.

Stevens (1965), on the basis of petrology and distribution, named 3 members of the Main Range Volcanics - Spicers Gap Trachyte, Swanfels Trachyte, and Steamers Trachyte. In some places basalt alternates with the trachyte. The boundaries shown by Stevens (1965) were generalized for the geological map accompanying this record. Only the leucotrachytes can be distinguished in the field, so they alone are shown on the map. Stevens (1965) found rocks 'ranging from olivine basalts to rocks with the chemical composition of rhyolites'. Basalt is the most abundant rock type and overall the sequence is a fairly normal alkali-basalt - trachyte suite typical of continental non-orogenic regions.

Lamington Volcanics

The Queensland portion of these volcanics was first discussed in some detail by Richards (1916). Bryan & Jones (1945) named them the Lamington Series and suggested a Pliocene age. The name Lamington Volcanics was first used by Stephenson, Stevens, & Tweedale (in Hill & Denmead, 1960, p. 355). The volcanics consist predominantly of basalt with some interbedded rhyolite, rhyolitic pyroclastics, and sediments. The general threefold vertical subdivision into basalt-rhyolite-basalt was recognized by Richards (1916). The volcanics were, in large part, extruded from the Mt Warning Shield volcano west of Murwillumbah.

The volcano and its products were discussed at some length by McTaggart (1961) and Solomon (1964). The rocks have a maximum thickness of about 1100 m and form a shield volcano, the lavas extending in all directions for up to 55 km (Solomon, 1964). Spine-like supplementary vents of acid material - Egg Rock and Charrambomba Rock - were noted by Tweedale (1950) in the Binna Burra area just east of here. Solomon (1964) noted similar spines within the erosion caldera.

McElroy (1962) found a threefold division to exist south and east of the Warwick Sheet area. He used the name 'McPherson Volcanics' for the sequence, but noted in a footnote (p. 53) that Lamington Volcanics had priority. He named the lower 200 m basaltic sequence the Lismore Basalt. Overlying this is a rhyolitic sequence (Nimbin Rhyolite), which attains a maximum thickness of 500 m near Nimbin. The upper basalt (the Blue Knob Basalt) reaches a maximum thickness of 250 m, also near Nimbin.

As a result of the recent mapping it is now apparent that rhyolite was emitted in different areas at different times. Perhaps the earliest was the phase that led to deposition of the Hillview Rhyolite and the Chinghee Conglomerate (McTaggart, 1961) between Hillview and Wiangaree. The Binna Burra Rhyolite (McTaggart, 1961) and the Nimbin Rhyolite (McElroy, 1962) are at a higher level but farther east. They may or may not be contemporaneous, but they are separated by a considerable distance. The Mt Lindesay Rhyolite (McTaggart, 1961) exposed at Mt Lindesay and Mt Glennis is a fourth body. It was impossible to establish the relationship to the rhyolites in the east in our regional mapping programme. The Mt Lindesay Rhyolite certainly has a different origin from the eastern rhyolite as it thickens northwestwards.

The names Albert Basalt, Beechmont Basalt, Hobwee Basalt, Lismore Basalt, and Blue Knob Basalt have local application. We have used the symbol Tml for all the basalts of the Lamington Volcanics. As the volcanic sequence is often not divisible we prefer the earlier name Lamington Volcanics to McTaggart's (1961) Lamington Group.

Hillview Rhyolite and Chinghee Conglomerate

These names were proposed by McTaggart (1961) for sequences in the Hillview area. The cliff-forming Hillview Rhyolite consists of agglomeratic tuffs and brecciated rhyolite and is up to 60 m thick.

The Chinghee Conglomerate consists of alternating beds of argillaceous current bedded sandstone and polymictic conglomerate which contains boulders up to 0.5 m in diameter. Boulders consist of Palaeozoic sediments, rhyolite, and granophyre, the last being similar to that of the Mount Barney central stock (Tweedale, 1950). McTaggart states that it everywhere overlies the Hillview Rhyolite, and reaches a maximum thickness of 30 m in the type area.

The Chinghee Conglomerate is regarded as a fluviatile sequence deposited during a period of acid vulcanism. The Hillview Rhyolite, which is largely agglomerate, is a dumped deposit, which has been reworked by streams. The vent must have been in the Hillview - Chinghee area, where the unit is coarsest.

The Hillview Rhyolite and Chinghee Conglomerate, which are interbedded outside the type area, are included in unit Tmr on the geological map. This unit thins steadily southwards from about 60 m near Cougal to about 30 m south of Mt Lion, and there is a very gentle dip in this direction.

Mt Lindesay Rhyolite

This name was introduced by McTaggart (1961) for the sequence of tuff, agglomerate, obsidian, and rhyolite that forms the cliffs on Mt Lindesay and nearby Mt Glennie. Stephenson (in McElroy, 1962, p. 55) recorded on Mt Lindesay 420 m of basalt overlain by 60 m of rhyolitic agglomerate and light coloured tuffs. Above this are 180 m of cliffs containing rhyolite, with local thin basalts, and acid pyroclastics at the base. The mountain is topped with 30 m of basalt. This acid sequence and the 120 m sequence at Mt Glennie correspond. The two flows on Mt Glennie are more uniform, being largely white rhyolite with feldspar phenocrysts.

A dip to the south is visible on Mt Glennie, and the same beds are about 180 m higher on Mt Lindesay to the northeast. As the Mt Lindesay sequence is thicker and more agglomeratic as well as higher, the interpretation of Tweedale & Stephenson (Hill & Denmead, 1960, p. 356) that Mt Gillies, 8 km to the north, was the vent for the Lindesay Rhyolite, is very reasonable.

The original, and indeed the present, distribution of the Lindesay Rhyolite is a problem. Richards (1916) recorded sporadic cappings of acid volcanics on the McPherson Range between Mt Lindesay and Running Creek. We could find no acid volcanics in situ in accessible areas north of Old Grevillea, but in all the creeks there are large and abundant cobbles and boulders of acid volcanics which vary from very fine rhyolite to very coarse acid porphyries, and must have been derived from the headwaters of the creeks.

The Basalts

Richards (1916) was the first to make a comprehensive study of these rocks. Chemical analyses listed by a number of workers, including Richards, show that the Lamington Volcanics are less alkaline than the Main Range Volcanics (Webb, Stevens, & McDougall, 1967, text-fig. 2). Webb, Stevens, & McDougall pointed out that the Lamington Volcanics, while not tholeiitic by generally accepted standards, are closer to that suite than the Main Range Volcanics.

The basalts vary from glassy to coarsely porphyritic. Phenocrysts are normally olivine or feldspar. Richards (1916) reported porphyritic andesite from the upper sequence to the north. Vesicular and amygdaloidal basalts occur sporadically and zeolite infillings are common. Basaltic agglomerate and tuff have only been seen in the lower part of the sequence and are rare.

Age: Webb, Stevens, & McDougall (1967) using K/Ar dating, obtained apparent ages ranging from 22 to 20 million years for four samples from the volcanics. These dates were all younger than the biotite age of 22.5 to 23 million years obtained from the Mt Warning gabbro. They stated: 'The present evidence does not justify the conclusion that the volcanism in the Main Range began before that in the Mt Warning Shield. The results suggested that alkali olivine basalt magma and sub-alkaline magma were being extruded during the same interval from centres only 80 km apart'.

Dates on basalt from Fingal and Burleigh Heads (22.6 and 22.9 million years respectively) and an age of 23.6 million years from an olivine tholeiite near Tabulam (Main Range Volcanics?) were given by McDougall & Wilkinson (1967). There is no doubt that the Lamington Volcanics are of early Miocene age.

Miocene Sediments associated with the Main Range Volcanics

In several localities near Cunninghams Gap, sediments are interbedded with basalt flows, or overlie basalt; the sediments are dominantly volcanolithic (both explosive debris and clasts derived from erosion of pre-existing basalts). A typical sequence was observed in a creek bank at 540523 north of the Cunningham Highway; a thickness of 12 m of sediment was made up of the following rock types:

Unit 8. yellow, fibrous, very low density volcanic ash.

" 7. hard, well crystallized (? silicified) tuff displaying a conchoidal fracture which cuts across crystals.

" 6. vesicular tuff, replaced laterally by very coarse pebbly sandstone.

" 5. hard grey mudstone interbedded with grey to white fine grained sublabile to labile sandstone.

" 4. very vesicular, very fine grained tuff with some quartz and feldspar pebbles.

" 3. pebbly sandstone and conglomerate overlying unit 2 with scour and fill structure; clasts largely intraformational in derivation, showing very poor sorting and very irregular shape.

" 2. very fine grained white tuff, with mainly fine quartz and feldspar crystals, and some medium feldspar.

" 1. fine grained, very low density tuff, with some sand-size shards of volcanic glass and minor feldspar and quartz crystals.

The sequence suggests explosive vulcanism during a lull in extrusive activity and deposition in a lacustrine or fluviatile environment developed on a basalt surface.

QUATERNARY SEDIMENTS

The major accumulations of Quaternary sediments in this area are related to the Condamine, Logan, Richmond, and Clarence River systems.

Condamine alluvium (Qpc)

The alluvium of the Condamine River system, especially its vertebrate content, has been discussed in some detail by Woods (1960), Bartholomai & Woods (1968), and Bartholomai (1969). Downstream from Dalby, Pliocene vertebrates are found in the Chinchilla Sand; the younger unit Qpc contains Pleistocene vertebrates along its length. Overlying these sandy sediments is a patchy veneer of Recent mud, which Bartholomai (1969) states 'does not appear to be much more than a metre in depth'.

In the headwaters of the Condamine River, in the Warwick Sheet area, Pleistocene vertebrates have been found in several localities, particularly in Freestone and Emu Creeks. The alluvium of the Condamine River, which is largely drawn from Palaeozoic sediments and granite, and the Mesozoic Marburg Sandstone, is quite sandy. It probably does not exceed 30 m in thickness in this area. The westward-flowing tributaries, which are derived in part from the basalt of the Main Range, as well as the feldspathic Marburg Sandstone and the muddy lithic sediments of the Walloon Coal Measures, contain alluvium which is more muddy than usual. Although some of the sediment exposed at the surface is undoubtedly Recent, the bulk of the sediment is probably Pleistocene.

Other alluvium (Qa)

The alluvium of the other main rivers has not been studied in the same detail as the Condamine. Pleistocene vertebrates have only been found in Knapps Creek, a tributary of the Logan River near Tamrookum (Woods, 1960, p. 402).

As there is so little knowledge of the age of this alluvium, which forms the present-day floodplains of the various rivers and streams, it is shown on the map as undifferentiated Quaternary alluvium.

That the alluvium of the broad flood plain of Logan River is thick and sandy is shown by the numerous water bores along its length. It is highly likely that there are extensive Pleistocene deposits in this river system also. The same applies to the alluvium of the Richmond River, which forms a broad plain. The Clarence River alluvium is more restricted in extent, but is very sandy. Just west of the river on the main road west from Tabulam about 6 m abve the present-day alluvium, there are consolidated river gravels at least 2 m thick, which are probably of Pleistocene or older age.

STRUCTURE

The Warwick area forms part of the western flank of the meridional Clarence - Moreton Basin (see Fig. 7). The basin structure is simple overall but is complicated in this area by several faults and related anticlines, and by the domes of Mt Alford and Mt Barney intrusions, and the Hogarth Dome.

The Palaeozoic sediments and granites of the Texas High form the western margin of the basin and similar Palaeozoic sediments form the basement throughout the Warwick Sheet area. The eroded surface of the basement rocks declines to the north and east, from the Texas High. Average slope is less than half a degree, although it is somewhat steeper at the basin margin. The Mesozoic fill of the basin conforms to the basement structure. In the middle of the basin, on the eastern side of the Sheet area, Mid Eastern Kyogle No. 1 penetrated 2500 m (Warner, 1963) of Mesozoic sediments, and seismic and aeromagnetic data (Zarzavatjian, 1965) suggest that this approximates the maximum thickness.

The two cross sections on the geological map illustrate the general structure as inferred from surface and subsurface data. Unfortunately the widespread Miocene basalt cover has prevented geophysical work in most of the Sheet area, and has obscured much of the pre-Tertiary outcrop.

In the north (Section A-B-C) the Triassic and lowermost Jurassic sediments fill the centre of the Basin (information from Queensland American The Overflow No. 1) but do not appear in outcrop on the western side of the basin. The same situation applies in the south (Section D-E-F), where there are several relevant holes and some seismic data. Whether this is the result of early Jurassic bevelling, or of an onlap relationship to the Texas High, or both, is not known with certainty, although the second appears more likely.

The major Miocene intrusions of Mt Barney and Mt Alford have domed the surrounding Mesozoic sediments. A remarkable line of flexure is developed around the Mt Barney Complex; inside it, dips are steep, but outside they are virtually flat. The Swan Creek and Maryvale Anticlines (Fig. 7), which display only shallow dips, are probably due to basement adjustment and associated faulting. The faulting on the western side of the Swan Creek Anticline is illustrated in Photoplate 8.

The south Moreton Anticline, the related Grevillia and Toonumbar Anticlines, and the associated faults, are the most remarkable features of the Sheet area. They appear to have been caused by basement readjustment and faulting, in pre-Miocene times. Discussing the Moreton Basin as a whole, Hill (p. 6 in Hill & Denmead, 1960) stated that the main faulting occurred between the mid Jurassic and the early Cainozoic, although some movement occurred in the late Triassic, and again in the Cainozoic when the Mesozoic structures were accentuated. The west Ipswich disturbance, a major structural line trending south-southeast, affected the Walloon Coal Measures, but not the Cainozoic. In the Warwick Sheet area, and immediately north of it (see Hill & Tweedale, 1955) Miocene basalts lie directly on the South Moreton Anticline and are undisturbed; the same situation applies at the Grevillia Anticline. Jorgenson & Barton (1966), from photogeological interpretation, suggested that the eastern edge of the Esk Trough, the West Ipswich disturbance, and the South Moreton Anticline, all of which are aligned, were controlled by a single system of crustal weakness.

The South Moreton Anticline is an asymmetrical structure with a shallowly dipping western limb (2°-5°), and a steeply dipping east limb (up to 70°) (see Photo Plate 8) which is sheared and faulted in places. Culminations on the anticline are delineated by outcrop of the Ripley Road Sandstone. The Grevillia Anticline is only visible as a window in the Miocene basalt. It is assumed that it is linked, under the basalt, to the South Moreton Anticline. Dip of 5-15° are visible on both flanks but no sign of faulting was seen in the small area of outcrop. The Toonumbar Anticline, farther south and on the same trend, is similar to the South Moreton Anticline in that it has a shallow dipping western flank and a faulted eastern flank with dips up to 30°. The preferred interpretation is that all the resistant sandstone in the vicinity is part of the Marburg Sandstone. The alternative interpretation is that there has been displacement of more than 300 m on the fault, bringing the Kangaroo Creek Sandstone into juxtaposition with the Marburg Sandstone.

a. Steeply dipping and probably faulted Marburg Sandstone in eastern flank of South Moreton Anticline (grid ref. 605513)

b. Faulted Marburg Sandstone on western side of Swan Creek Anticline. Looking south at roadside (grid ref. 524503)

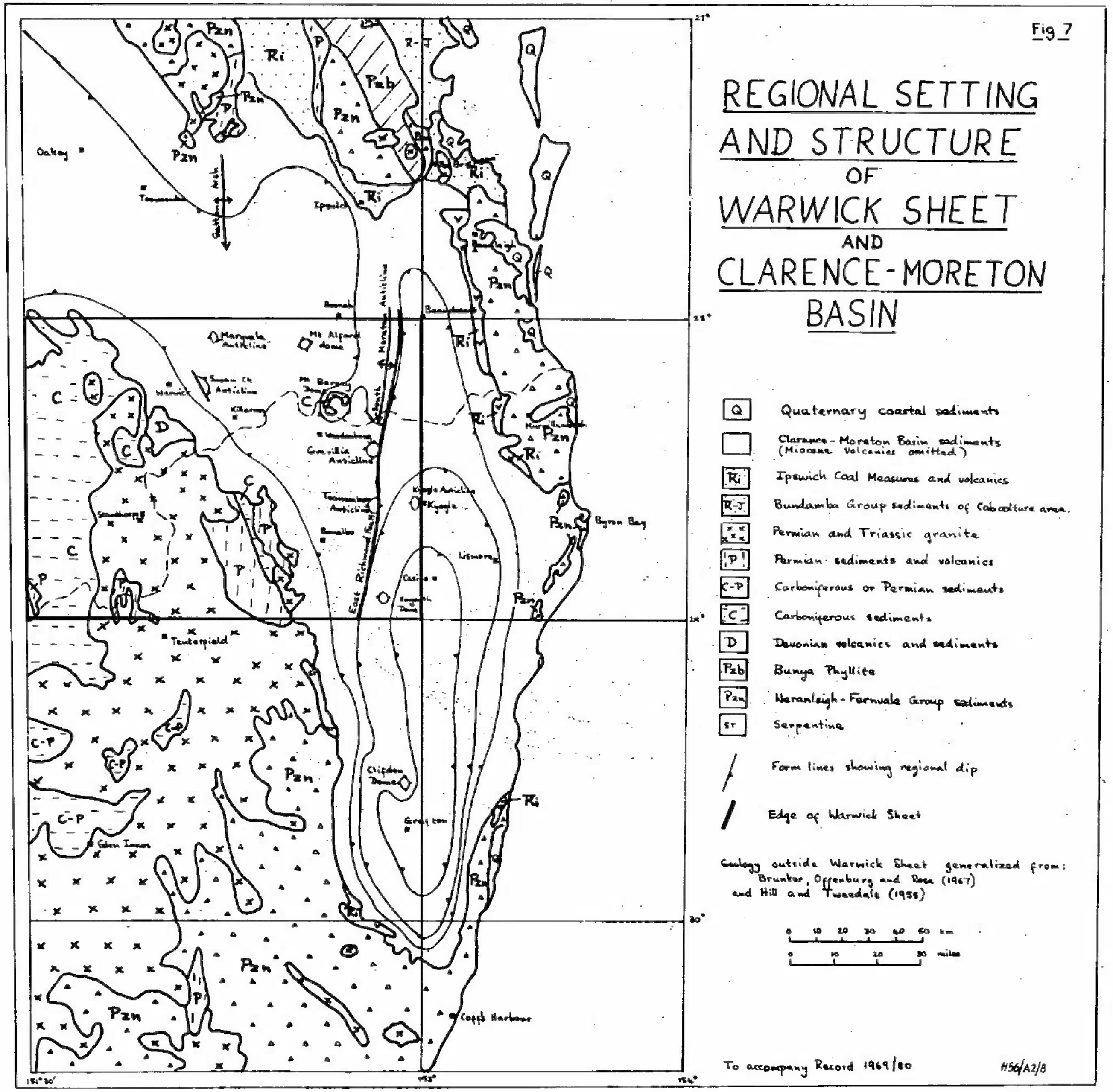
Fig 7
REGIONAL SETTING AND STRUCTURE OF WARWICK SHEET AND CLARENCE-MORETON BASIN
Q Quaternary coastal sediments
Clarence-Moreton Basin sediments (Miocene Volcanics omitted)
Ri Ipswich Coal Measures and volcanics
R-J Bundamba Group sediments of Caboolture area.
Permian and Triassic granite
P Permian sediments and volcanics
C-P Carboniferous or Permian sediments
C Carboniferous sediments
D Devonian volcanics and sediments
Pzb Bunya Phyllite
Pzn Neranleigh-Fernvale Group sediments
ST Serpentine
Form lines showing regional dip
Edge of Warwick Sheet
Geology outside Warwick Sheet generalized from: Brunker, Offenburg and Rose (1967) and Hill and Tweedale (1955)
0 10 20 30 40 50 km
0 10 20 30 miles
To accompany Record 1969/80
H56/A2/8
Oakey
Ipswich
Warwick
Killarney
Stanthorpe
Tenterfield
Glen Innes
Bonalbo
Kyogle
Casino
Lismore
Byron Bay
Grafton
Coffs Harbour
Marquela Anticline
Mt Alford dome
Swan Ck Anticline
Mt Barney Dome
Gravillie Anticline
Kyogle Anticline
Clifden Dome
East Richmond Fault
South Moreton Anticline
Pzn
Pzb
Ri
R-J
Q
C
D
P
C-P
151°30'
152°
154°
27°
28°
29°
30°

The East Richmond Fault (McElroy, 1962) is the southerly continuation of this line of structures. It is a zone of faulting apparent in both seismic and aeromagnetic maps. Feather faulting, with azimuth approximately 200°, is evident in the Ghinnighi area. Maximum displacement down to the east is probably about 80 m in outcrop near Mummulgum, but seismic data suggest it is more than 150 m in the subsurface. Thus the fault probably moved slowly during the Mesozoic.

The West Richmond Fault (McElroy, 1962) is a less obvious feature which is not apparent on the seismic map. McElroy (pp. 68-69) describes shallowly dipping Walloon and Kangaroo Creek sediments at the same level on either side of a northern tributary of Gorge Creek (MR 583437). From this and other evidence in the vicinity, he concludes that there is displacement of more than 200 m on the fault, with upthrow to the east.

The 8 km wide upthrown area separating the East and West Richmond Faults in the Richmond Range area was named the Richmond Horst by McElroy (1962). The seismic and outcrop evidence suggests that the feature terminates southwards east of Bonalbo, although seismic data show that a platform with a faulted eastern side persists southwards (Section D-E-F). To the north the horst disappears under the basalt of the McPherson Ranges, and it cannot be traced beyond the basalt. Thus it is only recognizable over a distance of 24 km.

In the south, and east of the East Richmond Fault, the Hogarth Dome is a broad gentle structure centred on Hogarth Trig Station. It was mapped by Hanlon on the basis of structure contours in the upper Jurassic sequence; he proved a culmination of 100 m. The structure was drilled in 1968 by Clarence Basin Hogarth No. 1 (Hanlon, 1968).

GEOLOGICAL HISTORY

In early Triassic time the Texas High and the surrounding area were being steadily eroded by streams to form a fairly flat surface. Possibly the Beenleigh Block to the east (see Fig. 7) was also being eroded at this time.

In mid-Triassic time the Ipswich Coal Measures were accumulating in low areas, and bursts of vulcanism contributed tuffs and flows. Periods of energetic stream deposition gave rise to beds of polymiatic conglomerate. Similar sedimentation persisted to form the lower part of the Bundamba Group. The sediments lapped farther onto the Texas High as time passed. In early

Jurassic time the rate of erosion and deposition increased and the fluviatile arkosic sandstone of the Ripley Road Sandstone was laid down on top of the coal measures. The Marburg Sandstone overlapped the Ripley Road Sandstone; early deposits were still coarse and arkosic, but finer grained overbank and lacustrine deposits became more important with time. The sea invaded low areas for short periods.

During the Middle Jurassic, the Walloon Coal Measures were laid down in and near swamps and lakes; a large proportion of andesitic volcanic debris and the presence of bentonite suggest contemporaneous vulcanism. Deposition of point bar and channel sands by southeasterly flowing streams followed, giving rise to the labile Woodenbong Beds in the north, and the quartzose Kangaroo Creek Sandstone in the south. The Jurassic came to a close with the overbank, lake, and in small part marine, deposits of the Grafton Formation. Abundant volcanic debris suggests contemporaneous vulcanism. The accumulation of Mesozoic sediments reached more than 2000 m in places.

A long period of steady erosion was interrupted by a burst of tectonic activity during which the major structure of the South Moreton Anticline - East Richmond Fault developed. It is probable that the Beenleigh Block was raised and that the present basin shape developed at that time.

In early Miocene time, the Mt Warning volcano and other vents poured out a mass of volcanic material, which formed a sheet over a thousand metres thick over large parts of the area. This was dominantly basalt, but more acidic flows and pyroclastics were also widespread. The larger acid bodies caused doming of the Mesozoic sequence, and a profusion of sills, dykes, and plugs were intruded.

Since then erosion has been the major process in the area, although Pliocene and Pleistocene sands containing vertebrate fossils have been deposited along the major stream courses. Several thousand metres of volcanics and Mesozoic sediments were removed in the more actively eroding areas. The underlying Miocene intrusions have been exposed in the area south of Boonah, and in places rise more than 1000 m above the surrounding plain.

ECONOMIC GEOLOGY

Water

(L. Stephenson, GSNSNW; D.J. Casey, G.S.Q.)

The following notes have been compiled from water-bore data held by the Water Conservation and Irrigation Commission of New South Wales and the Irrigation and Water Supply Commission of Queensland. A summary of N.S.W. borehole data is provided in Appendix 5. Only sketchy records are available in the Queensland part of the area.

Most of the available information in Water Conservation and Irrigation Commission records has been provided from drillers records submitted at the time of drilling. Records for many of these boreholes are incomplete and no comprehensive field borehole survey has been carried out in this area.

All recorded New South Wales boreholes are located in the eastern third of the Sheet, to the east of the New England Tableland. Rainfall within the area is normally adequate for pastoral purposes (over 60 cm), so that widespread use is made of surface catchments, and more restricted use of groundwater. Groundwater is used mainly for stockwater supplies. Yields are reported to range from 450 to 18,000 lph but generally appear to be insufficient for irrigation supplied. There are 87 boreholes recorded in the NSW part of the Warwick Sheet. Water is derived from Quaternary alluvium in 43%, Tertiary alluvium in 1, Tertiary basalt in 8% and Jurassic-Cretaceous sediments in 13%. There are no logs recorded for 36% of the boreholes.

In Queensland the rugged sandstone and basalt country away from the alluvial valleys has a relatively low stock-carrying capacity. Pastoralists obtain sufficient water for their stock requirements in earth tanks and from surface water. Most of the streams rise in the McPherson or Liverpool ranges and many are permanent.

Quaternary Alluvial Sediments

In New South Wales the majority of boreholes have been sunk in shallow alluvium close to rivers and streams. The depth of unconsolidated sediments averages 10 m, with a maximum recorded thickness of 30 m. These sediments consist of sand, sandy clay, gravel, and clay. The water is obtained mainly from the sand and gravel beds. Yields obtained from boreholes and wells in the alluvium average 2250 lph. One borehole has a reported yield of 18,000 lph. No analyses of salt content have been recorded. However, the groundwater appears generally to be suitable for stock.

In Queensland in 1959, the Irrigation and Water Supply Commission carried out a groundwater investigation of the Logan and Albert Rivers. Most of this work was done in the Tweed Heads Sheet area east of Warwick Sheet but three lines, at Round Mountain, Tamrookum, and Hillview, were drilled across the alluvium in Warwick Sheet area, the last one along Christmas Creek, a tributary of the Logan River. The holes were generally between 18 m and 24 m deep, the thickness of the alluvium, and pumping supplies of up to 65000 lph were obtained. However, the average supply was about 3300 lph. Average solids content was about 500 ppm, which is suitable for irrigation of most crops. Very little use is made of this water as most irrigation farmers use the surface water in the Logan River and its tributaries.

Miocene Basalt

In New South Wales boreholes in basalt produce groundwater yields ranging from 2250 lph to 4500 lph. There is no recorded information about the quality of the water. One borehole (at Grid ref. 613445) produced good quality water from Tertiary alluvium below the basalt with a maximum yield of 5500 lph.

Small springs are common at the basalt/sediment contact along the border. However, these tend to dry up during prolonged dry spells so that as a source of water they are unreliable. The basalt/sediment contact could be a suitable target for groundwater away from the dissected margin of the basalt.

Jurassic-Cretaceous sediments

In New South Wales the Grafton Formation consists of labile sandstone and shale. Boreholes drilled into this formation have provided yields of up to 2250 lph. Boreholes drilled into the underlying Kangaroo Creek Sandstone intersected mainly sandstone, and groundwater yields range from 900 lph to 6500 lph. The Walloon Coal Measures underlie the Kangaroo Creek Sandstone and consist of sandstone and shale with interbedded coal seams. Reported yields from boreholes in this unit range up to 9000 lph. Recorded information concerning the quality of the ground water from these units is not available.

In Queensland the Marburg Sandstone and Walloon Formation are not major sources of underground water because sandstone in these units are usually impermeable. The Ripley Road Sandstone is somewhat more permeable but its outcrop is very restricted and because of the steep dips in the area, the Ripley Road would be at too great a depth for economic exploitation.

Petroleum

A summary of petroleum exploration drilling is given in Table 1.

Queensland American The Overflow No. 1, was drilled on the South Moreton Anticline just north of this Sheet area. It penetrated 500 m of Lower Jurassic and Triassic sediments before entering volcanics of possible Tertiary age. Small hydrocarbon shows were associated with coal seams. Phillips-Sunray Swan Creek No. 1 was drilled on the Swan Creek Anticline near Warwick and penetrated a Lower Jurassic sequence overlying volcanics of possibly Triassic age at 350 m. No shows were recorded. The presence of unprospective volcanics at shallow depth has discouraged exploration in the area. No seismic work has been done in the north, presumably because of the great expanse of basalt, and the abundant intrusive bodies in the Walloon sediments.

Three wells have been drilled in the southeast and these have shown that a thick Mesozoic sedimentary succession is present with considerable porosity and permeability in places, and some hydrocarbons traces have been found. The seismic method has been used successfully in the area.

Mid-Eastern Kyogle No. 1 was drilled in 1963 on a small anticline west of Kyogle in the axial part of the Clarence Basin, and penetrated Jurassic and Triassic sediments to 2430 m, where it entered volcanics of possible Triassic age. Oil was found in sidewall cores in the upper and lower parts of the Bundamba Group. The upper part was generally very tight, but the section containing oil had fair porosity and some permeability. The upper sequence of the lower part also contained oil in places but the permeability was low. The lower sequence of the lower part had high porosity and permeability up to 57 m.

Mid-Eastern Sextonville No. 1 was drilled in 1964, farther west, on the Richmond Horst. Jurassic and Triassic sediments were penetrated to 2034 m, where indurated Palaeozoic sediments were entered. In this well, which is closer to the (westerly) source of the sediments, the Bundamba sequence is coarser grained, tighter, and thinner than that in Kyogle No. 1. Minor gas shows were encountered in the lower part of the group.

Clarence River Basin Hogarth No. 1 was drilled in 1968 to 1218 m in Mesozoic sediments on a gentle dome farther south. The Bundamba sequence was generally tight and no shows were recorded.

Bentonite

Abundant montmorillonite and mixed-layer montmorillonite-illite occur in the Walloon Coal Measures (McElroy, 1962, p. 40) although kaolinite is the dominant clay mineral. A pure bentonite occurs in the Rosewood Coalfield Smithfield No. 3 Colliery, near Ipswich. We found outcropping bentonite beside the Brisbane-Warwick road in a 0.5 m seam, and lesser occurrences elsewhere. Bentonite is also abundant at some levels in the Jurassic of the Surat Basin (Duff & Milligan, 1967; Exon & Duff, 1968). Thus it seems that vulcanism of a type giving rise to bentonite was widespread in or near the Surat and Clarence-Moreton basins in Jurassic times. The Walloon Coal Measures, in which quiet deposition prevailed, could contain significant bentonite deposits in the Clarence-Moreton Basin.

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APPENDIX I

PETROGRAPHY OF ROCK SPECIMENS

by

N.F. Exon and J. Smart

About 60 thin sections of rocks, mostly from the Warwick Sheet area, were examined. Estimates of mineral percentages were made without the aid of point counting. Cards with more detailed descriptions, the thin sections, and the hand specimens, are held at the Bureau of Mineral Resources in Canberra.

(Field No.) Registered No. (prefix 6858)	Grain size	Quartz	Feldspar	Mica	Dark Minerals	Opaque Minerals	Other Minerals	Phenocrysts (v.f. rocks)	Groundmass	Classification	Grid Reference
PERMIAN GRANITE											
(106) 1010	m.	15%	Orthoclase 50% Plagioclase 20%	Biotite tr.	Hornblende 10%	-	-	-		Hornblende granite	564413
(1018) 1269	m.	50%	Orthoclase 40% Plagioclase 8%	2%	-	-	-	-		Granite	560421
TERTIARY ACID AND INTERMEDIATE INTRUSIONS											
(91) 1007	f.	-	Abundant	Biotite tr. Chlorite 3%	Clinopyroxene 5%	Fe ore 2%	Calcite 5%	Potash Feldspar 15%	Most of rock	Microsyenite	570457
(1043) 1279	f.	2%	Potassic 80%			Magnetite/Haematite 7%	Calcite 1%	Holocrystalline	Feldspar-quartz intergrowths 10%	Microsyenite	564500
(1161) 1292	f. (large phenocrysts)							Potash feldspar 30% Magnetite/Haematite 5% Pyroxene tr.	Two feldspars 60% Fe ore 5%	Porphyritic Trachyte	555483
(1162) 1293	f. (porphyritic)							Potash feldspar 30% Plagioclase 20% Clinopyroxene tr.	Two feldspars 40% Brown glass 15%	Porphyritic Trachyte	555484
TERTIARY ACID AND INTERMEDIATE EXTRUSIONS											
(1148) 1291	v.f.							Glass, fine volcanics, feldspar, magnetite, ?ortho-pyroxene. 30%	Glass, feldspar + augite, 70%	Flow banded Trachyte	556475
(1037) 1310	f. (porphyritic)							?Anorthoclase, brown pyroxene 20%	Two feldspar, iron ore, pyroxene, tridymite infillings 80%	Trachyte	547486
(1030) 1311	f. (porphyritic)							Potash feldspar 8% ?Sodalite 2%	Two feldspars 80% Fe ore + ? augite 10%	Trachyte	545509

TERTIARY BASIC IGNEOUS ROCKS

(Field No.) Registered No. (prefix 6858)	Grainsize	Plagioclase	Augite	Olivine	Opaques	Groundmass	Classification	Grid reference
(894) 1252	v.f. (porphyritic)	Labradorite, olivine 5%				Labradorite, augite, iron ore, olivine 95%	Microporphyritic basalt	513515
(907) 1255	v.f. (porphyritic)	Labradorite 10%				Labradorite, augite, olivine, iron ore 90%	Porphyritic basalt	508510
(938) 1258	v.f. (porphyritic)	Labradorite 10%		10%		Labradorite, augite, iron ore, olivine 80%	Basalt	532505
(972) 1262	v.f. (porphyritic)	Labradorite 10%				Labradorite, augite, iron ore 90%	Basalt	541494
(995) 1264	f.	90%	3%	tr.	Fe ore 2%	Glass 5%	Basalt	541500
(1018) 1268	f.	50%		5%		Dusty glass 30% Green glass 15%	Basalt	524518
(1007) 1273	v.f. (porphyritic)	Labradorite 20%				Labradorite, olivine iron ore, augite 80%	Basalt	527516
(1092) 1289C	glassy (phenocrysts)	Labradorite 5%	5%	tr.		Glass, partly devitrified 90%	Pitchstone	560491
(1183) 1295	m-c	Labradorite 30%	40%	25%	Fe ore 5%		Dolerite sill	549472

WALLOON COAL MEASURES

(Field No.) Registered No. (prefix 6858)	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
(826) 1243	c.	5%	Albite 2%		Andesite 15% Quartzite tr.			Ironstained clay replacing calcite and rock fragments 75%	Clayey lithic sandstone	522497
(900) 1253	m.	5%	Albite 20%	Muscovite tr.	Andesite 20%	Iron ore tr.		Calcite and some chlorite 55%	Calcareous labile sandstone	507515
(948) 1259	m.	5%	Albite 10%		Andesite 35%			Calcite 50%	Calcareous lithic sandstone	521504
(969/2) 1261	m.	10%	Albite 5%	Biotite tr.	Andesite and fine sediments 70%	Iron ore tr.		Clay 15% Iron ore 1%	Lithic sandstone	539492
(1055) 1282	m.	3%	Plagioclase 2%		Andesite 45%	Iron ore tr.		Calcite, clay replacing rock fragments 50%	Lithic sandstone	570497

WALLOON COAL MEASURES - WEST IPSWICH SHEET

(Field No.) Registered No. (prefix 6858)	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
1274	m.	5%	tr.		Andesite, minor fine sediments 35%	Iron ore 2%		Calcite 60%	Calcareous lithic sandstone	Ipswich 518554

Walloon Coal Measures discussion: These lithic sandstones are of largely intermediate to basic volcanic provenance. They are fairly well size sorted, and grains are generally subangular. Distance of transport has not been particularly great.

KANGAROO CREEK SANDSTONE - WOODENBONG BEDS

(Field No.) Registered No. (prefix 6858)	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
(89) 1006	c.	80% (includes aggregates)	3% (? potash)	-	f. grained, probably metasediments 2%			Clay 5% Pore space 10%	Quartzose sandstone	568463
(115) 1009	c.	85% (includes aggregates)	Potash 1%	-	Quartzite 5%			Clay 5% Pore space 5%	Quartzose sandstone	Northern Grafton Sheet
(113) 1011	c.	85% (includes aggregates)	Potash 3%	-	f. grained, some acid volcanics 2%	Iron ore tr.		Clay 5% Pore space 5%	Quartzose sandstone	579414

GRAFTON FORMATION

(Field No.) Registered No. prefix 6858	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
(144) 1012(1)	m.	20%	10% (pseudomorphed by calcite)	-	?volcanics 10% v.f. sediments 25%			Chloritic (probably after calcite) 35%	Calcareous lithic sandstone	604423
(144) 1012(2)	m.	20%			f. volcanics, some sst. 60%	Iron ore tr.		Degraded rock fragments	Pebbly lithic sandstone	604423
(144) 1012(3)	m.	30%	Potash and plagioclase, some calcite replacement 15%		Andesite 20% sediments or volcanics 10% Ferruginized? sediments 5%	Iron ore 1%		Chloritic, ironstained 20%	Calcareous lithic sandstone	604423
1272	m.	35%	Potash and plagioclase 10%	Muscovite tr. Biotite tr.	Andesite and v.f. ?sediments 30%			Chloritic 25%	Lithic sandstone	604423

MARBURG SANDSTONE

(Field No.) Registered No. (prefix 6858)	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
(5) 1003	v.c.	50%	Potash 5%		f. sediments and acid volcanics 30%, quartzite 1%			Clay, limonite 10%	Lithic sandstone	531484
(17) 1004	v.c.	35%	Potash 20%	tr.	v.f. acid volcanics 30%	Iron Ore tr.	Zircon tr.	Clay 10%	Labile sandstone	537464
(18) 1005	m.	25%	Potash 10%	5%	f. sediments and acid volcanics (?) 55%	Iron ore 1%		Silt 10%	Lithic sandstone	536470
(96) 1008	m.	25%	Potash and albite 15%	1%	f. sediments, quartzite, acid volcanics 45%	Iron ore 4%		f. Sand 10%	Lithic sandstone	565445
(762) 1235	m.	80%				Iron ore 5%		f. Sand 15%	Quartzose sandstone	458509
(764/1) 1237	m.	30%	Potash and albite 5%		f. sediments 20%	Iron ore 5%		f. Sand, silt 40%	Lithic sandstone	459509
(820) 1242A	f.	45%	Potash and albite 15%	Biotite 5%	f. sediments 10%	Iron ore 2%		f. Sand 25%	Labile sandstone	508494
(820) 1242B	m-c	60%	Potash, some albite 5%	Biotite tr.	v.f. sediments 15%	Iron ore 2%		f. Sand 20%	Lithic sandstone	508494
(820) 1242C	m.	30%	Albite, some potash 30%		f. sediments 15%	Iron ore 5%	One grain glauconite?	f. Sand 20%	Labile sandstone	508494
(831) 1244	c.	45%	Potash 25%		Quartzite, f. acid volcanics 8%	Iron ore 2%		f. Sand 20%	Feldspathic sandstone	Southwest Ipswich Sheet
(834) 1245	f.	40%	Potash 15%	Biotite 2% Muscovite tr.	Quartzite, f. acid volcanics 15%	Iron ore 3%		f. Sand 30%	Labile sandstone	Southwest Ipswich Sheet
(903/1) 1254	f.	35%	Potash, 30%		f. sediments and f. acid volcanics, 15%	Iron ore 5%		f. Sand 20%	Labile sandstone	506514
(921) 1257	f.	30%	Potash, some albite 10%		f. sediments and f. acid volcanics 30%	Iron ore 5%		f. Sand 25%	Lithic sandstone	522512

(Field No.) Registered No. (prefix 6858)	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
(1011) 1266	m.	20%	Potash tr.		v.f. sediments and f. acid volcanics 70%	Iron ore tr.		Clayey 10%	Lithic sandstone	529518
(1021) 1270	c.	25%	Albite, some potash 20%	Biotite 2%	f. sediments 35%	Iron ore 3%		f. Sand 15%	Labile sandstone	568418
(1023) 1271	f.	20%	Potash, albite 20%	Muscovite 2%	f. sediments and f. acid volcanics 45%	Iron ore 3%		f. Sand 10%	Lithic sandstone	569417
Average (range)		35% (20–60)	20% (5–30)	Tr. (0–5)	25% (10–70)	Iron ore 2% (0–5)		15% (10–25)	Labile sandstone	

WEST IPSWICH SHEET – HEIFER CREEK SANDSTONE MEMBER OF MARBURG SANDSTONE

Registered No.	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
1275A	m.	10%	Potash 60%			Iron ore 5%		Clayey – f. Sand 15%	Arkose	517560
1275B	f.	60%	Orthoclase, some plagioclase 6%			Iron ore 4%		Sandy 30%	Sublabile sandstone	517560
1275C	m.	25%	Potash 35% Plagioclase 5%			Iron ore 5%		f. Sand 30%	Feldspathic sandstone	517560

WEST IPSWICH SHEET – HELIDON SANDSTONE IN WRIGHT'S QUARRY

Registered No.	Grainsize	Quartz	Feldspar	Mica	Rock Fragments	Opaques	Other Minerals	Matrix	Classification	Grid reference
1276B	m.	40%			Quartzite, v.f. acid volcanics (?) 20%	Iron ore 2%		Sandy, mica tr., feldspar tr. 40%	Lithic sandstone	

<u>Marburg Sandstone Discussion</u>. These labile sandstones vary from feldspathic to lithic. The dominant feldspar is orthoclase. Rock fragments are weathered, but fine grained sediments, acid volcanics and quartzite are identifiable. The sandy matrix largely represents broken down lithic fragments and feldspar. The sandstones are generally subangular and well sorted for size. No uniform trend in composition within the formation can be seen. It is of interest that McTaggart's (1963) Heifer Creek Sandstone, described by him as siliceous, varies from arkose to quartzose sandstone. In fact there is little obvious difference between sandstones in the Heifer Creek Sandstone, Ma Ma Creek Sandstone, and Helidon Sandstone.

APPENDIX 2

PALYNOLOGY OF SAMPLES FROM WARWICK SHEET AREA

by

D. Burger

BMR WARWICK No. 4. STRATIGRAPHIC HOLE

Warwick No. 4 was drilled in the interval of the lower Walloon Coal Measures and the upper part of the underlying Marburg Sandstone. Two cores were sampled, both of which yielded plant microfossils.

Sample 4933 from core 1 (depth 102'7-8") yielded the following stratigraphically significant forms:

Annulispora folliculosa

Applanopsis trilobatus & dampieri

Acanthotriletes pallidus

Leptolepidites verrucatus

Nevesisporites vallatus

Rugulatisporites ramosus

These forms have been widely observed from Jurassic strata in Queensland. The presence of L. verrucatus dates this assemblage as not older than spore unit J4 (Burger, 1968; also subsequent unpublished information). A younger age is considered improbable in view of the absence of Contignisporites cooksonii and Murospora florida, of which the first appearance is taken as the base of spore unit J5 (Evans, 1966; Burger, op. cit.). The absence of Dinoflagellates and acritarchs, together with the presence of the freshwater alga Botryococcus, points to nonmarine depositional environments.

Sample 4931 from core 2 (depth 177'0"-1") produced the following forms:

Spores: Annulispora folliculosa

Applanopsis dampieri

Ischyosporites marburgensis

cf. Leptolepidites verrucatus

Nevesisporites vallatus

Rugulatisporite ramosus

Microplankton: cf. Baltisphaeridium sp.

aff. Diconodinium spp.

Hystrichosphaeridium spp.

This assemblage is very similar to the previous one and is therefore regarded as of similar age, although L. verrucatus was not identified beyond doubt. The microplankton species resemble certain forms that occur in higher Jurassic and Lower Cretaceous marine sediments in the Papuan area, of which the presence in J4 spore assemblages was hitherto unknown. If the microplankton are to be regarded as in situ, then a (brief) marine incursion in the Moreton Basin must have occurred during J4 time, of which farther west in the Surat Basin area no evidence exists up to the present time.

Assuming that the microfloras from cores 1 and 2 belong to spore unit J4, the strata involved can be compared, on the basis of their palynological age, with the upper part of the Hutton Sandstone and the lower part of the Birkhead Formation in the Surat and Eromanga Basins.

BMR WARWICK No. 5A STRATIGRAPHIC HOLE

Samples from cores and cuttings, taken from the Grafton Formation, eastern Warwick 1:250,000 Sheet area were examined on spores and microplankton for palynological age determination. The following results were obtained:

Cuttings (depth 90-100 feet)	MFP 4894	Spore units J5-6
Core 1 (depth 103'8-9")	MFP 4880	Barren
Cuttings (depth 110-120 feet)	MFP 4895	Very few spores

Sample 4894 yielded a microfloral assemblage that was poorly to moderately well preserved and contained among others the following species:

Leptolepidites verrucatus

Murospora florida

Nevesisporites vallatus

Contignisporites fornicatus

Staplinisporites caminus

Klukisporites cf. scaberis

Hystrichosphaeridium sp.

The presence of C. fornicatus and M. florida indicates that the microflora is not older than spore unit J5 (Evans, 1966), while the presence of M. florida and N. vallatus points to an age not younger than spore unit K 1a (Evans, 1966; Burger, in prep.). The absence of such spores as Cicatricosisporites australiensis, Crybelosporites stylosus and Cyclosporites hughesi favours a Jurassic rather than a Cretaceous age. S. caminus is a common constituent of Jurassic assemblages and is very scarce in the Cretaceous. The microflora is therefore very likely of Jurassic age, belonging to spore units J5-6.

Microfloras of J5-6 age are known in the Surat and Eromanga Basins as early as the upper Birkhead Formation (Evans, 1966; Burger, 1968). The contact of units J6 and K 1a appears to be closely connected with the base of the Mooga Sandstone in the Surat Basin (Burger, 1968), so that sample 4894 may be regarded as the palynological equivalent of somewhere in the interval from the upper Birkhead Formation to close to the base of the Mooga Sandstone. The presence of Hystrichosphaeridium sp. suggests a marine environment.

Sample 4895 yielded very few badly preserved, stratigraphically long-ranging spore types. Age determination on the base of these forms is not possible.

OUTCROP SAMPLE, WALLABY CREEK

Spores and pollen grains were recovered from a rock sample (sample 4792), consisting of pale grey mudstone, collected from an outcrop locality at Wallaby Creek (Grid ref. 554469) in the Walloon Coal Measures. It was possible, after gentle chemical treatment, to extract a microflora that was sufficiently rich and well preserved for detailed age determination.

From the microfossils recognized, the spore types that are regarded as stratigraphically important are listed below.

Classopollis spp.

Applanopsis dampieri

Inaperturopollenites turbatus

Polycingulatisporites cf. crenulatus (1 specimen)

Cadargasporites sp. (2 specimens)

Rugulatisporites ramosus

cf. Duplexisporites gyratus (1 specimen)

Leptolepidites verrucatus

Neoraistrickia truncata

Lycopodiumsporites rosewoodensis (1 specimen)

L. semimurus (2 specimens)

Triletes sp. (B.M.R. no. 527) (*)

Concavisporites jurienensis

These types form a typically Jurassic assemblage. The presence of A. dampieri, coupled with an absence of Contignisporites spp., restricts the palynological age to the interval of Evans' spore units J2-4 (Evans, 1966). The presence of Leptolepidites verrucatus indicates spore unit J4 (Burger, 1968), which was identified in various subsurface sections drilled in the Eromanga and Surat Basins. Microfloras of J4 age only known from the upper part of the Hutton-Eurombah interval and from the lower part of the Birkhead Formation in the Surat Basin and their stratigraphic equivalents in the Eromanga Basin.

BMR species No. 527* has been encountered in microfloras of J4-5 age from the Injune Creek Group in the Surat and eastern Eromanga Basins and, according to the information available, seems to be restricted to the interval of the Group in these regions. The presence of this type in the assemblage might therefore indicate that sample 4792 belongs to the correlate in the Moreton Basin of the lower Birkhead Formation. Freshwater depositions environments are indicated by the presence of remains of the freshwater alga Botryococcus.

* Provisionally assigned to Perotriletes pseudoreticulatus Couper

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APPENDIX 3

REPORT ON PLANT FOSSILS FROM DURIKAI, SOUTHEASTERN QUEENSLAND

by

R.E. Gould

Data on fossil plants from the locality at Durikai have been given by Walkom (1921), Whitehouse (1932, p. xv; 1955, p. 7; and in Longman, 1941, p. 32), Tweedale (in Hill & Denmead 1960, p. 285), and Hill, Playford, & Woods (1966). Specimens of Otozamites, Phlebopteris, and Sagenopteris localized as 'near Thane', 'Talgai', or even 'Darling Downs, near Toowoomba', by Feistmantel (1879, 1881, 1890), Tenison Woods (1883), Etheridge (1888, 1890; and in Jack & Etheridge 1892), and Walkom (1917a, b, 1921), may also have come from the beds at Durikai (or their lateral equivalents) which contain numerous impressions of these plants (e.g. see Whitehouse, 1955).

Determinations: (The plants are preserved as impressions, and hence accuracy of determinations is restricted).

Phlebopteris alethopteroides Etheridge Jr, 1888. Figured by Etheridge (1888, 1890).

Phlebopteris sp. Fertile and infertile, pedate fronds, smaller than P. alethopteroides.

Dictyophyllum sp. Infertile fragments of large frond; lamina divided at to least 2/3-3/4 of way to midrib; vein meshes polygonal.

Cladophlebis sp. Infertile, bipinnate fronds with straight pinnules. Two species of undetermined fern fronds (one possibly referable to Coniopteris sp.).

Sagenopteris nilssoniana (Brongniart) Ward, 1900. This species includes S. rhoifolia Presl 1838 (Harris, 1932, p. 7). Figured by Tenison Woods (1883) and Hill et al. (1966).

Otozamites sp. or spp. Referable to O. bengalensis (Oldham & Morris) Seward, 1917, and (or) O. feistmanteli Zigno, 1881 (see Walkom, 1921).

Elatocladus-like shoots.

In addition, an undetermined, fairly large bivalve was collected by J.D. Armstrong.

Age of the flora: Presence of Phlebopteris, Sagenopteris, and Otozamites is indicative of a Jurassic age (Whitehouse in Longman 1941, p. 32). Dictyophyllum ranges from Upper Triassic to Middle Jurassic. Sagenopteris nilssoniana occurs in the Liassic of Greenland (Harris, 1932), and similar forms occur in the Lower and Middle(?) Jurassic of South America (Frenguelli, 1941; Menendez, 1957; Herbst, 1965). Harris (1937, p. 100) discussed the Queensland specimens referred to S. rhoifolia and considered a Liassic age probable. Fronds of Dicroidium, which range into the Rhaeto-Liassic (Townrow, 1966), are not found in the Durikai flora, which would thus be younger than the "mixed" Dicroidium flora described from Cracow by Jones (1948); the Cracos locality is considered to be in the Precipice Sandstone (McTaggart, 1963a, b) of probable lower Liassic age (de Jersey & Paten, 1964). The fossil evidence thus points to an upper Liassic age for the plant bearing strata at Durikai.

Horizon: Marburg Sandstone (N.F. Exon & R.F. Reiser, pers. comm.).

Material: The specimens available to the author included those of Tenison Woods (1883), Etheridge (1888), Walkom (1917b, 1921), and others collected by J.D. Armstrong, F.S. Colliver, A. Day, N.S. Foote, R.E. Gould, R.F. Reiser, and P.G. Telford.

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APPENDIX 4

SHALLOW STRATIGRAPHIC DRILLING, WARWICK SHEET AREA, 1968

by

N.F. Exon

General

The Surat Basin Party supervised the drilling of 6 holes in the Warwick Sheet area from 5th to 28th November, 1968 a period of 18 working days. The rig used was a Fox-Mobile and the driller was J. Keunen. 400 feet of drill pipe, a ten-foot core barrel, and equipment for drilling with mud were available. A Widco portalogger with electric and gamma probes recovered logs from most holes.

Drilling

The drilling statistics are presented in the table. Logs of the holes are presented in the body of this Record. The holes were drilled to obtain lithological information and wireline logs of poorly exposed and weathered formations, and to obtain material for palynological investigation.

Hole No.	Grid Ref.	Total Depth (feet)	Drilling (feet)	Coring (feet)	No. of cores	Core Recovery Actual	Core Recovery %
Warwick 1	498507	140	127	13	2	12	93
Warwick 2	505494	183	173	10	1	7	70
Warwick 3	597423	130	120	10	1	9	90
Warwick 4	577417	180	164	16	2	15	94
Warwick 5	612420	60	60		0		
Warwick 5a	612420	310	280	30	3	22	73
Total		1003	924	79	9	65	82

APPENDIX 5

WATER BORE DETAILS - N.S.W. PART OF WARWICK SHEET AREA

by

L. Stephenson - GSNSW Hydrological Section

Map No.	W.C. & I.C. No.	Year Sunk	Status	Depth of Bore (ft)	BORE LOG: Interval (ft)	BORE LOG: Summary of Log	QUALITY: PPM	QUALITY: Description	AQUIFER: Depth (ft)	AQUIFER: Supply (gph)	AQUIFER: S.W.L. (ft)
1	15860	-	-	84	-	No record available	-	-	-	-	-
2	15861	-	-	124	-	No record available	-	-	-	-	-
3	15867	-	-	21	-	No record available	-	-	-	-	-
4	15869	-	-	12	-	No record available	-	-	-	-	-
5	15868	-	-	11.5	-	No record available	-	-	-	-	-
6	11556	1956	-	50	0-50	Quaternary Alluvium	-	-	27-33	300	12
					0-24	Quaternary Alluvium	-	-	20-24	-	-
7	24220	-	-	82	24-82	Mallanganee Coal Measures	-	-	42-42.5 53-60 67-69	- - 2,200	- - 6
8	13351	-	-	-	-	No log available	-	-	-	-	18
9	13347	-	Well	-	-	No log available	-	-	-	1,000	0.5
10	12578	1956	-	35	0-35	Quaternary Alluvium	-	Fresh	20-30	750	20
11	16028	1957	-	40	-	No log available	-	-	23	3,500	23
12	18495	-	-	60	0-60	Quaternary Alluvium	-	-	49-60	750	49
13	14090	1959	-	51	0-50	Quaternary Alluvium	-	-	-	-	-
					51-52	Tertiary Basalt	-	-	48-50	720	35
14	14272	1957	-	69	0-69	Quaternary Alluvium	-	-	60	220	50
15	11570	1956	-	48	0-48	Quaternary Alluvium	-	-	30-35	300	5
16	16301	1959	-	105	0-15	Quaternary Alluvium	-	-	-	-	-
					15-90	Tertiary basalt	-	-	-	-	-
					90-105	Tertiary Honeycomb Basalt	-	-	90	1,000	3
17	26320	1967	-	60	0-48	Quaternary Alluvium	-	-	-	-	-
					48-56	Weathered Tertiary Basalt	-	-	-	-	-
					56-60	Fresh Tertiary Basalt	-	-	45-63	1000-1200	30
18	27738	-	-	42	-	No log available	-	-	35	200	1
19	18125	1960	-	50	0-50	Tertiary Basalt	-	-	27	1,000	16
20	17661	-	-	30	-	No record available	-	-	-	-	-
21	16482	-	abandoned	30	0-30	Quaternary Alluvium	-	-	-	-	-
22	16481	-	-	95	0-95	Quaternary Alluvium	-	-	-	-	-
23	13141	1952	-	40	0-40	Quaternary Alluvium	-	Good	15-30	600	10
24	17660	-	-	15	0-15	Quaternary Alluvium	-	Brackish	-	-	-
25	11583	1954	-	53	-	No log available	-	Poor	45	500	15
26	16437	1952	-	65	0-18 18-65	Quaternary Alluvium Mallanganee Coal	- -	- -	- 45-65	- 200	- 20

The programme was moderately successful although suitable material for palynological work was rare (see Appendix 2). Cores and cuttings were examined under a binocular microscope.

Map No.	W.C. & I.C. No.	Year Sunk	Status	Depth of Bore (ft)	BORE LOG Interval (ft)	Summary of Log	QUALITY PPM	Description	AQUIFER Depth (ft)	Supply (gph)	S.W.L. (ft)
55	22936	1965	-	81	-	No log available	-	-	8	2,000	4
56	17307	-	-	20	-	No log available	-	-	18-20	7,000	4
57	17839	1958	Failure, Well	19	0-19	Quaternary Alluvium	-	-	19	25	6
58	17841	1951	Well	25	0-25	Quaternary Alluvium	-	-	15-17	75	10
									20-25	850	10
59	26759	-	-	90	0-67	Quaternary Alluvium					
					67-90	Mallanganee Coal Measures	-	-	74-86	500	55
60	17876	1958	Spear Point	16	0-16	Quaternary Alluvium	-	Good Drinkable Water	8-16	4,200	8
61	18128	1960	-	15.5	-	No Record Available	-	-	-	1,000	-
62	16303	-	-	45	-	No Record Available	-	-	-	-	-
63	16308	-	-	12	-	No Record Available	-	-	-	-	-
64	16305	-	-	12	-	No Record Available	-	-	-	-	-
65	18138	1958	-	44	0-18	Quaternary Alluvium	-	-	-	-	-
					18-44	Tertiary Basalt	-	-	35-37	600	8
66	12641	-	Well	-	-	No Record Available	-	-	-	-	-
67	12640	1915	Well	19	-	No Log Available	-	Good	-	350	-
68	12801	-	Well	24	-	No Record Available	-	-	-	-	-
69	12800	-	Well	22	-	No Record Available	-	-	-	-	-
70	12802	-	Well	10	-	No Record Available	-	-	-	-	-
71	12803	-	Well	20	-	No Record Available	-	-	-	-	-
72	12500	-	Well	28	-	No Record Available	-	-	-	-	-
73	11999	1952	-	32	0-10	Quaternary Alluvium	-	-	-	-	-
					10-32	Grafton Formation	-	Brackish	30	400	20
74	18127	1961	-	40	0-24	Quaternary Alluvium	-	-	-	-	-
					24-40	Grafton Formation	-	-	22-24	175	9
75	11993	-	Well	32	-	No Record Available	-	-	-	-	-
76	18126	1961	-	54	0-54	Quaternary Alluvium	-	-	28-31	200	12
									48-53	600	12
77	17813	-	-	62	0-60	Quaternary Alluvium	-	-	-	-	-
					60-62	Grafton Formation	-	-	36-39	250	15
78	13371	1957	-	201	0-20	Quaternary Alluvium	-	-	-	-	-
					20-201	Grafton Formation	-	-	37-40	180	12
79	11996	-	-	54	0-54	Quaternary Alluvium	-	-	46	120	10
80	11998	-	-	48	0-48	Quaternary Alluvium	-	Stock	42	1,400	12
81	11994	-	Well	30	-	No Record Available	-	-	-	-	-
82	13786	-	-	35	35	Quaternary Alluvium	-	-	30-34	400	-
83	11992	-	Well	-	-	No log Available	-	Brackish	25	-	-
84	11997	-	-	37	0-37	Quaternary Alluvium	-	Stock	15	1,000	8
85	11995	-	-	18	0-18	Quaternary Alluvium	-	-	-	-	-
86	22113	1916	Well	32	0-32	Quaternary Alluvium	-	Stock	30-32	300	12
87	21599	1957	-	62	0-62	Quaternary Alluvium	-	-	-	400	45

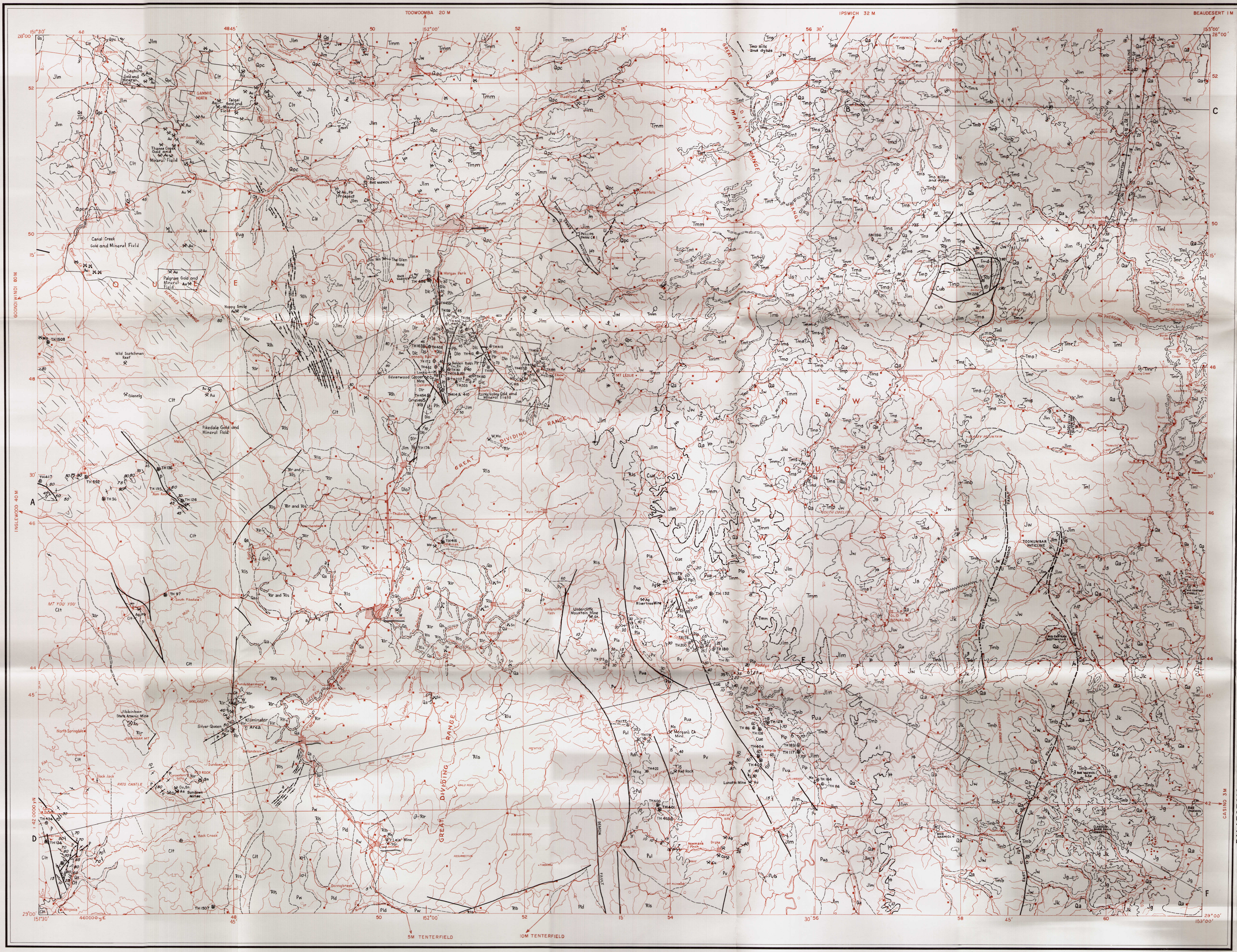
Map No.	W.C. & I.C. No.	Year Sunk	Status	Depth of Bore (ft)	BORE LOG Interval (ft)	Summary of Log	QUALITY PPM	Description	AQUIFER Depth (ft)	Supply (gph)	S.W.L. (ft)
27	16438	1954	-	45	0-45	Quaternary Alluvium	-	-	18-20	-	18
28	16436	1959	-	30	0-30	Quaternary Alluvium	-	-	18-30	700	18
29	11647	-	-	48	-	No log available	-	-	-	850	-
30	16333	1952	-	45	0-45	Quaternary Alluvium	-	-	14-30	-	14
31	12830	1957	-	59	0-59	Quaternary Alluvium	-	-	50-59	500	30
32	12643	1956	-	55	0-47	Quaternary Alluvium	-	-	25-47	250	24
					47-55	Kangaroo Creek Sandstone	-	-	-	-	-
33	11737	1956	-	39	0-34	Quaternary Alluvium	-	-	30-34	400	29
					34-39	Tertiary Basalt	-	-	-	-	-
34	11862	-	Well	7	0-7	Quaternary Alluvium	-	-	7	-	1
35	11863	-	Well	11	0-11	Quaternary Alluvium	-	-	11	-	1
36	11864	-	Well	7	0-7	Quaternary Alluvium	-	Hard	7	Seepage	-
37	11567	1955	-	97	0-97	Kangaroo Creek Sandstone	-	-	87-93	400	75
38	13013	1955	abandoned	97	0-97	Quaternary Alluvium	-	Medium	33-35	10	-
39	13295	1916	Well	43	0-42	Quaternary Alluvium	-	-	-	-	-
					42-43	Tertiary Basalt	-	-	43	500	15
40	12639	1951	Well	37	-	No log available	-	-	-	-	19
41	15772	1955	-	76	0-76	Quaternary Alluvium	-	-	70	600	40
42	12844	1957	-	80	0-30	Quaternary Alluvium	-	-	-	-	-
					30-80	Kangaroo Creek Sandstone	-	-	-	-	-
43	15758	1957	Failure	50	0-50	Quaternary Alluvium	-	-	20	60	8
44	18114	-	Well	6	-	No Record Available	-	-	-	-	-
45	20032	1963	-	125	0-32	Quaternary Alluvium	-	Liquid mud	24-32	-	3
					32-125	Kangaroo Creek Sandstone	-	-	62-70	1440	3
46	18189	1961	-	85	0-14	Tertiary Basalt	-	-	-	-	-
					14-85	Tertiary Alluvium	-	-	64-85	1200	3
47	27512	1967	-	70	0-39	Quaternary Alluvium	-	-	-	-	-
					39-70	Basalt	-	-	60-70	500	15
48	24208	1965	-	56	0-56	Alluvium	-	Good	20-56	375	4
49	19928	-	-	60	-	No log available	-	-	-	400	-
50	21609	-	-	172	0-20	Quaternary Alluvium	-	-	-	-	-
					20-172	Kangaroo Creek Sandstone	-	-	-	120	20
51	21611	-	-	200	0-20	Quaternary Alluvium	-	-	-	-	-
					20-200	Kangaroo Creek Sandstone	-	-	80	250	20
52	21610	-	-	250	0-25	Quaternary Alluvium	-	-	-	-	-
					25-250	Kangaroo Creek Sandstone	-	-	100	100	30
53	21689	-	-	60	0-60	Quaternary Alluvium	-	-	60	600	48
54	16552	1953	-	60	0-5	Quaternary Alluvium	-	-	-	-	-
					5-60	Grafton Formation	-	-	55	100	30

AUSTRALIA 1:250,000 GEOLOGICAL SERIES

WARWICK

QUEENSLAND AND NEW SOUTH WALES

SHEET SH 56-2



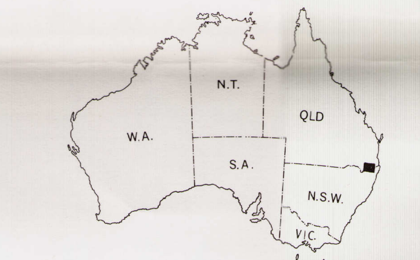
Reference

	Geological boundary
	Facies boundary
	Unconformity
	Anticline
	Plunge of minor anticline
U / D	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, folds are dotted, faults are shown by short dashes
30	Strike and dip of strata
	Prevailing strike and dip of strata
	Vertical strata
	Horizontal strata
80	Overturned strata
	Dip <5° (air-photo interpretation)
	Dip 5°-15° (air-photo interpretation)
	Dip 15°-45° (air-photo interpretation)
	Dip >45° (air-photo interpretation)
	Trend lines (air-photo interpretation)
	Joint pattern (air-photo interpretation)
	Fossil locality-general
TH 124	Macrofossil locality and field collection number
SB1286	Plant fossil locality and field collection number
	Fossil wood locality
	Fossil wood horizon
	Dyke or vein; a-aplite, d-diorite, p-porphyry
	Boundary of gold or mineral field
	Prospect
	Mine
	Mine not worked
	Quarry
	Quarry not worked
	Alluvial working not worked
As	Arsenic
C	Coal
Cu	Copper
Au	Gold
Gt	Graphite
Pb	Lead
Ma	Marble
Mn	Manganese
Mo	Molybdenite
Ag	Silver
Sn	Tin
W	Wolfram
Zn	Zinc
	Oil well, dry hole, abandoned
St	Stratigraphic hole
	Shallow water bore
	Highway
	Road and vehicle track
	Railway with station and siding
"Melva"	Homestead
	Built up area
	State boundary
889'	Elevation in feet - accurate
45	Photo centre point

Reference

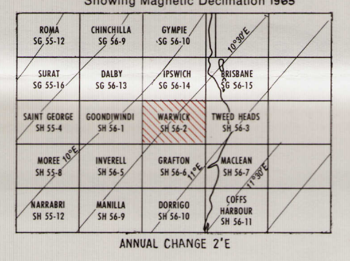
CAINOZOIC	QUATERNARY		Qs	Soil cover
			Qa	Alluvium: sand, silt, mud, gravel
	PLEISTOCENE		Qpc	Sandy alluvium of Condamine River, vertebrate fossils
	TERTIARY (MIOCENE)	Main Range Volcanics	Tmm	Alkali-olivine basalt, minor tuff and sediment
			Tmt	Trachyte
			Tmo	Dolerite sills and dykes
		Lamington Volcanics	Tml	Sub-alkali basalt, minor tuff and agglomerate
			Tmr	Rhyolite, tuff, agglomerate, conglomerate, sandstone
			Tmb	Basalt
			Tmp, Tms, Tmd	Rhyolite, trachyte, granophyre; minor diorite and andesite. Tmp-plug; Tms-sill; Tmd-dyke
MESOZOIC	UPPER JURASSIC	Grafton Formation	Jg	Lithic sandstone, siltstone, mudstone
		Kangaroo Creek Sandstone	Jk	Quartzose to feldspathic sublabile sandstone
		Woodenbong Beds	Js	Medium-grained feldspathic to feldspathic sublabile sandstone, siltstone
	MIDDLE TO UPPER JURASSIC	Walloon Coal Measures	Jw	Fine-grained labile sandstone, siltstone, mudstone, coal. Calcareous in part. Plant fossils
	LOWER JURASSIC	Bundamba Group	R-Jb	Sandstone, lesser siltstone, mudstone, conglomerate. Section only
		Marburg Sandstone	Jlm	Feldspathic to feldspathic sublabile sandstone, pebbly in part; lesser siltstone, mudstone. Basal pebbly arkose in west
		Ripley Road Sandstone	Jlr	Feldspathic to quartzose sandstone with massive cross-beds
	UPPER TRIASSIC	Raceview Formation and Aberdare Conglomerate	Rr	Feldspathic to quartzose sandstone and siltstone with massive conglomerate near base (section only)
	MIDDLE TO UPPER TRIASSIC	Ipswich Coal Measures	Ri	Shale, siltstone, sandstone, conglomerate, coal (section only)
			Rv	Basalt, andesite, trachyte, coal (section only)
			Rb	Conglomerate, basic lava and tuff, quartzose sandstone, carbonaceous shale
	LOWER TRIASSIC	Ruby Creek Granite	Rlr	Granite
		Herries Adamellite	Rlh	Adamellite
		Stanthorpe Adamellite	Rls	Adamellite
		Undercliffe Falls Adamellite	Rlu	Adamellite
		Bungulla Adamellite	Rlb	Adamellite
	UPPER PERMIAN OR TRIASSIC		Pua	Granite, granodiorite
		Maryland Granite	Pum	Granite
		Greymare Granodiorite	Pug	Granodiorite
			Pub	Diorite
			Pur	Spherulitic rhyolite, quartz-feldspar porphyry
PALAEOZOIC	UPPER PERMIAN	Gilgurry Mudstone	Pul	Mudstone
	LOWER TO UPPER PERMIAN	Condamine Beds	Puc	Mudstone, poorly sorted sandstone, conglomerate; minor tuff
			Pw	Rhyolite, rhyodacite, tuff
		Drake Volcanics	Pv	Agglomerate, crystal and crystal lithic tuff; minor flows and interbedded sediments
	LOWER PERMIAN	Dundee Adamellite Porphyrite	Pld	Adamellite-porphyrite
		Rhyolite Range Beds	Plh	Spherulitic rhyolite, dacite, andesite, agglomerate, tuff; minor conglomerate, sandstone and mudstone at base
		Eight Mile Creek Beds	Ple	Conglomerate, sandstone, mudstone; minor agglomerate at top
		Razorback Creek Mudstone	Pla	Mudstone
		Eurydesma and Wallaby Beds	Plr	Conglomerate, sandstone, mudstone, pebbly mudstone, minor limestone
			P	Conglomerate, sandstone, mudstone, pebbly sandstone and mudstone, minor limestone and tuff
		Paddys Flat Formation	Plp	Conglomerate, sandstone, mudstone; minor volcanics and limestone
	UPPER CARBONIFEROUS	Mount Barney Beds	Cub	Lithic and feldspathic sandstone, conglomerate, mudstone; minor acid volcanics
		Emu Creek Formation	Cue	Interbedded sandstone and mudstone; minor conglomerate
	UPPER DEVONIAN(?) TO UPPER(?) CARBONIFEROUS	Texas Beds	Clt	Interbedded sandstone and mudstone, intraformational conglomerate, chert, jasper, andesite, limestone
	SILURIAN(?) TO LOWER DEVONIAN	Silverwood Group: Rosenthal Creek Formation	Dlo	Interbedded sandstone and mudstone; chert, intraformational conglomerate, limestone
		Silverwood Group: Connolly Volcanics	Dlc	Andesitic agglomerate, volcanic breccia, tuff; minor lithic sandstone; limestone lenses
		Silverwood Group: Risdon Stud Formation	Dlr	Silicified fine-grained pyroclastic and sedimentary rocks
	LOWER PALAEOZOIC		Pz	Undifferentiated Devonian, Carboniferous and Permian strata. Section only

Compiled by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Issued under the authority of the Hon. R.W. Swartz, M.B.E., E.D., Minister for National Development. Provisional base map (1968) compiled by the Royal Australian Survey Corps from aerial photography at 1:85,000 scale.
Transverse Mercator Projection

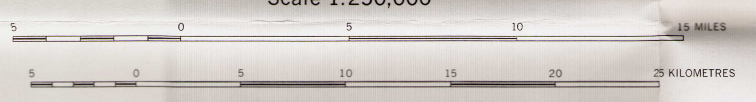


INDEX TO ADJOINING SHEETS

Showing Magnetic Declination 1965



Scale 1:250,000



Palaeozoic Geology 1968-69 by F. Olgers, P.G. Flood, W.J. Perry, J.M. Dickins (BMR); A.C. Offenberg, J. Cramsie (G.S.N.S.W.);
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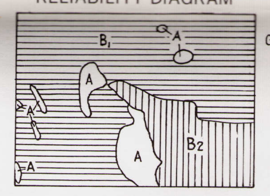
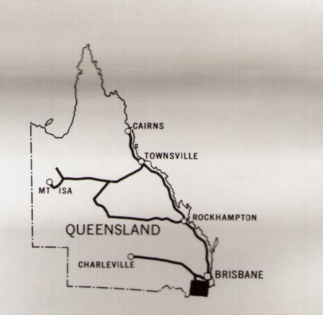
Cartography by Geological Branch, BMR
Drawn by Miss J.G.A. Den Hertog, I.D. Johnston, J.L. McGovern.

RELIABILITY DIAGRAM

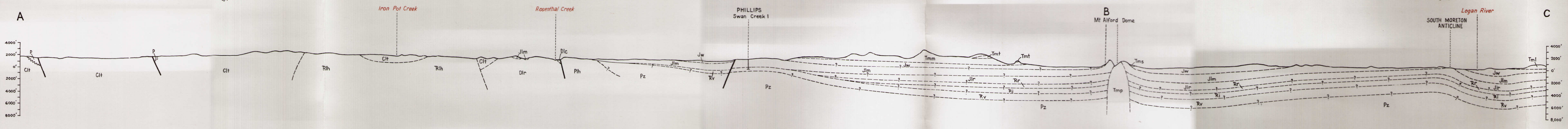


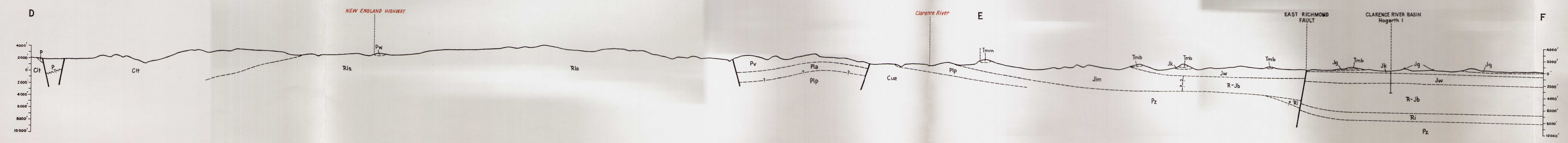
Geology
A Detailed mapping
B1 Detailed reconnaissance: numerous traverses and air-photo interpretation
B2 General reconnaissance: compilation of previous work and air-photo interpretation



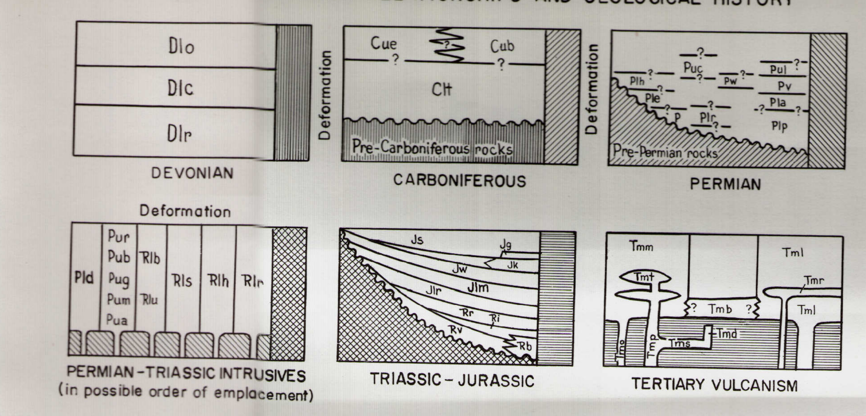
Sections

Cainozoic sediments omitted





DIAGRAMMATIC ROCK RELATIONSHIPS AND GEOLOGICAL HISTORY



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