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STRATIGRAPHIC DRILLING REPORT - GSQ MUTTABURRA 1

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CONTENTS

SUMMARY

GSQ Muttaburra 1 was drilled approximately 14 km south-southwest of Muttaburra township and three kilometres southwest of Warrandaroo homestead. The bore penetrated Middle Jurassic to Early Cretaceous and Early Permian to Triassic sedimentary rocks of the Eromanga and Galilee Basins respectively. Palynological age dating of Permian strata has proven to be essential in the selection of formation boundaries within the Galilee Basin sequence. No hydrocarbon shows were recorded in the bore. The bore terminated in the Jochmus Formation at a total depth of 1301.79m.

This record presents core analysis results, lithologic log and composite (graphic/ wireline) log of GSQ Muttaburra 1.

Keywords. Stratigraphy; stratigraphic wells; geological logs; geophysical logs; biostratigraphy; palynology; formation tests; fluorescence; porosity; permeability; vitrinite reflectance; organic geochemistry; water analysis; Eromanga Basin; Galilee Basin; Permian; Triassic; Jurassic; Cretaceous; Queensland; Muttaburra; SF55-9 7852.

INTRODUCTION

The stratigraphic bore, GSQ Muttaburra 1, was drilled by the Department of Resource Industries during the period March to July, 1990 in the southwestern Koburra Trough of the Galilee Basin, central Queensland (Figure 1). The bore was sited approximately 14 km south-southwest of Muttaburra, on ESSO seismic line W80A-17, shotpoint 4150 (ESSO Exploration and Production Australia Inc., 1984). GSQ Muttaburra 1, the third bore in a program of Departmental stratigraphic drilling, provides a fully cored reference section of the Eromanga and Galilee Basin sequences in the Koburra Trough.

The primary objectives for drilling the stratigraphic bore GSQ Muttaburra 1 were:

1) to determine whether the Late Permian strata in the Muttaburra area are Bandanna Formation and Colinlea Sandstone correlatives of the Bowen Basin or the Betts

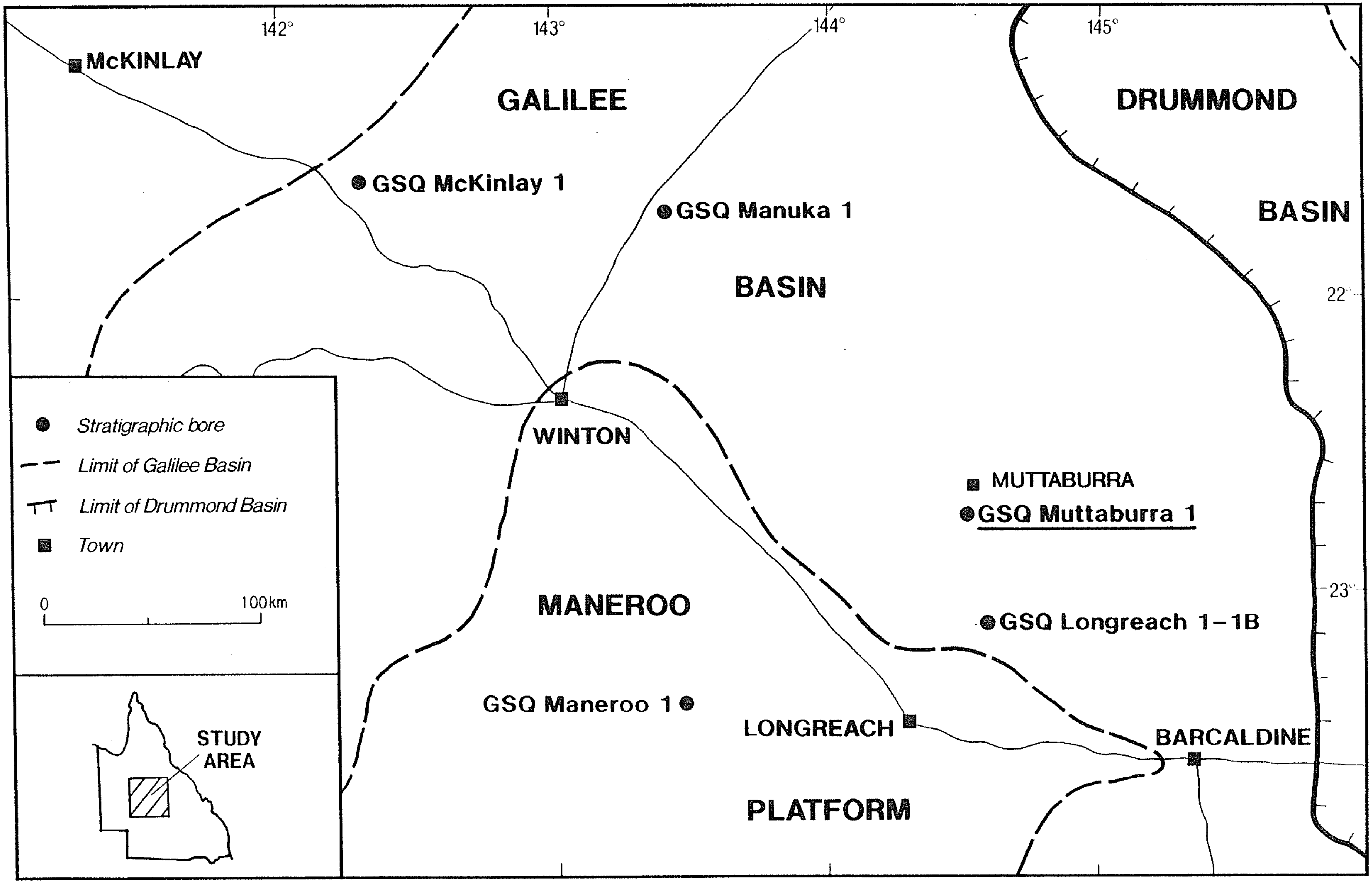


Figure 1: Locality map

2

Creek beds intersected in GSQ Hughenden 3-4R,

2) to determine the relationship between the Jochmus Formation and the Aramac Coal Measures,

3) to determine the presence or absence of Triassic sediments, and

4) to assess the hydrocarbon potential of the Eromanga and Galilee Basin sequences.

DRILLING DATA

The well history is summarised in Table 1.

GSQ Muttaburra 1 reached a total depth of 1301.79m. No appreciable core loss was encountered during the course of drilling. The progress of drilling GSQ Muttaburra 1, including drilling breaks, reaming, and fuel rationing (due to extensive flooding in April, 1990) is illustrated on Figure 2.

Digital wireline log data were acquired in the bore (Table 1) by staff of the Basin Studies Subprogram (presently the Petroleum and Coal Geology Section) using a Geosource T500 logging unit. Detailed lithologic logs are presented in Appendix 1 and a composite log is reproduced as Figure 3.

A well velocity survey was conducted by staff from the Geological Mapping Subprogram. The results of this survey are reported separately (Dixon, 1991).

On completion of drilling and downhole operations, aquifers were cemented off in accordance with Water Resources Commission (1990) specifications and the bore plugged and abandoned.

STRATIGRAPHY

The stratigraphic nomenclature used in this report for the Galilee Basin sequence follows that of Gray & Swarbrick (1975) and Vine & others (1964). Senior, Mond & Harrison (1978) has been used for the Eromanga Basin sequence. A summary of the stratigraphic sequence intersected in GSQ Muttaburra 1 is given in Table 2.

Table 1: <u>Well history - GSQ Muttaburra 1</u>

Location:	Lat. 22°43'13"S) not yet surveyed Long. 144°29'49"E)
Elevation:	225m, approximate
Drilling rig:	Failing 2500, operated by the Drilling Subprogram, Geological Survey Program, Department of Resource Industries, Queensland.
Spudded:	March 16, 1990
Completed:	July 12, 1990
Drilling datum:	Ground level
Total depth:	1301.79m
Status:	Plugged & abandoned
Coring:	Essentially continuous except for minor open-holed intervals as shown on lithologic log sheets (Appendix 1).
Casing:	150mm to 133.35m 100mm to 449.30m 78mm to 671.80m
Plugs:	0 - 50m (approx.) 590 - 655m 773 - 891m
Drill stem test intervals:	1: 587.33 - 641.03m 2: 723.53 - 764.88m 3: 783.53 - 858.08m
Wireline logging:	Gamma-ray : 1.7 - 460.0m; 423.9 - 668.1m; 525.9 - 1301.8m SP & resistivity : 420.8 - 669.8m; 657.7 - 1301.8m Caliper : 394.1 - 668.6m Long & short spaced density : 652.9 - 1301.8m Sonic : 644.0 - 1299.6m
Bottom hole temperature:	80°C at 1300m

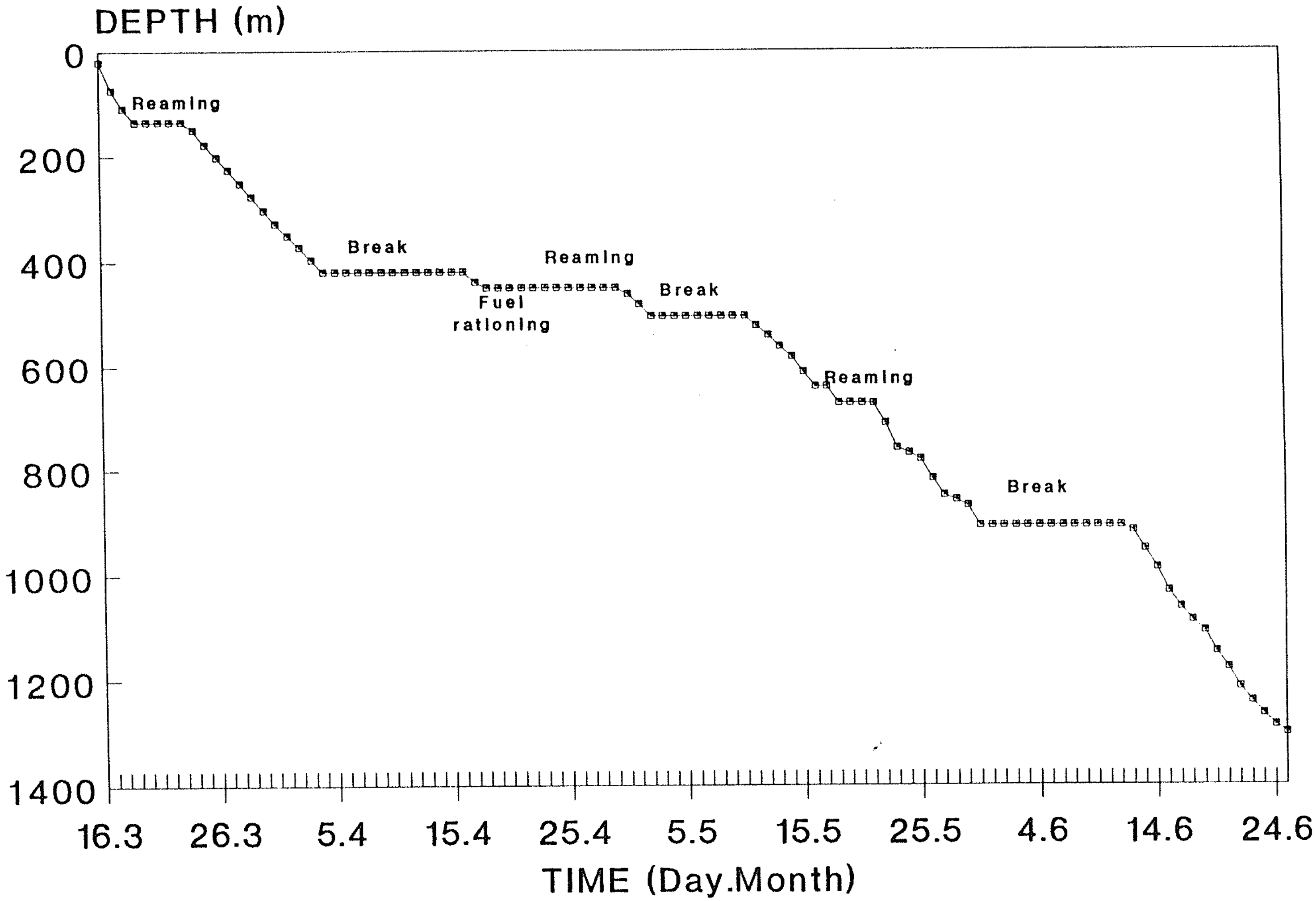


Figure 2: Drilling progress - GSQ Muttaburra 1.

Table 2: Preliminary stratigraphic subdivision - GSQ Muttaburra 1

Structural unit	Age	Stratigraphic unit	Top (m)	Thickness (m)
Eromanga Basin	E.Cretaceous	Mackunda Formation	surface	>184.95
		Allaru Mudstone	184.95	223.29
		Toolebuc Formation	408.24	25.08
		Wallumbilla Formation	433.32	165.82
	L.Jurassic - E.Cretaceous	Hooray Sandstone	599.14	85.10
	L.Jurassic	Westbourne Formation	684.24	35.17
	M.- L.Jurassic	Adori Sandstone	719.41	11.55
	M.Jurassic	Birkhead Formation	730.96	78.87
	M.Jurassic	Hutton Sandstone	809.83	84.47
Galilee Basin	Early Triassic	Rewan Formation	894.30	55.75
	Late Permian	Betts Creek beds	950.05	93.56
	Early Permian	Aramac Coal Measures	1043.61	168.75
	Early Permian	Jochmus Formation (upper)	1212.36	42.17
		Edie Tuff Member	1254.53	38.96
		Jochmus Formation (lower)	1293.49	> 8.30

GALILEE BASIN

The major findings in GSQ Muttaburra 1 with regard to the stratigraphy of the Galilee Basin are:

1. Late Permian strata generally referred to as Bowen Basin correlatives of the Bandanna Formation and Colinlea Sandstone are assigned to the Betts Creek beds,
2. a younger age (APP3) for the upper Aramac Coal Measures than previously reported has been determined,
3. the base of the Aramac Coal Measures is stratigraphically lower than that defined in the type section, and
4. the boundary between the Jochmus Formation and overlying Aramac Coal Measures reflects a change in sandstone composition.

Jochmus Formation

The Jochmus Formation was cored from 1212.36m to 1301.79 (total depth) in GSQ Muttaburra 1. The formation can be subdivided into three units; the upper Jochmus Formation (1212.36m - 1254.53m), the Edie Tuff Member (1254.53m - 1293.49m), and the lower Jochmus Formation (1293.49m - 1301.79m).

The upper and lower subdivisions of the Jochmus Formation comprise sandstone, siltstone and subordinate mudstone. Stacked fining upward sequences up to 13.9 metres in thickness are a common feature in both intervals. The sandstone is very fine to medium grained, light grey to light green, labile feldspathic and generally well sorted. The finer grained sandstones commonly have an argillaceous matrix and contain mica and trace amounts of an unidentified orange-brown mineral as grains. Siltstones are grey to light green, laminated to thinly bedded and are well sorted. The basal contacts with underlying sandstone beds are generally gradational. Mudstone is rare, grey to dark grey, carbonaceous and is restricted to the top of the upper subdivision.

The Edie Tuff Member of the Jochmus Formation comprises siltstone, sandstone, mudstone and tuff. The siltstone is grey, light green and red, commonly siliceous, tuffaceous in part and well sorted. The sandstone is very fine to fine grained, rarely medium grained, light grey, labile feldspathic, well sorted and has an argillaceous matrix. Mica is present as a minor constituent in most of the siltstones and sandstones. The mudstone is mottled grey and red, dark grey, grey-green and tuffaceous. Red zeolites are common in the mudstones and siltstones, particularly towards the top and bottom of the unit. Tuffs are cream and red and restricted to the upper part of the unit.

The Edie Tuff Member has generally higher and lower gamma-ray and resistivity log values respectively than the upper and lower subdivisions of the Jochmus Formation. The thickness of the Edie Tuff Member (38.96m) in the bore is considerably less than that defined by Gray & Swarbrick (1975) in ENL Lake Galilee 1 (132m). Green & others (1991) reported the thickness of the Edie Tuff Member in GSQ Longreach 1-1B to be 19.50m which is less than that in GSQ Muttaburra 1.

The top of the Edie Tuff Member is placed at the upper limit of the red, grey-green and cream coloured mudstones and tuffs, above which light grey to light green sandstones of the upper Jochmus Formation are the dominant lithologies.

In GSQ Muttaburra 1, the top of the Jochmus Formation is placed approximately 42 metres above the top of the Edie Tuff Member. This boundary corresponds to the upper limit of a siltstone and mudstone interval within the Jochmus Formation. Sandstones above this interval are more quartzose (sub-labile) than the labile feldspathic sandstones below the interval.

Aramac Coal Measures

Strata considered to belong to the Aramac Coal Measures were cored over the interval 1043.61m to 1212.36m and conformably overly the Jochmus Formation.

In GSQ Muttaburra 1, the Aramac Coal Measures can be subdivided into two units; an upper coal-bearing unit (1043.61 - 1117.95m) and a lower sandstone dominated unit (1117.95 - 1212.36m). A similar informal subdivision of the Aramac Coal Measures was identified by Green & others (1991) in GSQ Longreach 1-1B.

The lower subdivision of the Aramac Coal Measures comprises dominantly sandstone, with subordinate siltstone, mudstone and coal. The sandstone is very fine to medium grained, light grey and well sorted. Sandstone composition is generally sub-labile, however quartz content is slightly greater towards the top of the subdivision. The sandstones have an argillaceous matrix, are micaceous, and generally medium to thickly bedded. The siltstones are grey, laminated, and in part contain sandstone filled burrows and rooted horizons. The mudstone is dark grey to black, carbonaceous and, in part, bioturbated. The coals are dull with few bright bands and comprise less than one percent of the total thickness (94.41m) of the unit.

The upper subdivision of the Aramac Coal Measures comprises sandstone, siltstone, conglomerate, mudstone and coal. The sandstone is very fine to medium grained, light grey, quartzose to sub-labile, generally thin to medium bedded and well sorted. The sandstone has an argillaceous matrix and commonly contains mica as a minor constituent. The siltstone is grey to dark grey, well sorted and often interlaminated to thinly bedded with very fine grained sandstone. Conglomerates are light grey and multicoloured, granular to pebble sized and contain well rounded sedimentary and igneous fragments in part. Sorting commonly has a bimodal distribution. Mudstone is dark grey, dark brown and black, and is tuffaceous and carbonaceous in part. The coals are generally dull to inferior. Tuffaceous argillaceous sediments are associated with some of the coal seams in the interval 1092.62m to 1108.31m.

In GSQ Longreach 1-1B (Green & others, 1991), coal seams are better developed within the Aramac Coal Measures than in GSQ Muttaburra 1. In GSQ Muttaburra 1, a total of 8 coal seams greater than 0.30m in thicknes average 0.76m in the upper subdivision of the Aramac Coal Measures compared with approximately 2.26m for 14 seams over a similar interval in GSQ Longreach 1-1B.

Palynological age dating of core samples taken from the upper Aramac Coal Measures indicates a late Early Permian age corresponding to Stage 4 of Evans (1969). Stage 4 or APP3 (Draper & others, 1990) sediments were not intersected in the type section of the Aramac Coal Measures as defined by Gray & Swarbrick (1975) in QDM Aramac 1.

Gray & Swarbrick (1975) defined the base of the Aramac Coal Measures "arbitrarily at the bottom of the lowest significant coal seam". According to their definition, the base of the Aramac Coal Measures in GSQ Muttaburra 1 would correspond to the base of the upper subdivision (1117.95m), and hence attain a thickness of 74.34m.

The top of the lower subdivision is taken at 1117.95m, which corresponds to the base of a 0.7 metre thick coal seam. It may be argued that this coal should belong in the lower subdivision as it completes a thick (8.2m) fining upwards cycle within the lower subdivision.

The top of the Aramac Coal Measures is difficult to pick solely on lithological grounds due to the similarity with the overlying coal bearing Betts Creek beds. Sandstones within the Aramac Coal Measures are generally finer grained and have marginally higher gamma-ray and lower resistivity log responses than those of the overlying Betts Creek beds. These boundary criteria agree with those defined by Gray & Swarbrick (1975) for the boundary between the Aramac Coal Measures and the Late Permian sediments in QDM Aramac 1.

Betts Creek beds

Late Permian strata cored over the interval 950.05m to 1043.61m are lithologically similar to the Betts Creek beds (Vine & others, 1964) as described by Gray (1977) in the Hughenden area. On the basis of this similarity and subsurface wireline log correlations (P.Hawkins, personal communication, 1991) the name

Betts Creek beds is used in preference to the Bandanna Formation/Colinlea Sandstone correlative.

In GSQ Muttaburra 1, the Betts Creek beds comprise sandstone, siltstone and coal. The sandstone is very fine to coarse grained, light grey, and quartzose to sub-labile. The finer grained sandstones are laminated to medium bedded whereas the coarser sandstones are generally thickly bedded and have sharp or erosional basal contacts. Sandstones are partly micaceous and generally have a white argillaceous matrix. Siltstone is grey and in part displays a rooted horizon immediately below some coal seams. The coal is generally dull in lustre with few to rare bright bands and in part inferior.

The fluvial Betts Creek beds essentially contain a series of stacked fining-upwards cycles. These cycles grade from medium to very coarse grained, light grey, thickly bedded, quartzose sandstone into very fine to fine grained, interlaminated to thinly bedded, quartzose to sub-labile sandstone and grey siltstone and commonly into an inferior or dull coal with few bright bands.

Seismically, the 'P' horizon is often considered to represent the top of the uppermost Permian coal. In GSQ Muttaburra 1, this 'P' horizon would relate to the near top of the Betts Creek beds. The lithostratigraphic top of the Betts Creek Beds selected in GSQ Muttaburra 1 occurs 14.05m above the top of the uppermost Permian coal at 964.10m. Elsewhere in the Galilee Basin, this seismic horizon may represent the Aramac Coal Measures in the absence of younger Permian strata.

The top of the Betts Creek beds is placed at the top of the uppermost grey siltstone, above which a slight green/cream colouration is observed in the core of the overlying Triassic sediments. The Betts Creek beds display lower gamma-ray and higher resistivity log responses than the sediments of the Rewan Formation.

Rewan Formation

The Triassic sediments intersected in GSQ Muttaburra 1 between 894.30m and 950.05m are assigned to the Rewan Formation. Palynological age dating of a sample taken at 936.76m indicates an Early Triassic (APT1) age. Red mudstones were not encountered in the Rewan Formation drilled in GSQ Muttaburra 1, and are rarely seen in the subsurface (Casey, 1970).

The Rewan Formation dominantly comprises sandstone and siltstone. The sandstone is light grey to cream in colour, very fine to very coarse grained, quartzose in composition with a kaolinitic matrix. Angular grey siltstone clasts and coarse grained sideritic nodules are common in some of the fine grained sandstones. Coarser grained sandstones are poorly sorted and grade to conglomerate in part. Siltstones are grey to light green and laminated.

The top of the Rewan Formation intersected in GSQ Muttaburra 1 is placed at 894.30m. This depth corresponds to a marked increase in gamma-ray (GR) log values and a lowering of the resistivity (RES) log baseline in comparison to those of the Hutton Sandstone (Fig. 3). Lithologically, the basal 13.5m of Hutton Sandstone sediments appears very similar to those in the upper part of the Rewan Formation, however, the sandstones assigned to the Rewan Formation are generally finer grained.

EROMANGA BASIN

Hutton Sandstone

The Hutton Sandstone was cored over the interval 809.83m to 894.30m and unconformably overlies Triassic sedimentary rocks of the Galilee Basin sequence in GSQ Muttaburra 1.

The formation comprises dominantly sandstone and conglomerate with subordinate siltstone. The sandstone is fine to very coarse grained, light grey, quartzose, porous and is generally thickly bedded with small to medium scale cross-beds in part. Garnet is a common minor constituent. The conglomerate is light grey, quartzose, generally granular and in part pebble sized, very porous and fair to poorly sorted. The siltstones are grey and are commonly interlaminated with very fine grained light grey sandstone.

Light grey to cream sandstones from 880.77m to the base of the Hutton Sandstone exhibit greater similarity to those drilled in the Rewan Formation and may be the product of reworking of the underlying Triassic sediments. Typical sandstones within the Hutton Sandstone are light grey in colour. In addition, there is a noticeable absence in the core of any plant matter over this interval.

The top of the formation is placed where the composition of the sandstones becomes more labile than the dominantly quartzose composition of the Hutton Sandstone.

Birkhead Formation

The Birkhead Formation was cored between 730.96m and 809.83m and conformably overlies the Hutton Sandstone.

The dominant rock type encountered in the Birkhead Formation is a fine to medium grained, light grey, quartzose to sub-lablie sandstone with an argillaceous matrix. It is generally well sorted and bedding is commonly massive with small and medium scale cross-beds in part. Minor grey siltstone is laminated to thinly bedded, and generally, where associated with light grey, very fine grained sandstone, is interlaminated. The siltstone contains numerous plant remains on bedding surfaces, and in part contains rooted horizons.

The top of the Birkhead Formation is placed at the top of a grey, rooted siltstone and very fine grained light grey sandstone interval.

Adori Sandstone

The Adori Sandstone was cored between 719.41m and 730.96m and rests conformably on the Birkhead Formation.

The formation comprises light grey, quartzose, generally well sorted sandstone with an argillaceous matrix. The unit generally fines upwards from a medium grained, medium bedded sandstone with a sharp basal contact to a fine grained, thin to medium bedded sandstone and finally to a very fine grained, laminated to thin bedded micaceous sandstone with minor grey siltstone. The porosity of the formation is generally poor due to the argillaceous matrix.

The top of the Adori Sandstone is placed at the boundary between the very fine grained sandstone and siltstone interval and a churned, interlaminated silty sanstone and mudstone interval which is assigned to the overlying Westbourne Formation.

Westbourne Formation

THe Westbourne Formation was cored over the interval 684.24m to 719.41m and conformably overlies the Adori Sandstone.

The formation comprises approximately equal proportions of dark grey interlaminated to thinly bedded mudstone and light grey silty sandstone. Wavy and graded bedding is common. Scours at the base of the graded beds are common and soft sediment deformation and associated microfaulting is evident in part. Mica is present as a minor constituent and is generally in the finer grained sediments.

The top of the Westbourne Formation is placed at the sharp contact between the fine grained sediments of the Westbourne Formation and a medium grained sandstone interval of the overlying Hooray Sandstone. This boundary is evident on wireline logs as a significant reduction and increase in gamma-ray and resistivity log values respectively above the boundary.

Hooray Sandstone

The Hooray Sandstone was cored between 599.14m and 684.24m

The formation comprises dominantly sandstone and conglomerate with lesser amounts of siltstone and mudstone. Sandstone is very fine to medium grained, light grey, quartzose, fair to well sorted, and generally thin to medium bedded with common small scale cross-beds in part. The finer grained sandstones commonly havean argillaceous matrix and are micaceous in part. The conglomerate is granular to pebble sized and porous. Siltstone is grey, laminated to thin bedded and generally contains rootlets. Rare mudstone is dark grey and in part carbonaceous. Porosity of the unit is excellent towards the top, elsewhere it is moderate to poor.

The top of the Hooray Sandstone is taken at the boundary between the porous, medium bedded, quartzose sandstone and the mudstone and churned sandstone interval of the overlying Wallumbilla Formation.

Lithological characteristics and the typical "bell" shaped gamma-ray log pattern of the Cadna-owie Formation were not observed in the Early Cretaceous sediments drilled in the bore. Therefore, the dominantly clastic interval intersected below the Wallumbilla Formation is interpreted to be the Hooray Sandstone.

Wallumbilla Formation

The Wallumbilla Formation was cored over the interval 433.32m to 599.14m and is probably conformable on the underlying Hooray Sandstone.

The formation consists mainly of mudstone and siltstone with very minor sandstone. The mudstone is dark grey, laminated and is well sorted. The siltstone is grey, sandy and glauconitic in part, and commonly interlaminated to thinly bedded with mudstone. Pyrite, although rare, is present as nodules and lenses. Graded bedding and soft sediment deformation are common features in the interlaminated to thin bedded mudstone and siltstone intervals.

The top of the Wallumbilla Formation is interpreted from drill core to be at 433.32m, which corresponds to the lower boundary of the typical "positive gamma-ray log anomaly" (Senior & others, 1975) of the Toolebuc Formation (Fig. 3, Appendix 1).

Toolebuc Formation

The Toolebuc Formation was cored between 408.24m and 433.32m and conformably overlies the Wallumbilla Formation.

The formation essentially consists of a dark grey to black, laminated mudstone which contains Inoceramus and unidentified shell fragments. The relative abundance of shell fragments gradually decreases towards the top of the unit. Delineation of the formation is obvious on wireline logs by its marked increase in gamma-ray log values in comparison to the bounding formations.

The top of the Toolebuc Formation is difficult to detect in core from the overlying Allaru Mudstone as the core was badly fretted. The gamma-ray log response has been used to determine the upper limit of the Toolebuc Formation at 408.24m in GSQ Muttaburra 1.

Allaru Mudstone

The Allaru Mudstone was cored between 184.94m and 408.24m and conformably overlies the Toolebuc Formation.

The formation comprises almost entirely silty mudstone which is grey to light green, and in parts dark grey, laminated and well sorted. In the lower 45m, the unit is laminated to thinly bedded. Hard, light brown carbonate bands occurring as thin beds contain variable proportions of calcium and iron as evident from differing reaction rates on application of dilute hydrochloric acid. Cone-in-cone limestone is present but rare. Rare shell fragments occur throughout most of the unit. Soft sediment deformation is present in the upper 23m of the formation.

The top of the Allaru Mudstone is placed at the base of the first appearence of graded bedding in the laminated to thinly bedded siltstone and mudstone of the overlying Mackunda Formation. The boundary between the Allaru Mudstone and Mackunda Formation is gradational and there is no obvious change in character of the gamma-ray log over the interval.

Mackunda Formation

The Mackunda Formation was drilled from surface to 184.95m and conformably overlies the Allaru Mudstone. The interval from surface to 6m was open holed, the remainder of the formation was fully cored.

The interval 6m to 23.67m was weathered and comprised mottled light brown and grey, very fine grained, laminated to thinly bedded sub-labile sandstone and mudstone with rare shell fragments in the lower half of the interval. Below the weathered zone, the formation comprises light grey, grey and light green, sub-labile to labile sandstone, sandy siltstone, siltstone and mudstone.

Graded bedding, soft sediment deformation and erosive structures are common throughout most of the formation. Shell fragments are generally rare, but are more abundant towards the base of the formation.

PALYNOSTRATIGRAPHY

Twenty-eight samples from GSQ Muttaburra 1 were examined for palynomorphs in order to determine the biostratigraphy of the sequence penetrated. Seven of these were barren and the remainder yielded the palynofloras documented in Appendices 2 and 3. These data, interpreted in terms of the spore-pollen and dinocyst zonal schemes of Price & others (1985), Price in Draper & others (1990), Filatoff & Price (1986, 1988), Morgan (1980), and Helby & others (1987), form the basis of the palynostratigraphic conclusions given below and summarised in Table 3.

GALILEE BASIN

A low-yield palynoflora recovered from a sample taken at **1241.32m** in GSQ Muttaburra 1 contains Protohaploxypinus spp. in the absence of Microbaculispora tentula and Pseudoreticulatispora pseudoreticulata. A maximum unit APP1 age is favoured; and thus it is no older than Late Carboniferous-Early Permian assemblages from the Jericho and lower Jochmus Formations (Price & others, 1985).

P. pseudoreticulata, in the absence of Granulatisporites trisinus, occurs as a minor component of the palynoflora at **1216.91m**, together with moderately common disaccate pollen and Marsupipollenites triradiatus/striatus. Other noteworthy species include Apiculatisporis cornutus, Verrucosisporites andersonii, and Diatomozonotriletes townrowii. Assignment to unit APP2.1 is suggested, indicating an Early Permian age and correlation with the interval encompassing the mid-upper Jochmus Formation and the lowermost Aramac Coal Measures.

Disaccate pollen, lycopod spores, and M. triradiatus/striatus are conspicuous elements of the Early Permian palynoflora at **1193.62m**. From a biostratigraphic aspect, the presence of G. trisinus and one specimen tentatively recorded as Phaselisporites cicatricosus favour its assignment to the unit APP2.2-(?)APP3.1 succession. In the Galilee Basin, unit APP2.2 is associated with the uppermost Jochmus Formation and the Aramac Coal Measures; and unit APP3.1 has not been recorded previously, as an intrabasinal hiatus generally occurs at this level, separating Early and Late Permian strata (Price & others, 1985). A minor aquatic component (Botryococcus, Haplocystia pellucida, Maculatasporites, Tetraporina, Brazilea scissa, Mehlisphaeridium fibratum, Quadrisporites horridus) suggests a lacustrine/marginal lacustrine environment of deposition.

The overlying samples at **1081.63 and 1074.98m** are no older than unit APP2.2, as they contain Granulatisporites trisinus.

TABLE 3: PALYNOLOGICAL DETERMINATIONS - GSQ MUTTABURRA 1

Sample Depth (m)	Palynomorph Yield	Palynomorph Preservation	Biostratigraphic Unit	Age	Depositional Environment
597.96	moderate-rich	fair	APK3 ADK1.5-1.7/lower *O. operculata* Zone	Barremian-early Aptian	marginal marine
613.30	rich	good	APKI	Late Jurassic-Early Cretaceous	terrestrial (lacustrine influence)
681.80	moderate-rich	fair-good	APKI	Late Jurassic-Early Cretaceous	terrestrial (lacustrine influence)
684.48	moderate	fair-good	APJ6.2	Late Jurassic	terrestrial (lacustrine influence)
693.63	rich	fair-good	APJ6.2	Late Jurassic	terrestrial (lacustrine influence)
740.35	moderate-rich	fair-good	APJ5	late Middle Jurassic	terrestrial (lacustrine influence)
867.23	moderate-high	fair-good	APJ4.1	Middle Jurassic	terrestrial
883.96	barren	-	-	-	-
894.33	barren	-	-	-	-
894.76	barren	-	-	-	-
909.99	barren	-	-	-	-
936.76	moderate	good	APT1	Early Triassic	terrestrial
960.65	moderate-high	good	APP6	Late Permian	terrestrial
966.50	high	fair-good	APP5	Late Permian	terrestrial
973.86	moderate-high	fair	APP5	Late Permian	terrestrial
980.07	moderate	fair	APP5	Late Permian	terrestrial

TABLE 3 (CONTINUED): PALYNOLOGIAL DETERMINATIONS - GSQ MUTTABURRA 1

Sample Depth (m)	Palynomorph Yield	Palynomorph Preservation	Biostratigraphic Unit	Age	Depositional Environment
1032.23	moderate	fair	APP4.2-APP5 (probably APP5)	late Early Permian - Late Permian (probably Late Permian)	terrestrial (lacustrine influence)
1046.86	moderate-high	fair	APP3.2.1.2-APP5 (probably APP5)	Early-Late Permian (probably Late Permian)	terrestrial (lacustrine influence)
1055.02	low-moderate	poor-fair	APP3.1	Early Permian	terrestrial (lacustrine influence)
1063.66	moderate	fair	APP3.1	Early Permian	terrestrial
1074.98	moderate	fair	APP2.2-(?)APP3.1	Early Permian	terrestrial
1081.63	moderate	poor-fair	APP2.2-(?)APP3.1	Early Permian	terrestrial (lacustrine influence)
1193.62	moderate-high	fair-good	APP2.2-(?)APP3.1	Early Permian	terrestrial (lacustrine influence)
1216.91	moderate-high	fair	APP2.1	Early Permian	terrestrial
1241.32	low	poor	N.O. APP1	N.O. Late Carboniferous-Early Permian	terrestrial
1265.02	barren	-	-	-	-
1273.30	barren	-	-	-	
1290.61	barren	-	-	-	-

1.Palynomorph Yield: barren, low, moderate, high; 2. Preservation: poor, fair, good, excellent; N.O.= not older than.

However, in view of the provisional record of P. cicatricosus at 1193.62m, assignment of them to the APP2.2-(?)APP3.1 sequence is indicated. A small proportion of aquatic species is also present at 1081.63m.

At **1063.66m**, disaccate pollen, Deltoidospora directa, Retusotriletes nigritellus, Granulatisporites micronodosus and Microbaculispora tentula are moderately common constituents, with monosaccate pollen, G. trisinus, Pseudoreticulatispora pseudoreticulata, Indotriradites spp., and the unit APP3.1 index, P. cicatricosus, occurring less frequently. Assignment of the palynoflora to the latter zone is indicated, together with an Early Permian age. A similar age determination is suggested for the sample at **1055.02m** in which P. cicatricosus is also present. The lacustrine planktonic alga, Botryococcus, is of common occurrence at this level. As stated above, strata attributable to unit APP3.1 have not been reported previously in the Galilee Basin.

Commonly occurring striate and non-striate disaccate pollen in the palynoflora at **1046.86m** are associated with moderately common Marsupipollenites triradiatus/striatus, Retusotriletes nigritellus and Brazilea plurigenus. The presence of Granulatisporites sp. cf. Microbaculispora indica (spores intermediate between G. trisinus and Acanthotriletes villosus) indicates that the assemblage is no older than Early Permian assemblages in unit APP3.2.1.2 (Price in Draper & others, 1990). On the other hand, a unit APP5 (Late Permian) age appears more likely, considering the record of Polypodiisporites sp. cf. P. mutabilis, Brevitriletes hennellyi, and abundant disaccate pollen, although Dulhuntyispora parvitholus, the index species for this zone, was not recorded (P.Price, personal communication). The succeeding sample taken at **1032.23m** is palynologically similar, but contains Balmeospora gliksoniae, Bipartitisporis sp. cf. Verrucosisporites trisecatus (of Foster, 1979), Didecitriletes ericianus and Dulhuntyispora inornata. The latter two species point to the palynoflora being no older than unit APP4.2, but the abundance of striate and non-striate disaccate pollen suggest a unit APP5 age (P.Price, personal communication). Lacustrine conditions of deposition are indicated for both samples in view of the aquatic component present in the recorded assemblages (Appendix 2).

In the overlying sequence, typical Late Permian palynofloras of unit APP5 were recorded at **980.07**, **973.86**, and **966.50m**. As such, the index, D. parvitholus, was encountered in all three. Thus, in the Galilee Basin, correlation with the Betts Creek beds and strata previously referred to as the Bandanna Formation/Colinlea Sandstone correlative is evident.

Moderately common striate and non-striate disaccate pollen, Lundbladispora spp., and Brevitriletes hennellyi occur at **960.65m** in association with D. parvitholus, Triplexisporites playfordii, Nevesisporites fossulatus, N. limatulus, Playfordiaspora crenulata, Rewanispora foveolata, Thymospora ipsviciensis, T. sp. cf. T. ipsviciensis and Lunatisporites noviaulensis. This biostratigraphically distinctive palynoflora is conformable with unit APP6, thereby promoting a Late Permian age and correlation with some part of the upper Bandanna Formation correlative (Betts Creek beds) - basal Rewan Formation sequence.

Unit APT1 occurs at **936.76m**, suggesting correlation with the lower Rewan Formation. Palynomorphs recorded in this Early Triassic assemblage include moderately common - common Lundbladispora spp., Nevesisporites fossulatus/ Polycingulatisporites dejerseyi, and Sculptatomonoleti, with Triplexisporites playfordii, Playfordiaspora crenulata, Rewanispora foveolata, Lunatisporites noviaulensis and L. pellucidus being recorded in variably lower frequencies.

EROMANGA BASIN

A Middle Jurassic palynoflora containing Retitriletes circolumenus, the index species used in definition of unit APJ4.1, was recovered from the sample at **867.23m**. Associated forms include Leptolepidites verrucatus, Klukisporites scaberis and Dictyotosporites complex. Correlation with the middle to upper Hutton Sandstone in the Eromanga Basin is indicated.

Unit APJ5 was recorded at **740.35m**, with the index, Murospora florida, occurring in association with Contignisporites glebulentus, Kraeuselisporites whitfordensis, Aequitriradites norrisii, and Retitriletes facetus. A late Middle Jurassic age and correlation with the upper Birkhead Formation are suggested. A lacustrine influence in the depositional environment was likely, considering the presence of minor proportions of spinose acritarchs (Micrhystridium/Baltisphaeridium) and smooth walled, algal leiospheres.

In the overlying palynofloras at **693.63m** and **684.48m**, the presence of Retitriletes watherooensis and Neoraistrickia equalis favours assignment of the associated strata to unit APJ6.2 of Late Jurassic age. Other species present in both samples include "Concavissimisporites" informis, Lycopodiacidites sp. cf. L. asperatus, and Ischyosporites volkheimeri, the overall association being typical of the Westbourne Formation in the Eromanga Basin. A minor proportion of leiospheres was also recorded in these assemblages.

Samples from **681.80m** and **613.30m** in the bore are assigned to unit APK1 as they contain Cicatricosisporites spp.in the absence of Foraminisporis wonthaggiensis. Thus, strata in this interval are considered to be Late Jurassic to Early Cretaceous in age and a correlative of some part of the sequence containing the uppermost Westbourne Formation, Hooray Sandstone, and basal Cadna-owie Formation in the Eromanga Basin. Algal leiospheres, suggesting a lacustrine influence, are present in both palynofloras, being a minor component in the deeper sample and moderately common in the higher.

Marginal marine conditions of deposition are evident at **597.96m** from the occurrence of a number of dinoflagellate taxa, the most common of which comprise Dingodinium cerviculum, Kallosphaeridium romaensis, Cassiculosphaeridia delicata, and Sentusidinium spp. Spinose acritarchs (Micrhystridium/Baltisphaeridium spp., Veryhachium reductum) and algal leiospheres also form a minor component of the aquatic palynoflora.

The presence of Odontochitina operculata, Chlamydophorella ambigua, Circulodinium colliveri and Muderongia australis indicate association with: (i) some part of the Muderongia australis-Ascodinium cinctum-(lower) Odontochitina operculata zonal interval of Helby & others (1987) [=dinocyst units ADK 1.5-1.7 of Filatoff & Price (1986)], and (ii) the lower Odontochitina operculata Zone of Morgan (1980). In GSQ Wyandra 1, Burger (1988) recorded the latter from the uppermost Cadna-owie Formation and basal Doncaster Member. Thus, correlation with this part of the sequence is adopted here, indicating the facies differences between the uppermost Hooray Sandstone in Muttaburra 1 and the equivalent section in Wyandra 1. A Barremian to early Aptian age is evident.

The spore-pollen component of the palynoflora is assigned to unit APK3, which is associated with the uppermost Cadna-owie Formation and the Doncaster Member, thus supporting the dinocyst biostratigraphy. Foraminisporis asymmetricus, the index for this zonal unit, was not recorded, and the determination given is based on the presence of spores attributable to Pilosisporites, which first appear in the PK3 sequence in Queensland (D.Burger & J.Filatoff, personal communication).

DRILL-STEM TESTING & WATER ANALYSIS

A total of three drill stem tests (DST) were carried out during the course of drilling GSQ Muttaburra 1. Water analyses were carried out by the Government Chemical Laboratory, Brisbane on samples taken from DSTs 1, 2 and 3. Drill stem test and water analysis results are presented in Table 4.

All DSTs conducted within the bore tested potential aquifers within the Eromanga Basin sequence. Aquifers within the Galilee Basin sequence were not tested as porosities were considered to be poor based on visual core examination.

Flow rates for DSTs 1 and 3 were calculated from v-notch weir measurements and are presented as Figure 4. The DST 2 interval was not tested over a v-notch weir as the flow rate was

Table 4: Drill stem test results & water analyses - GSQ Muttaburra 1

	DST 1	DST 2	DST 3
Depth (m)	587.33-641.03	723.53-764.88	783.53-858.08
Recovery	water	water	water
Max. temperature (^{o}C)	52.7	-	57.5
Shut in pressure (kpa)	150	-	160
Flow rate (m^3/day)	105.27	8.40	133.59
Conductivity at 25^{o}C (uS/cm)	1450	1050	750
pH	8.4	7.9	8.2
	mg/l	mg/l	mg/l
Total dissolved solids	920	670	510
Total dissolved ions	1270	910	690
Total Hardness as $CaCO_3$	5.4	11.0	14.0
Alkalinity as $CaCO_3$	630	435	350
Free CO_2	5	11	4
Na^+	390	265	200
K^+	2.0	4.1	6.5
Ca^{++}	2.0	3.2	5.3
Mg^{++}	0.1	0.7	0.2
HCO_3^-	740	530	415
CO_3^{--}	13.0	2.8	4.3
Cl^-	120	92	55
F^-	4.0	2.9	1.2
NO_3^-	0.9	1.1	<0.5
SO_4^{--}	<2.0	14.0	2.7
Li	<0.05	<0.05	<0.05
Sr	0.2	0.4	0.2
Ba	0.1	0.2	0.1
V	<0.005	0.025	<0.005
PO_4	-	-	-
I	<0.1	<0.1	<0.1
B	2.5	1.1	0.17
Cu	<0.01	0.02	<0.01
Zn	0.01	0.13	0.09
Pb	0.005	0.028	<0.002
Fe	2.4	0.06	0.92
Al	0.24	1.9	<0.05
Mn	0.07	0.97	0.06
U	<0.005	0.005	<0.005
SiO_2	28	24	32

Note: All drill stem tests run through a 19mm choke. Temperatures listed above were recorded at the v-notch weir.

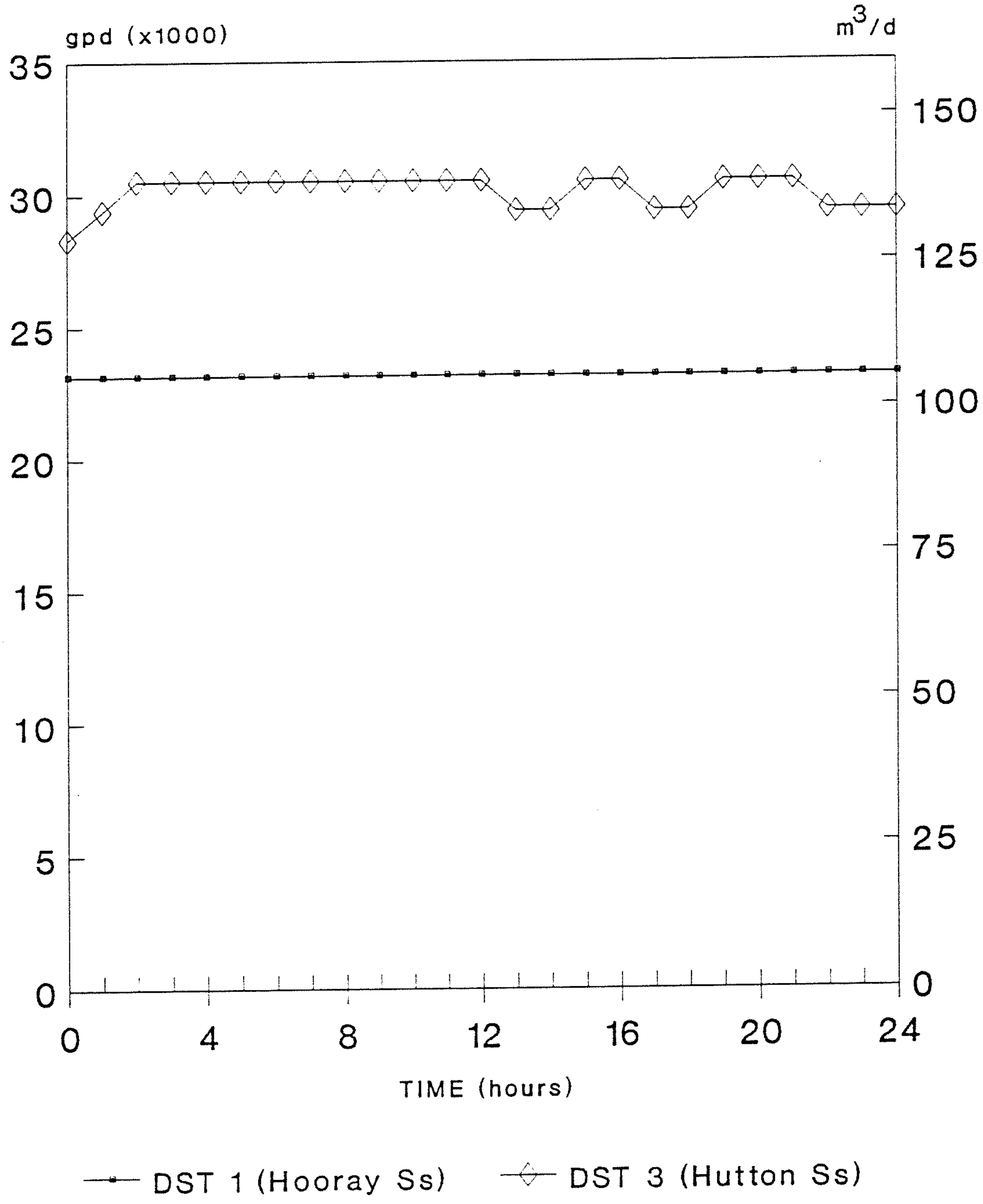


Figure 4. Drill-stem test results - GSQ Muttaburra 1. (gpd = gallons per day, m^3/d = cubic metres per day)

considered to be too low to warrant a full 24 hour test (Table 4). Swabbing the drillhole over a total period of five hours failed to improve the flow. The flow rate for DST 2 was calculated from measurements recorded at the top of the drill string.

Water analyses indicate all DST waters are of the sodium bicarbonate type as shown on Figure 5. Water quality improves with depth as the amount of total dissolved solids decreases with depth (Table 4) (P.Quarantotto, personal communication, 1990).

GEOTHERMAL GRADIENT

A total of six downhole temperatures were recorded in GSQ Muttaburra 1 (Table 5, Figure 6). Downhole temperatures were measured following completion of drill stem testing or after wireline logging operations. An ambient ground surface temperature of 20 degrees celsius (Pitt, 1986) was used in order to calculate present day geothermal gradients.

Assuming a linear data trend, the average geothermal gradient over the interval surface to total depth is $4.62^{o}C/100m$. As shown on Figure 6 this gradient poorly models the data. However, geothermal gradients over the intervals surface to near top Hooray Sandstone ($6.26^{o}C/100m$) and Hooray Sandstone to total depth ($3.25^{o}C/100m$) model the data more closely as shown on Figure 6.

The higher gradient ($6.26^{o}C/100m$) may be due to a blanketing affect of the dominantly argillaceous sediments of the Wallumbilla Formation and younger units intersected in the bore. Movement of groundwater through the coarser clastic sediments of the Hooray Sandstone and older units may be responsible for the lower geothermal gradient ($3.25^{o}C/100m$).

Table 5: <u>Geothermal gradient data - GSQ Muttaburra 1</u>

Depth (m)	Temperature (^{o}C)
0.00	20
591.33	57
727.53	62
787.53	64
900.00	64
1100.00	76
1300.00	80

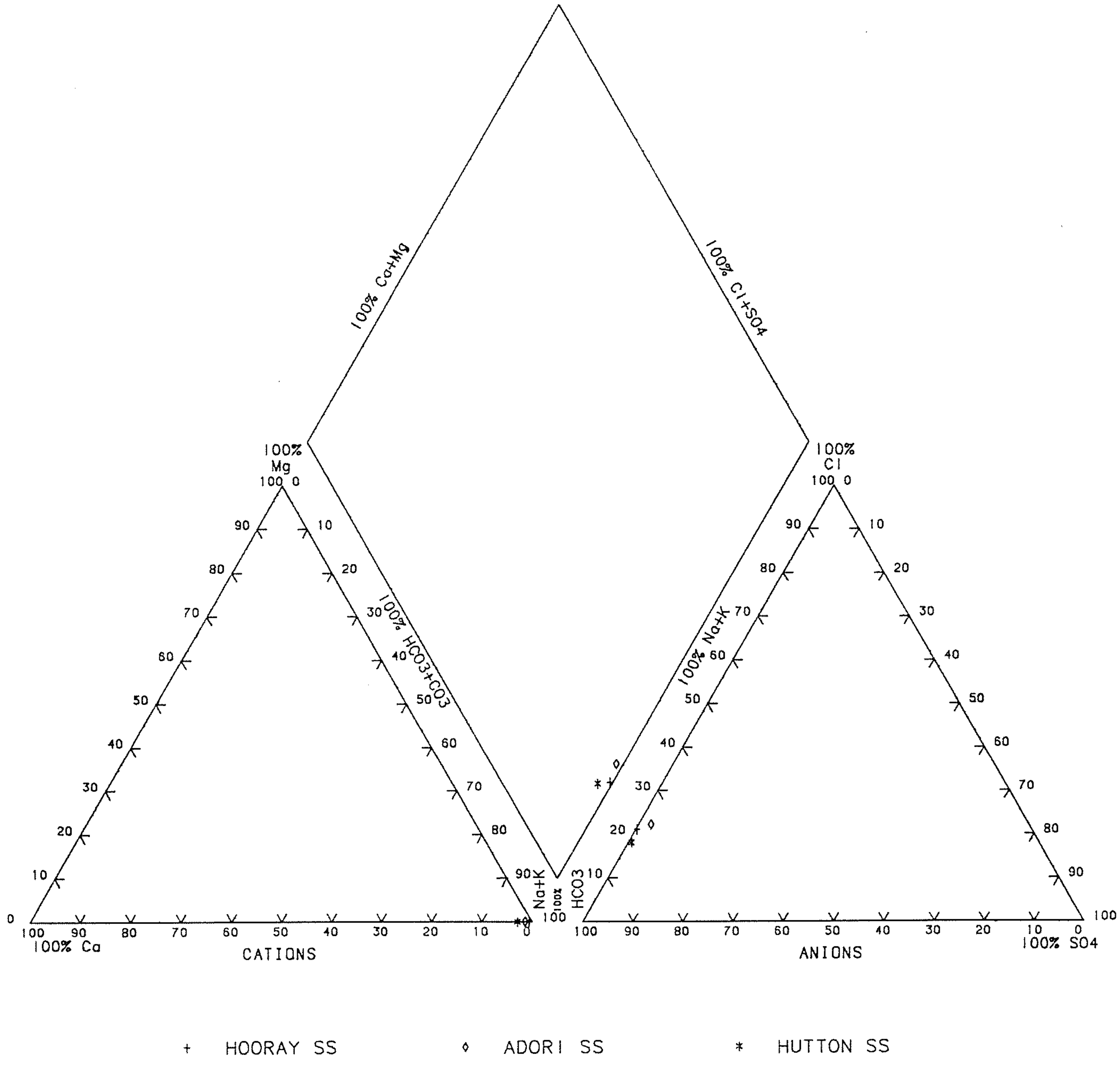


Figure 5. Percentage reacting values of major ions for groundwater from DST's 1, 2 & 3 - GSQ Muttaburra 1.

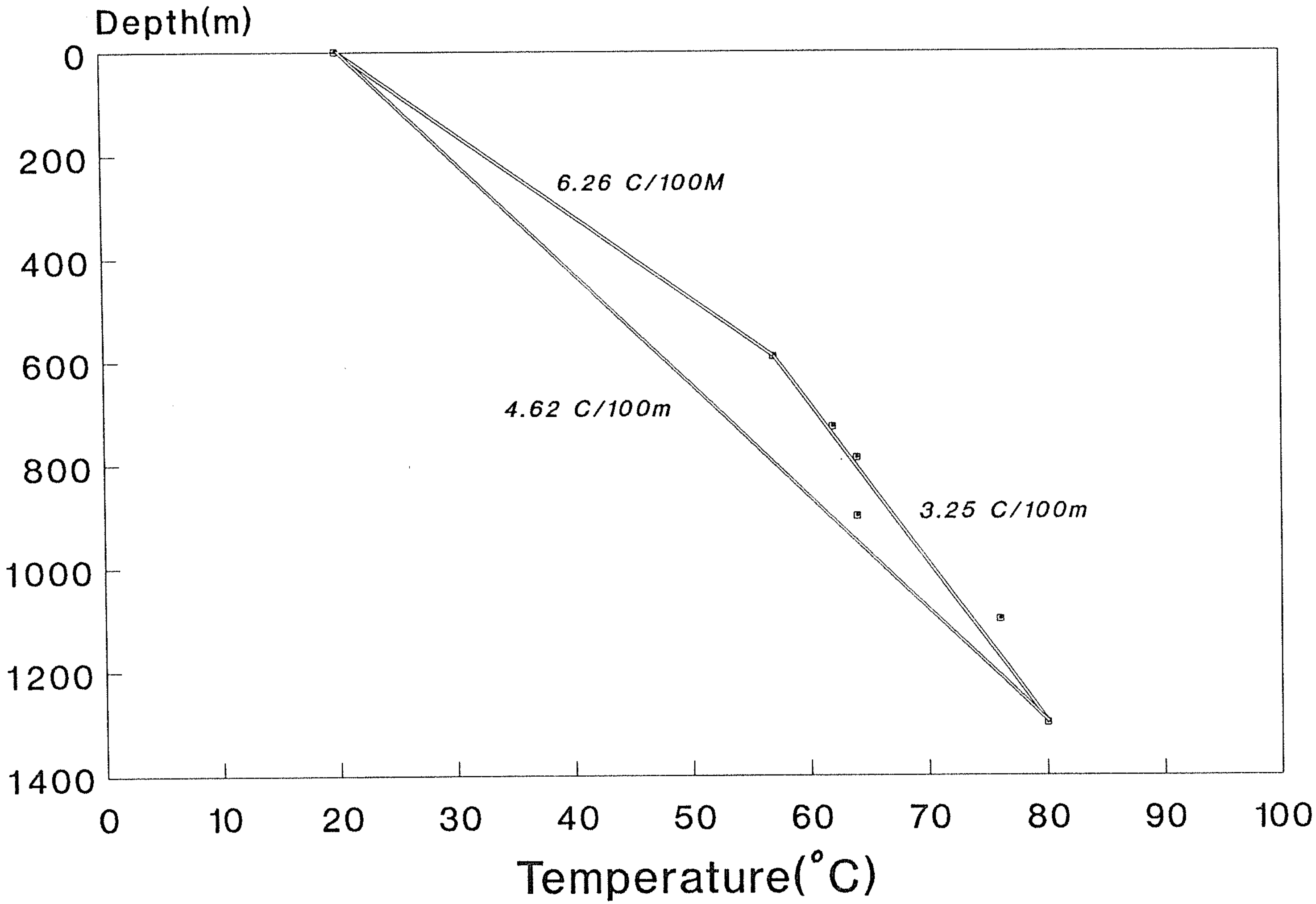


Figure 6: Geothermal gradient - GSQ Muttaburra 1.

VITRINITE REFLECTANCE

Vitrinite reflectance measurements were performed by R.J.Smith of the Coal and Oil Shale Resource Assessment and Development Subprogram on nineteen hand picked vitrain samples. Mean maximum reflectance of telovitrinite was measured as per Australian Standard 2486-1989. The vitrinite reflectance data are given in Table 6.

Coal analyses were carried out to provide additional rank parameters for the future assessment of maturation levels. The analyses were carried out by Australian Coal Industry Research Laboratories Ltd. (ACIRL) on two samples (Table 7). Sample R3659 consisted of 46 cm of coal which was crushed and floated at 1.30 g/cm^3 relative density to provide a low ash, high vitrinite concentrate suitable for chemical analysis and reflectance determinations. Sample R3666 consisted of a two centimetre vitrain band hand picked from core.

Corrected vitrinite reflectance values for samples R3659 and R3666 (Table 7) of 0.78 and 0.99 respectively are plotted on Figure 7. These values were determined following procedures described in Green & others (1991).

PYROLYSIS

The analyses of total organic carbon (TOC) and Rock-Eval pyrolysis were carried out on nineteen Eromanga and Galilee Basin core samples by Analabs, Perth. The results are listed in Table 8. The guidelines used for characterising TOC and pyrolysis results are included as Appendix 4.

TOC analyses of Eromanga Basin samples from GSQ Muttaburra 1 suggests that the Westbourne Formation (SD1679, SD1680) has the greatest source richness within the Jurassic to Cretaceous sequence. Source richness is highly variable in the Galilee Basin sediments (TOC: 0.10-13.20%). The Aramac Coal Measures (SD1668, SD1669, SD1670) and the Betts Creek beds (SD1672) have relatively high TOC, inferring above average to excellent source richness within the Galilee Basin interval.

With the exception of sample SD1668 (Aramac Coal Measures), the source rock potential of mudstone samples from GSQ Muttaburra 1 is generally poor as indicated by low S1 (volatile hydrocarbons, 0.01 to 0.15mg/g) and generally low S2 (hydrocarbon generating potential, 0.02 to 5.31mg/g) values (Table 8, Appendix 4).

Selected GSQ Muttaburra 1 source rock data have been plotted on hydrogen index (HI) versus Tmax, and HI versus vitrinite reflectance crossplots (Ower & Cooper, 1982) (Figures 8 & 9) to

Table 6: Vitrinite reflectance data - GSQ Muttaburra 1

Sample No.	Depth (m)	Vitrinite reflectance (Rv, max)	No. of readings	Standard deviation	Host lithology
R3652	75.25	0.42	10	0.02	mudstone
R3653	610.21	0.49	15	0.04	mudstone
R3654	652.31	0.50	12	0.05	mudstone
R3655	766.63	0.67	22	0.05	sandstone
R3656	780.87	0.61	7	0.05	sandstone
R3657	871.95	0.56	17	0.01	mudstone
R3658	975.30	0.79	25	0.05	coal
R3659	1000.79	0.76	33	0.04	coal
R3660	1042.43	0.75	22	0.02	coal
R3661	1064.00	0.75	25	0.03	mudstone
R3662	1076.50	0.78	18	0.03	sandstone
R3663	1080.48	0.74	30	0.03	coal
R3664	1085.96	0.81	23	0.02	sandstone
R3665	1117.50	0.76	17	0.02	coal
R3666	1134.28	0.76	5	0.04	sandstone
R3667	1172.29	0.66	30	0.01	mudstone
R3668	1212.72	0.74	21	0.02	conglom.
R3669	1250.47	0.88	6	0.05	sandstone
R3670	1298.26	0.99	22	0.05	sandstone

Table 7: Chemical analyses of vitrains - GSQ Muttaburra 1

Sample Details		R3659	R3666
Depth	m	1000.79	1134.28
Stratigraphy		Betts Creek beds	Aramac Coal Measures
Air dried basis			
Moisture	%	7.0	5.5
Ash	%	1.2	6.6
Volatile matter	%	35.4	33.8
Fixed carbon	%	56.4	54.1
Total sulphur	%	0.53	0.58
Specific energy	MJ/kg	31.66	31.00
Dry, ash free basis			
Carbon	%	83.3	85.7
Hydrogen	%	5.36	5.50
Nitrogen	%	1.85	1.54
Sulphur	%	0.58	0.66
Oxygen	%	8.9	6.6

illustrate kerogen type. In order to crossplot vitrinite reflectance and HI, vitrinite reflectance values were scaled off Figure 7 at corresponding pyrolysis sample depths. GSQ Muttaburra 1 pyrolysis samples have organic matter contents of Type IIIa and Type IIIb kerogen (Figure 9, Table 8). Kerogen of Type III may provide suitable gas source rocks (Tissot & Welte, 1984), however no gas was detected in GSQ Muttaburra 1.

The Tmax values indicate that the samples analysed are in the oil-generating window (Tmax: 435-465^{o}C) for Type III kerogen (Espitalie & others, 1985). In addition, vitrinite reflectance values suggest the samples are mature for oil generation (Rv: 0.65-1.20%)(Tissot & Welte, 1984).

Hawkins (1978) considered the Aramac Coal Measures to offer the best source rock potential within the Galilee Basin sequence. Source rock analysis of GSQ Muttaburra 1 samples indicate that the Aramac Coal Measures contain the most favourable source rocks within the intersected Galilee Basin sequence.

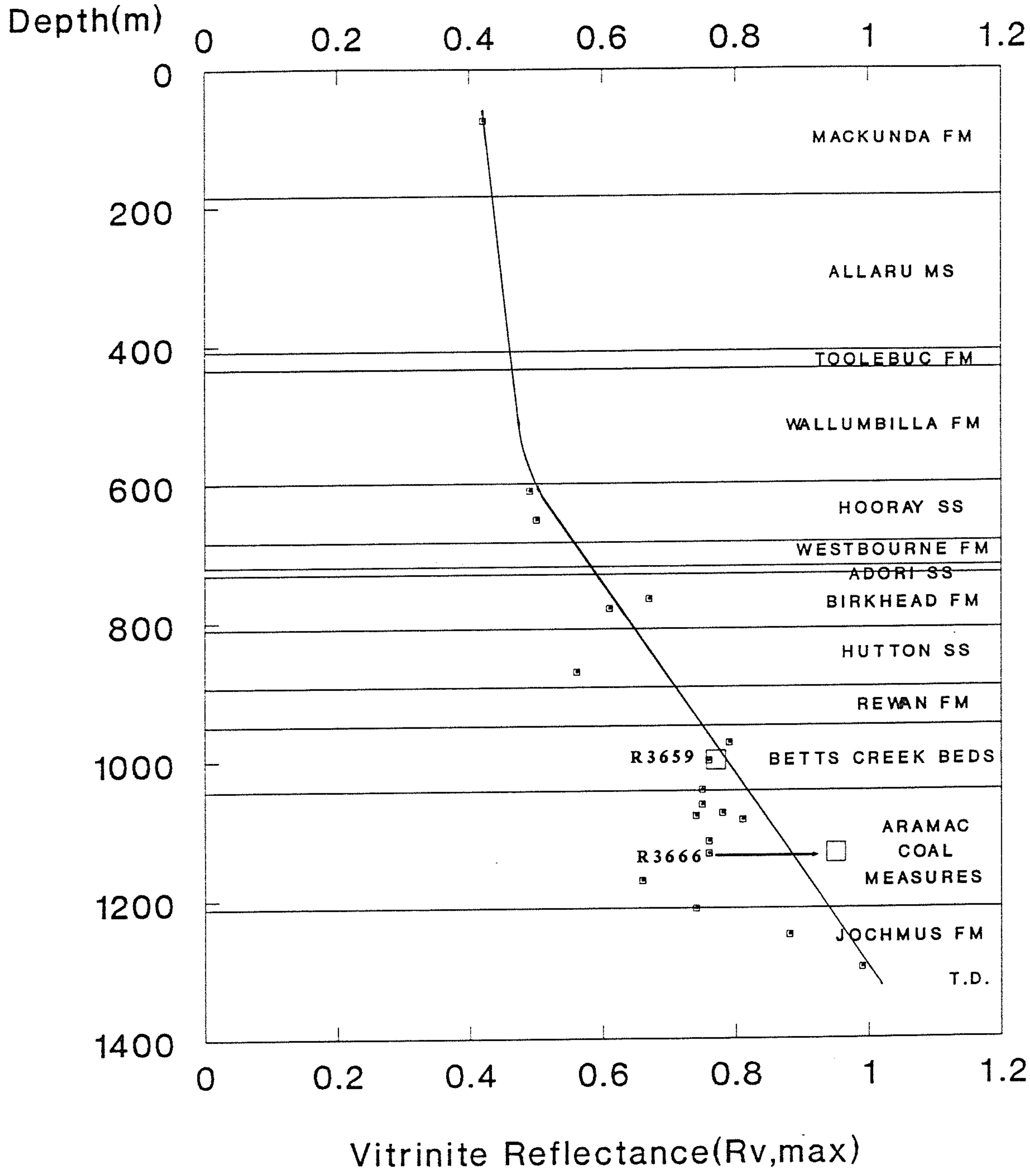


Figure 7. Vitrinite reflectance profile - GSQ Muttaburra 1.

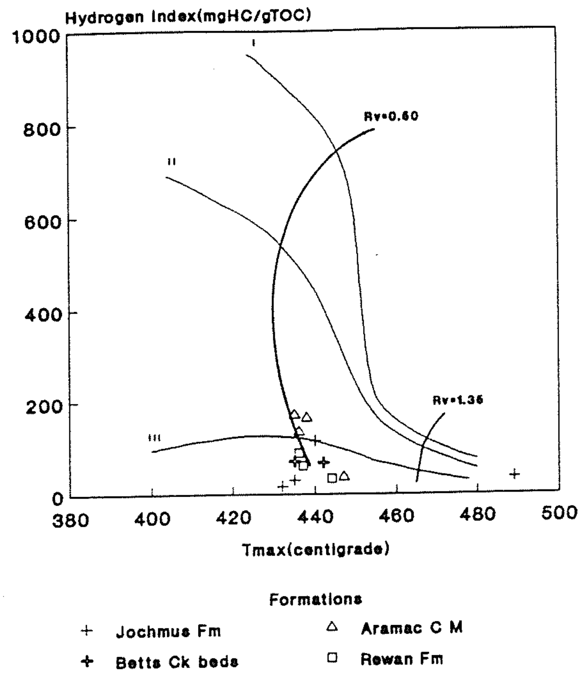
Table 8: TOC & Rock-Eval pyrolysis data - GSQ Muttaburra 1

Sample no.	Depth (m)	Tmax (°C)	S1	S2	S3	S1+S2	S2/S3	PI	PC	TOC (%)	HI	OI	Kerogen type
SD1682	613.10	439	0.04	1.02	0.05	1.06	20.40	0.04	0.09	0.90	113	5	IIIb
SD1681	686.80	436	0.03	0.80	0.07	0.83	11.43	0.04	0.07	0.66	121	10	IIIb
SD1680	703.00	435	0.06	3.39	0.13	3.45	26.08	0.02	0.29	1.43	237	9	IIIa
SD1679	715.87	437	0.06	2.20	0.06	2.26	36.67	0.03	0.19	1.11	198	5	IIIa
SD1678	770.34	441	0.04	0.97	0.08	1.01	12.13	0.04	0.08	0.90	107	8	IIIb
SD1677	772.05	439	0.05	1.11	0.08	1.16	13.88	0.04	0.10	0.98	113	8	IIIb
SD1675	900.43	437	0.05	0.14	0.09	0.19	1.56	0.26	0.02	0.23	60	39	IIIb
SD1674	913.75	436	0.10	0.24	0.61	0.34	0.39	0.29	0.03	0.27	88	225	IIIb
SD1673	938.28	444	0.04	0.03	0.03	0.07	1.00	0.57	0.01	0.09	33	33	IIIb
SD1672	969.15	435	0.10	1.46	1.27	1.56	1.15	0.06	0.13	2.08	70	61	IIIb
SD1671	1010.89	442	0.11	1.12	0.06	1.23	18.67	0.09	0.10	1.65	67	3	IIIb
SD1670	1045.03	435	0.10	5.31	0.15	5.41	35.40	0.02	0.45	3.07	172	4	IIIa
SD1669	1095.96	436	0.15	4.72	0.14	4.87	33.71	0.03	0.40	3.50	134	3	IIIa
SD1668	1103.95	438	0.79	21.75	0.44	22.54	49.43	0.04	1.87	13.20	164	3	IIIa
SD1667	1156.28	447	0.04	0.38	0.01	0.42	38.00	0.10	0.03	1.03	36	1	IIIb
SD1666	1216.86	440	0.04	0.91	0.01	0.95	91.00	0.04	0.08	0.79	115	1	IIIa
SD1665	1241.59	432	0.01	0.02	0.03	0.03	0.67	0.33	0.00	0.12	16	25	IIIb
SD1663	1268.44	489	0.15	0.42	0.05	0.57	8.40	0.26	0.05	1.17	35	4	IIIb
SD1661	1290.46	435	0.02	0.03	0.09	0.05	0.33	0.40	0.00	0.10	30	90	IIIb

Tmax = Max. temperature S2
S1 = Volatile hydrocarbons (HC)
S2 = HC generating potential
S3 = Organic carbon dioxide
S1+S2 = Potential yield
S2/S3 = Quality index

PI = Production index
PC = Pyrolysable carbon
TOC = Total organic carbon
HI = Hydrogen index
OI = Oxygen index

(a)



(b)

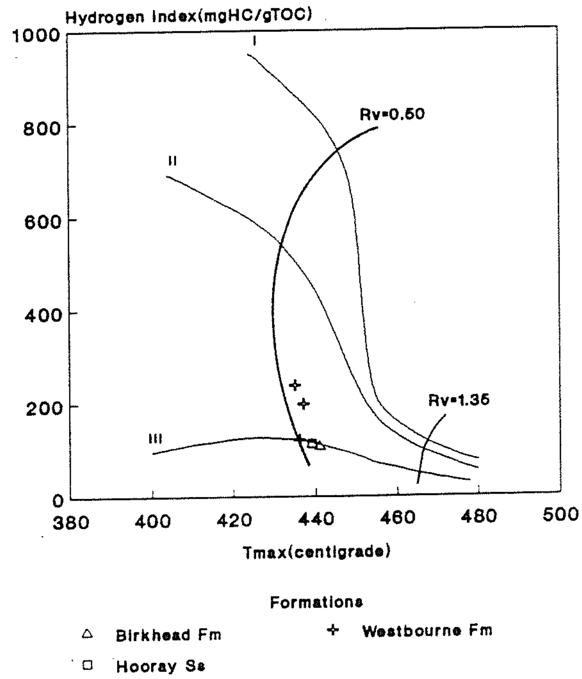
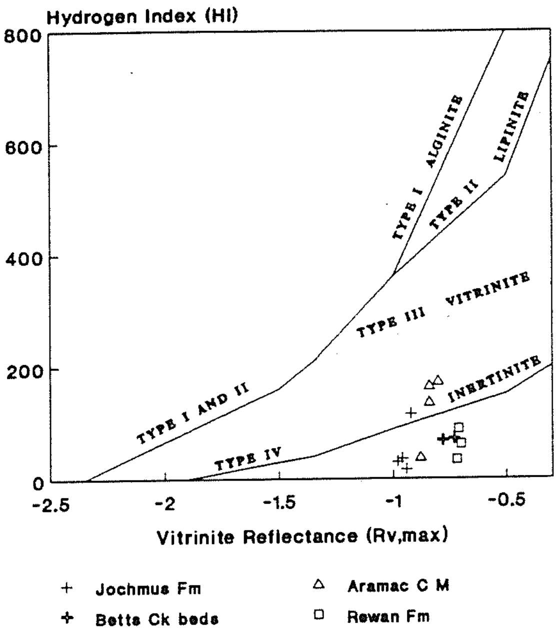


Figure 8 a,b. Hydrogen index versus Tmax crossplots - GSQ Muttaburra 1 : (a) Galilee Basin sequence; (b) Eromanga Basin sequence.

(a)



(b)

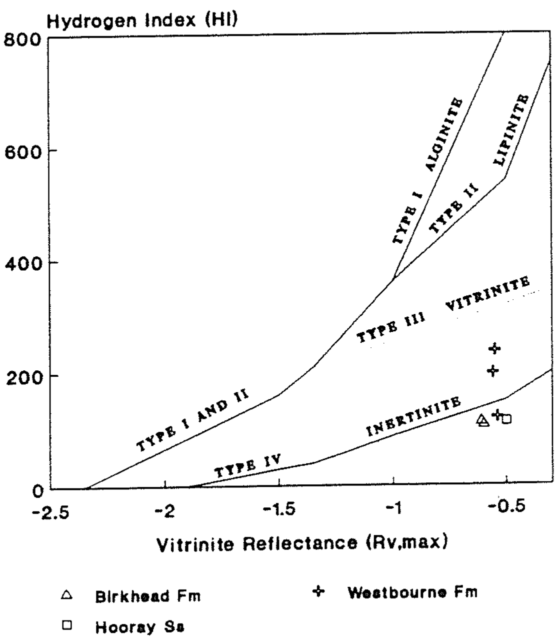


Figure 9 a,b. Kerogen quality from hydrogen index versus vitrinite reflectance crossplots - GSQ Muttaburra 1 (Modified after Ower & Cooper, 1985) : (a) Galilee Basin sequence; (b) Eromanga Basin sequence.

PETROPHYSICS

A total of thirty-four core samples were sent to Amdel Core Services, Brisbane for analysis of porosity, permeability and grain density. The petrophysical results from GSQ Muttaburra 1 core samples are listed in Table 9.

A crossplot of depth versus porosity (Figure 10) illustrates a general decrease in porosity with depth. However, when crossplotting depth versus Galilee Basin porosities and depth versus Eromanga Basin porosities, different trends are observed. The Galilee Basin samples tend to increase in porosity with depth (Figure 10b), contrary to Figure 10a. Figure 10c shows the Eromanga Basin porosities to be scattered with no obvious trend to the data. The average porosities for the Eromanga and Galilee Basin samples are 22.6 per cent and 19.4 per cent respectively, therefore suggesting a general decrease in porosity with depth.

Horizontal and vertical permeabilities are plotted against porosity on Figures 11 and 12 respectively. Samples from the Galilee Basin have lower permeabilities than those from Eromanga Basin sediments drilled in GSQ Muttaburra 1. Within the Galilee Basin, samples from the Aramac Coal Measures display the lowest permeabilities. Eromanga Basin sample permeabilities have the greatest distribution of values. The greatest permeabilities in the Eromanga Basin sequence are from the Hutton and Hooray Sandstones. Permeabilities from these formations are considerably higher than those from the Adori Sandstone, which agrees with flow rates calculated from drill-stem tests (Table 4).

MUDROCK MINERALOGY

The mineralogy of 25 mudrock units has been determined using X-ray powder diffraction (XRD) analyses. The relative percentages of the minerals in the whole-rock samples and the clay minerals in the clay-sized fraction are listed in Tables 10 and 11.

A reference intensity ratio method was used to determine the mineral percentages in the whole-rock samples. The whole-rock samples were prepared as randomly oriented cavity mounts and scanned from 5° to 76° 2-theta using cobalt radiation. The clay-sized fractions were prepared as oriented mounts and scanned from 4° to 30° 2-theta after ethylene glycol solvation and after heating at 375°C.

The total quartz content of the mudrocks increases with depth (Figure 13). This is attributed to the release of silica from the smectite to illite conversion, which proceeds with increasing depth of burial, along with the formation of authigenic quartz.

Table 9: Petrophysics - GSQ Muttaburra 1

Sample no.	Depth (m)	Porosity (%)	Horizontal permeability (md)	Vertical permeability (md)	Grain density (g/cm^3)
SD1659	600.78	25.2	2629	429	2.65
SD1658	606.03	22.7	3501	1562	2.65
SD1657	621.40	24.7	314	178	2.66
SD1656	632.72	27.5	1686	2302	2.65
SD1655	642.99	24.3	1013	224	2.65
SD1654	661.44	20.2	0.54	0.54	2.64
SD1653	677.51	19.6	309	321	2.65
SD1652	728.51	23.5	9.2	6.1	2.65
SD1651	730.46	21.6	1.1	1.1	2.65
SD1650	748.32	22.2	8.3	4.0	2.66
SD1649	762.82	17.5	0.25	0.24	2.67
SD1648	767.67	28.9	926	269	2.72
SD1647	796.85	22.6	367	314	2.65
SD1646	817.21	26.3	1181	784	2.65
SD1645	827.10	27.0	5729	1976	2.65
SD1644	841.18	22.6	90	27	2.65
SD1643	861.66	23.8	301	154	2.65
SD1660	874.57	16.9	5521	4558	2.65
SD1642	886.54	12.2	3.8	1.1	2.66
SD1641	906.37	18.2	76	7.0	2.65
SD1640	919.00	17.2	472	80	2.66
SD1639	929.30	20.3	309	30	2.65
SD1638	953.07	19.8	3.0	2.1	2.69
SD1637	978.40	18.1	60	46	2.64
SD1636	993.44	21.7	1507	189	2.65
SD1635	1029.09	19.5	90	19	2.65
SD1634	1056.83	19.7	39	13	2.65
SD1633	1086.14	20.6	6.3	6.3	2.64
SD1632	1114.33	19.9	2.1	0.75	2.64
SD1631	1134.05	17.7	1.1	1.2	2.65
SD1630	1164.40	16.2	0.43	0.25	2.64
SD1629	1198.94	17.9	1.1	0.39	2.65
SD1628	1252.64	21.8	94	58	2.59
SD1627	1296.08	21.9	121	24	2.56

Note : md = $^1/_{1000}$ Darcy

(One Darcy equals the permeability of a medium through which the rate of flow of a fluid of one centipoise viscosity under a pressure gradient of one atmosphere per centimetre would be one cubic centimetre per second per square centimetre cross section.)

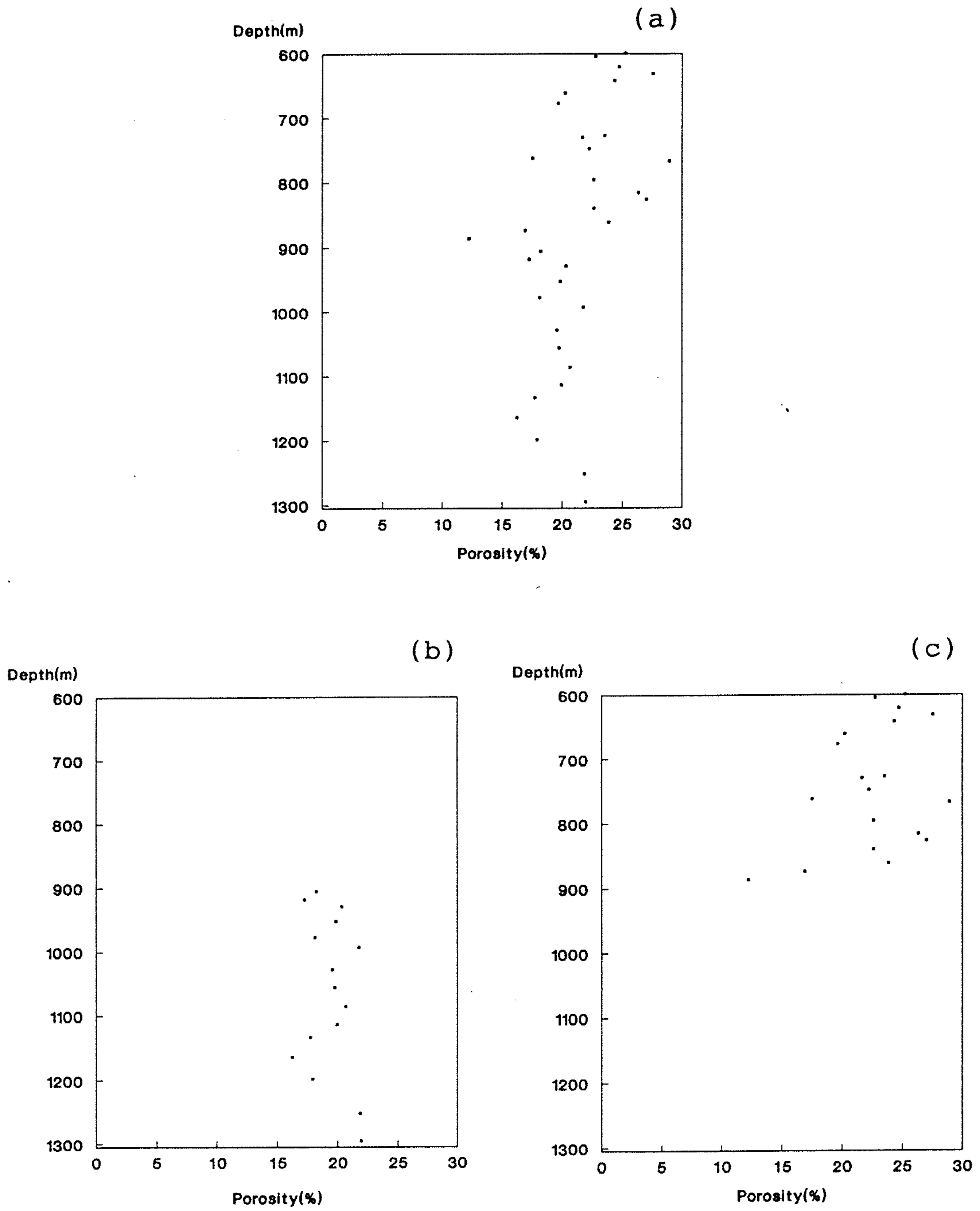
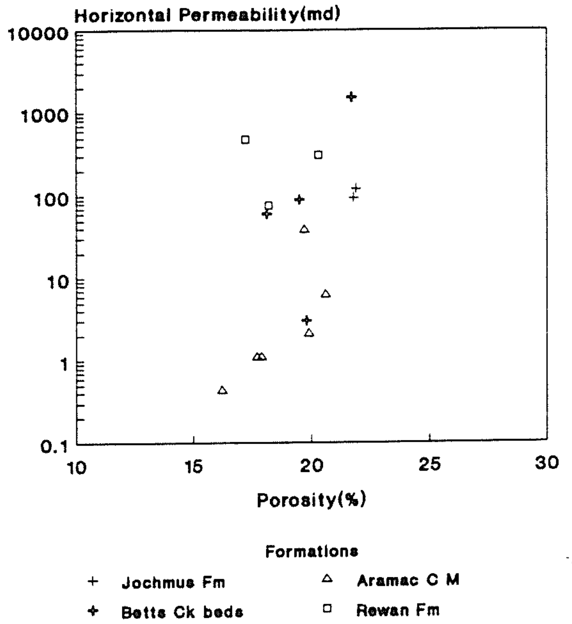


Figure 10 a-c. Porosity versus depth crossplots - GSQ Muttaburra 1 : (a) full suite of samples analysed; (b) 15 samples from Galilee Basin sequence; (c) 19 samples from Eromanga Basin sequence.

(a)



(b)

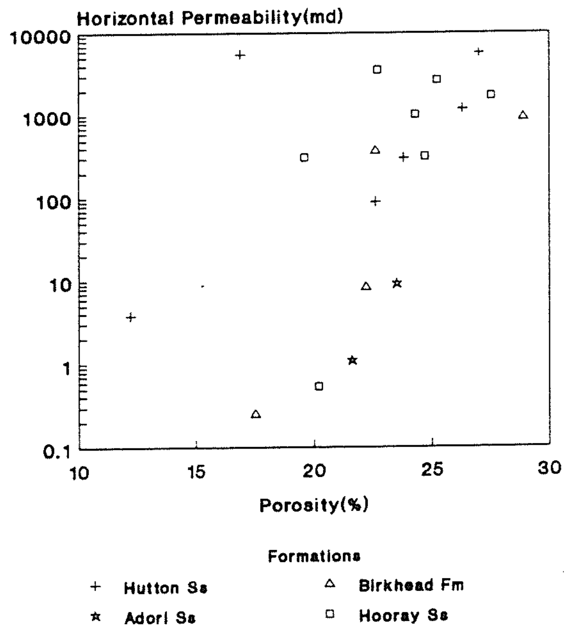
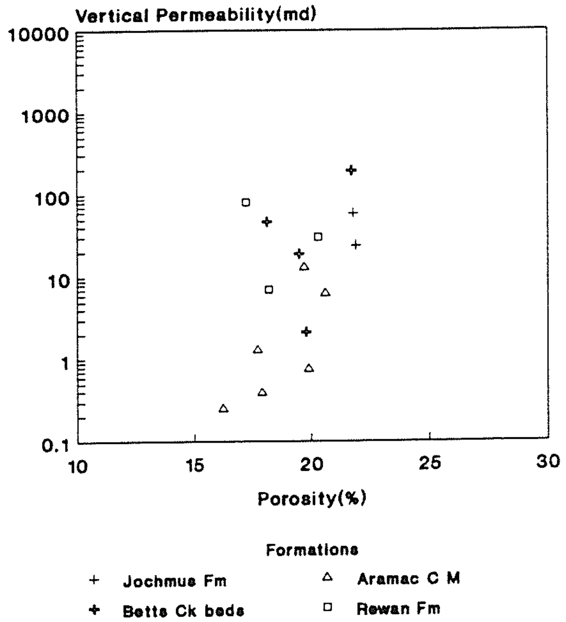


Figure 11 a,b. Horizontal permeability versus porosity crossplots - GSQ Muttaburra 1 : (a) Galilee Basin sequence; (b) Eromanga Basin sequence.

(a)



(b)

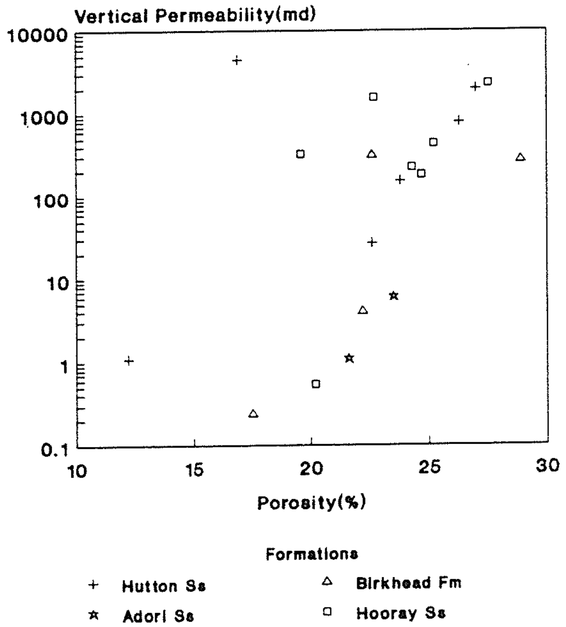


Figure 12 a,b. Vertical permeability versus porosity crossplots - GSQ Muttaburra 1 : (a) Galilee Basin sequence; (b) Eromanga Basin sequence.

Table 10: Whole-rock mineralogy - GSQ Muttaburra 1

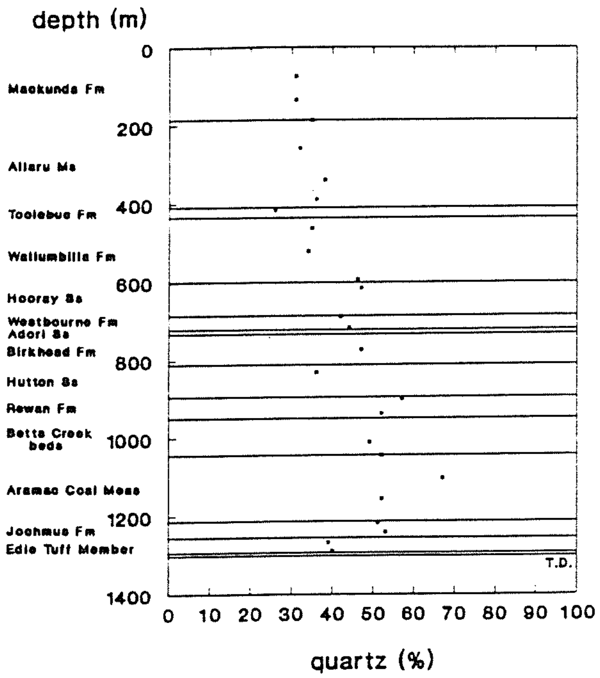
Depth(m)	Formation	Q%	K%	C%	I%	I/S%	P%	K-F%	Ca%	Py%
74.79	Mackunda Formation	31	9	4	6	27	13	4	1	5
134.20	Mackunda Formation	31	9	4	8	26	15	4	1	2
187.08	Allaru Mudstone	35	9	4	10	18	17	4	1	2
256.64	Allaru Mudstone	32	7	4	11	21	15	4	3	3
338.47	Allaru Mudstone	38	9	5	11	17	16	4	0	0
388.07	Allaru Mudstone	36	11	4	10	22	15	0	1	0
415.79	Toolebuc Formation	26	6	2	7	11	9	0	36	3
462.14	Wallumbilla Formation	35	9	0	11	21	15	4	1	4
521.10	Wallumbilla Formation	34	9	4	16	15	15	4	1	2
592.37	Wallumbilla Formation	46	10	0	6	21	13	4	0	0
613.10	Hooray Sandstone	47	31	0	5	5	6	6	0	0
686.80	Westbourne Formation	42	23	6	19	6	0	4	0	0
715.87	Westbourne Formation	44	23	6	15	8	0	4	0	0
772.05	Birkhead Formation	47	13	5	8	11	12	4	0	0
830.18	Hutton Sandstone	36	30	5	15	9	0	5	0	0
900.43	Rewan Formation	57	26	0	10	5	0	2	0	0
938.28	Rewan Formation	52	24	0	14	6	0	4	0	0
1010.89	Betts Creek beds	49	18	3	25	3	0	2	0	0
1045.03	Aramac Coal Measures	52	19	0	24	3	0	2	0	0
1103.95	Aramac Coal Measures	67	15	0	8	7	0	3	0	0
1156.28	Aramac Coal Measures	52	12	0	25	7	0	4	0	0
1216.86	Jochmus Formation	51	8	3	9	16	8	5	0	0
1241.59	Jochmus Formation	53	9	0	7	18	8	5	0	0
1268.44	Edie Tuff Member	39	8	3	16	11	18	5	0	0
1290.46	Edie Tuff Member	40	9	3	12	17	14	5	0	0

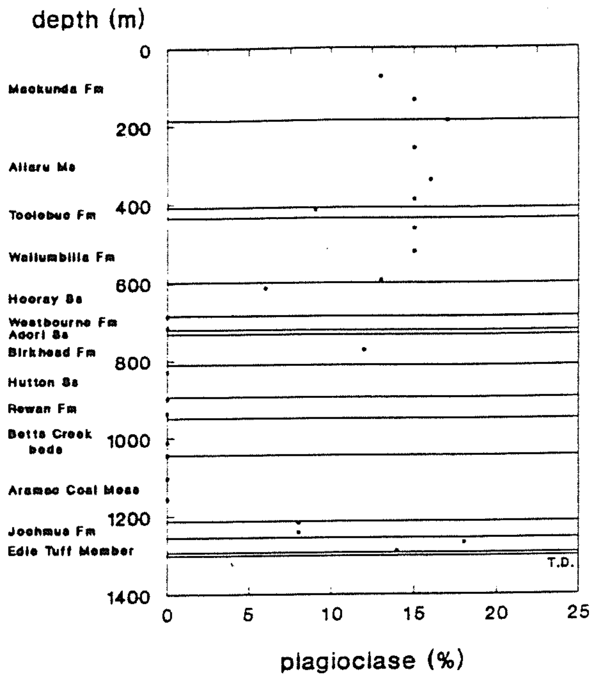
Legend: Q = quartz, K = kaolinite, C = chlorite, I = mica/illite, I/S = smectite or illite/smectite, P = plagioclase feldspar, K-F = K-feldspar, Ca = calcite, Py = pyrite.

Table 11: Clay minerals, clay fraction - GSQ Muttaburra 1

Depth(m)	Formation	I%	C%	K%	I/S%	IL%	Interstrat type
74.79	Mackunda Formation	17	5	15	63	6	R
134.20	Mackunda Formation	19	5	17	59	0	-
187.08	Allaru Mudstone	21	6	14	59	20	R
256.64	Allaru Mudstone	20	5	15	60	20	R
338.47	Allaru Mudstone	18	5	15	62	25	R
388.07	Allaru Mudstone	19	5	20	56	20	R
415.79	Toolebuc Formation	30	7	16	47	38	R
462.14	Wallumbilla Formation	18	6	16	60	29	R
521.10	Wallumbilla Formation	18	5	10	67	40	R
592.37	Wallumbilla Formation	16	6	9	69	33	R
613.10	Hooray Sandstone	9	0	75	16	55	R
686.80	Westbourne Formation	22	4	59	15	69	R/IS
715.87	Westbourne Formation	20	3	60	17	69	R/IS
772.05	Birkhead Formation	15	4	19	62	57	R/IS
830.18	Hutton Sandstone	23	3	51	23	75	IS
900.43	Rewan Formation	16	0	65	19	78	n.d.
938.28	Rewan Formation	27	0	47	26	78	IS/ISII
1010.89	Betts Creek beds	39	0	45	16	n.d.	n.d.
1045.03	Aramac Coal Measures	44	0	44	12	n.d.	n.d.
1103.95	Aramac Coal Measures	35	0	55	10	n.d.	n.d.
1156.28	Aramac Coal Measures	38	0	17	45	80	IS
1216.86	Jochmus Formation	36	3	4	57	78	IS
1241.59	Jochmus Formation	23	0	8	69	76	IS
1268.44	Edie Tuff Member	39	2	3	56	74	IS
1290.46	Edie Tuff Member	20	0	7	73	80	IS/ISII

Legend: I = mica/illite, C = chlorite, K = kaolinite, I/S = smectite or illite/smectite, IL = illite layers in illite/smectites, n.d. = no data, Interstrat type = interstratification type of illite/smectite.





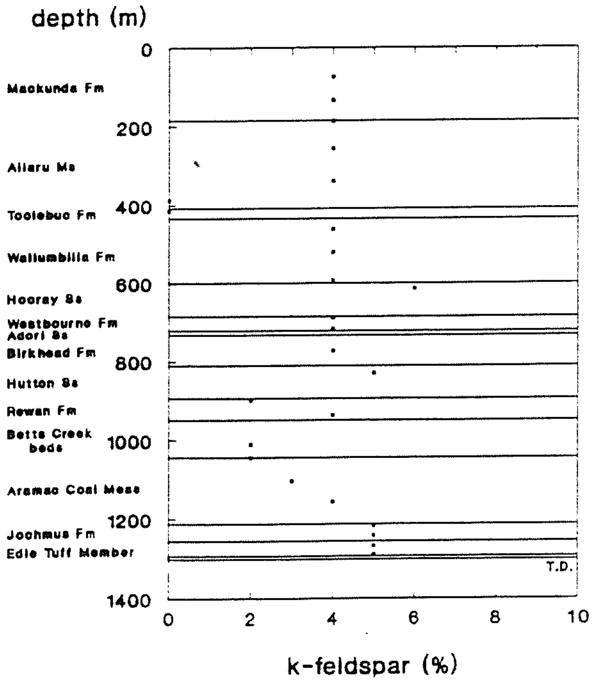


Figure 13. Quartz, plagioclase and k-feldspar versus depth in whole-rock - GSQ Muttaburra 1.

The two mudrocks from the Edie Tuff Member have quartz contents 15 to 20 per cent less than expected from an extrapolation of the quartz trend. This may be due to an initial quartz deficiency in the volcanic-sourced mudstones.

Plagioclase feldspar is common in the marine-deposited sediments of the Mackunda Formation, Allaru Mudstone, Toolebuc Formation and the Wallumbilla Formation, averaging 15 per cent (Figure 13). The underlying continental-deposited sediments have no plagioclase except for the Hooray Sandstone, Birkhead and Jochmus Formations and the Edie Tuff Member. The plagioclase present in the mudrocks of the Birkhead Formation, Jochmus Formation and Edie Tuff Member is most likely derived from a volcanic source.

The absence of plagioclase in the majority of the continental sediments may be due to an initial lack of plagioclase in the source areas or to harsher weathering conditions at the surface and possible reworking of the sediment compared to the marine environment. The presence of K-feldspar in the continental sediments suggests that weathering is not the dominant mechanism for the lack of plagioclase, rather provenance.

The K-feldspar content of the mudrocks does not vary greatly with depth (Figure 13) or have significant changes in content across formation boundaries to be of diagnostic use.

Calcite and pyrite, common minor constituents in the marine-deposited mudrocks, are absent in the mudrocks below the Wallumbilla Formation (Table 10).

Plots of clay minerals in the clay-sized fraction of the mudrocks versus depth are shown in Figure 14. Three broad groups of different clay mineral compositions are recognised.

Group 1 comprises the Mackunda Formation, Allaru Mudstone, Toolebuc Formation and the Wallumbilla Formation. These marine-deposited mudrocks are characterised by high illite/smectite compositions ranging from 47 to 69 per cent, low kaolinite content of 9 to 20 per cent, low illite content ranging from 16 to 30 per cent and relatively high chlorite content from 5 to 7 per cent.

Group 2 comprises continental-deposited mudrocks of the Hooray Sandstone, Westbourne Formation, Birkhead Formation, Hutton Sandstone, Rewan Formation, Betts Creek beds and the upper subdivision of the Aramac Coal Measures (above 1117.95m). Except for the volcanic-sourced Birkhead Formation mudstones, the illite/smectite content for this group is low with values ranging from 10 to 26 per cent. Kaolinite content is high with values ranging from 44 to 75 per cent. The illite content increases with depth from 9 to 44 per cent and the chlorite content varies from 0 to 4 per cent in the Eromanga Basin sequence with no chlorite present in the Galilee Basin sequence of this group.

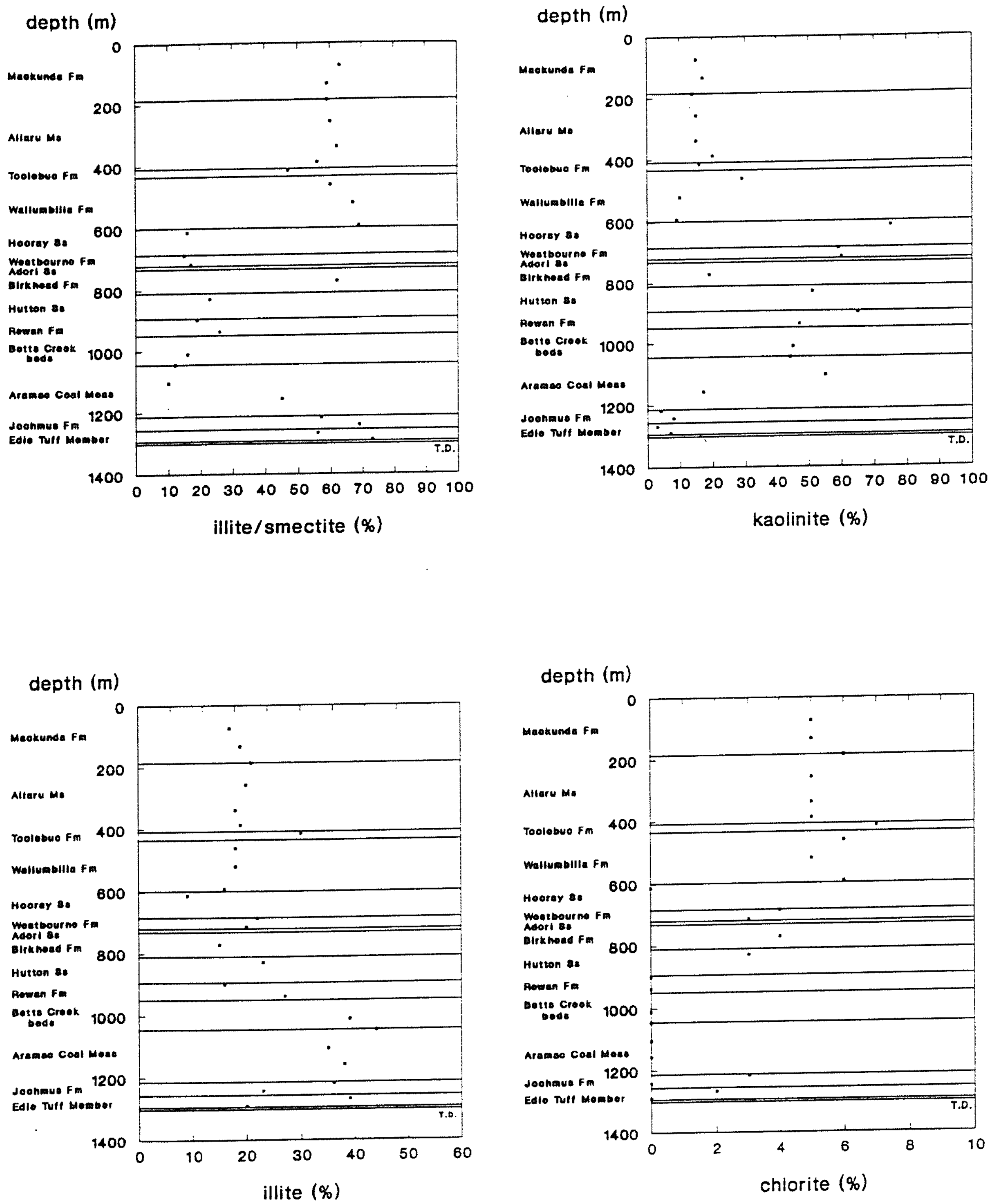


Figure 14. Clay minerals, clay fraction versus depth - GSQ Muttaburra 1.

Group 3 comprises continental-deposited mudrocks of the lower subdivision of the Aramac Coal Measures (below 1117.95m), Jochmus Formation and Edie Tuff Member. This group has high illite/smectite contents from 45 to 73 per cent, low kaolinite contents from 3 to 17 per cent, variable illite contents from 20 to 39 per cent and variable chlorite contents from 0 to 3 per cent.

The different clay mineral assemblages in these three groups are attributed largely to provenance changes and varying depositional environments. The high illite/smectite compositions of the mudrocks in Groups 1 and 2 suggest a substantial input of volcanic material.

Unconformities present in this bore are not reflected by noticeable changes in the clay mineral compositions of the mudrocks. However, there is a major change in clay mineralogy of the mudrocks at the boundary between the upper and lower subdivisions of the Aramac Coal Measures.

The illite layer percentage in the mixed-layer illite/smectite clays (Table 11) can be used as an inorganic indicator of thermal maturity of the mudrocks. Illite layer percentages versus depth are shown in Figure 15. Regionally, for the Eromanga Basin, north of 24°S, illite layer values of 52 per cent are equivalent to vitrinite reflectance values of 0.7 Rv,max (Carmichael & Shield, 1991). Illite layer values of 52 per cent to 79 per cent are within the peak oil generation window. Accordingly, mudrocks from the Westbourne Formation and below are considered to be within the peak oil generation window.

FLUORESCENCE

Continuous monitoring of core for hydrocarbon indications was carried out from 596.70m to total depth. No hydrocarbon indications were recorded. Procedure for testing core for hydrocarbons followed that outlined by Wyman and Castano (1974).

CONCLUSIONS

Strata drilled in GSQ Muttaburra 1, in addition to those in GSQ Longreach 1-1B have provided useful fully-cored sections of the Eromanga and Galilee Basin sequences in the central and southern regions of the Koburra Trough.

Palynofloras from the Galilee Basin sequence range in age from a maximum of Late Carboniferous-Early Permian at 1241.32m to Early Triassic at 936.76m; and, for the Eromanga Basin, from Middle

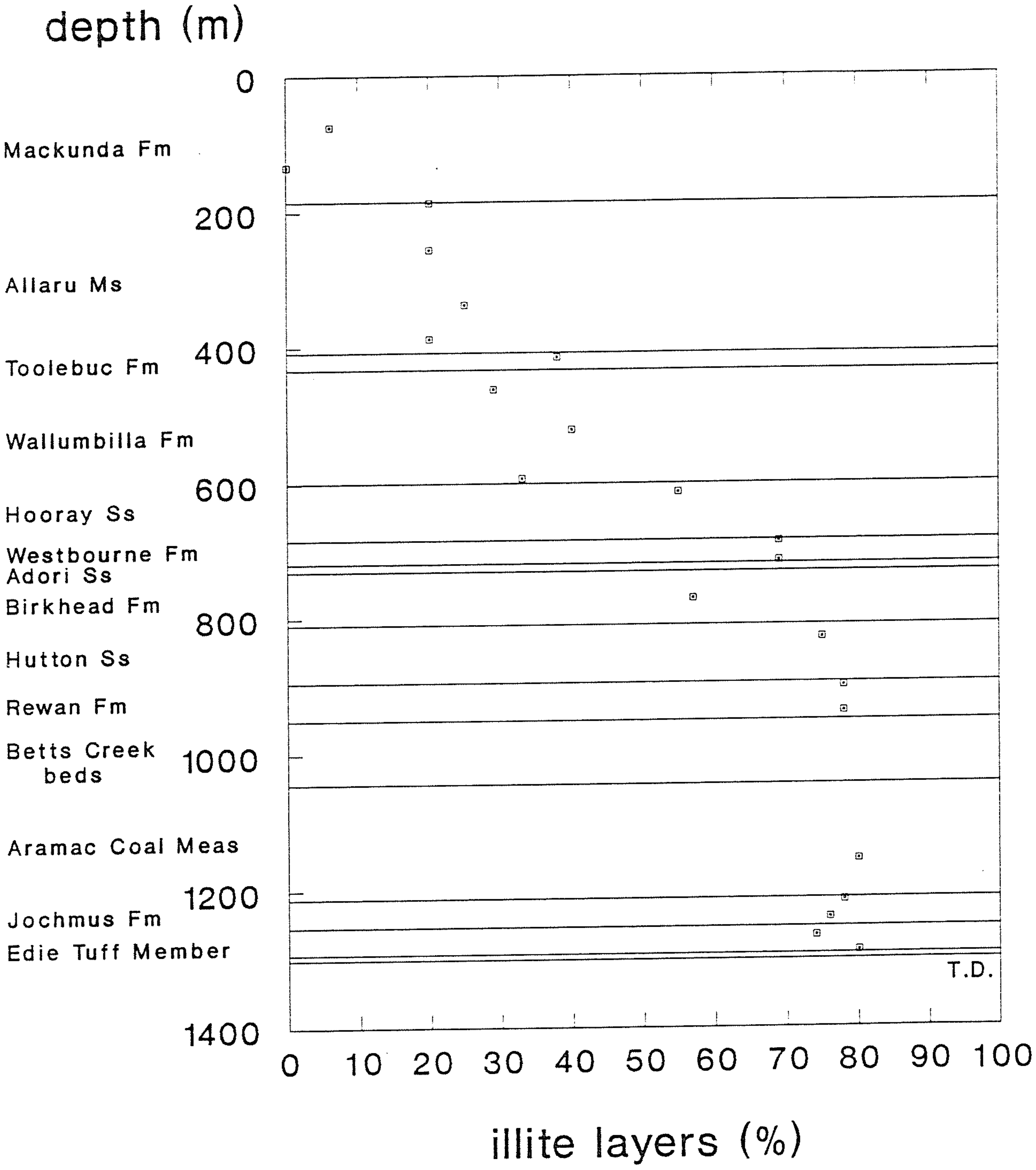


Figure 15. Illite layers in illite/smectite clays versus depth - GSQ Muttaburra 1.

Jurassic at 867.23m to Barremian-early Aptian at 597.96m.

Unit APP3 has not been reported previously in the Galilee Basin, as strata associated with unit APP2 are unconformably overlain by strata of unit APP5 in most areas. This intrabasinal hiatus, if present, in GSQ Muttaburra 1, occurs between 1032.23m (APP4.2-APP5, ?APP5) and 1055.02m (unit APP3.1). These unit APP3 strata represent a previously unknown upward extension of the Aramac Coal Measures.

The hiatus between the Galilee and Eromanga Basins occurs between 936.76m (Early Triassic) and 867.23m (Middle Jurassic) based on palynological assemblages from core samples.

A younger age (APP3) for the upper part of the Aramac Coal Measures has been determined by palynological studies. Strata of this age were not reported within the type section of the Aramac Coal Measures.

The dominantly fluvial sandstone, siltstone, mudstone, and coal interval drilled in the Galilee Basin intersected in GSQ Muttaburra 1 provides one of the most continuous stratigraphic records fully cored in the Koburra Trough based on results from palynological age determinations to date.

Aquifers within the Hooray and Hutton Sandstones have the greatest porosities and permeabilities within the bore and flowed water to surface at rates in excess of 105 cubic metres per day. No hydrocarbon shows were recorded in the bore.

Downhole temperatures indicate a change in the geothermal gradient at the base of the Wallumbilla Formation.

Vitrinite reflectance and pyrolysis results suggest that source rocks within the Galilee Basin are mature and those within the Eromanga Basin are immature for oil generation. The Aramac Coal Measures offer the best source rocks in the Galilee Basin sequence.

Clay mineral assemblages have identified three distinct groups of mudrocks attributed to changes in provenance of source material. A major change in clay mineralogy occurs between the upper and lower subdivisions of the Aramac Coal Measures.

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APPENDIX 1: Lithologic log - GSQ Muttaburra 1

Lithologic log - key to abbreviations and symbols

claystone/mudstone/shale	CY/MS/SH
siltstone	SL
sandstone	SS
conglomerate	CG
coal	CL
limestone	LS (see below)
tuff	TF
volcanics	VL
igneous intrusives	IG
metamorphics (undiff.) metasandstone/argillite	MT metaSS/AR

	cone-in-cone limestone
	shell layer
	silt/mud clasts
	coal clasts
Δ Δ Δ	breccia/brecciated zone
	calcareous
	calcareous lens/bed
	unconformity
E	erosional contact
L	sharp loaded contact
I	sharp irregular contact
S	sharp planar contact
U	unknown contact

	granules/pebbles/cobbles
Ca	calcite nodule
ph	phosphate nodule
	ooliths
	coquinite (CQ)

Limestones

Limestones are subdivided into the following categories (after Dunham, R.J., 1962: Classification of carbonate rocks according to depositional texture. American Association of Petroleum Geologists, Memoir 1, 108-121)

Mudstone	MS
Wackestone	WKS
Packstone	PKS
Grainstone	GNS
Boundstone	BDS
Crystalline carbonate	Cryst

Grain-size qualifiers

Very fine	vf
Fine	f
Medium	md
Coarse	c
Very coarse	vc
Granule	grn
Pebble	pbl
Cobble	cbl

Lithological qualifiers

clayey	cly	pebbly	pbly
muddy	mdy	cobbly	cbly
silty	sly	carbonaceous	carb
sandy	sdy	tuffaceous	tfc
granular	grl	calcareous	calc

Sorting

g	good
f	fair
p	poor
b	bimodal

Composition

Siliclastic rocks (after Crook, K.A.W., 1960: Classification of arenites. American Journal of Science, 258, 419-28)

q	quartzose
sl	sublabile
la	labile

qualifying terms

f	feldspathic
lf	lithofeldspathic
fl	feldspatholithic
li	lithic

eg. f,la = feldspathic labile
sl-la = sublabile to labile

Colour

wh	white	gn	green
cm	cream	kh	khaki
bf	buff	ol	olive
yw	yellow	gy	grey
pk	pink	bl	blue
rd	red	bk	black
or	orange	pu	purple
bn	brown		

lt	light
md	medium
dk	dark

Visible porosity

 good

 present

General abbreviations

abd	abundant
ang	angular
com	common
frag	fragment
grad	gradational
IB	interbedded
IL	interlaminated
intraform	intraformational
lam	laminae
metased	metasediment
min	minor
occ	occasional
rd	rounded
sbang	subangular
sbrd	subrounded
scatt	scattered
sl	slight
slicks	slickensides
sps	sparse
ssd	soft sediment deformation
struc	structure
tab	tabular
t/o	throughout
w	with
X-bed/lam	cross-bedding/lamination

Minor components

anhy	anhydrite	kaol	kaolinite
ap	arsenopyrite	lim	limonite
bi	biotite	mg	magnetite
ca	calcite	mi	mica
chl	chlorite	mu	muscovite
cpy	chalcopyrite	ph	phosphate
daw	dawsonite	py	pyrite
ep	epidote	q	quartz
gl	glauconite	s	sulphur
gt	garnet	sel	selenite
gyp	gypsum	si	silica
hem	hematite	sid	siderite
H.M.	heavy minerals	zr	zircon

Matrix/cement

ar	argillaceous
ca	calcareous
chl	chloritic
fe	ferruginous
si	siliceous

Fossils

- leaves, general plant remains
- logs, wood
- roots
- algae
- burrow
- trail
- macroinvertebrates
  - pelecypods
  - gastropods
  - echinoderms
- microinvertebrates
- vertebrates
  - fish remains

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 8/8/90

Formation	Depth m (interval)	Textural name	Sorting	Composition (QFR or Grain type)	Minor compon.	Matrix/Cement	Colour	Dip	Remarks
	0 – 6.00	NO							OPEN HOLE NO RECOVERY. 6.00
MACKUNDA FORMATION	6.00 – 14.31	SS	g	sl		ar	/bn		Weathered, bedding gen. MASSIVE. 14.31
MACKUNDA FORMATION	14.31 – 23.67	SS/MS	g	sl			Mottled /bn gy	0°	V. rare shell frags t/o. num shell frags (innoceramus + others) 18.75-18.87m 0.5cm gy bands at 14.37, 18.95m Oblique fault/ fracture plane at 22.10m. 23.67
MACKUNDA FORMATION	23.67 – 50	SS	g	sl–la	mi	ar	lgy lgn		SS dominated interval. Bedding appears massive. Mica only in trace amounts. V. rare shell frags (innoceramus + others) over the interval 36.67 - base. (No conclusive evidence to suggest WINTON Fm other than lack of fine gr. sediments). gy-lgn MS at 46.12 m.

BASE of WEATHERING.

Depth: 10, 20, 30, 40, 50

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 9/8/90

Formation	Depth m	Textural name	Sorting	Composition (QFR or Grain type)	Minor compon.	Matrix/Cement	Colour	Dip	Remarks
MACKUNDA FORMATION	– 54.20	SS	g	sl-la	Mi	ar	lgy lgn		lam of shell frags at base. 54.20
	54.20 – 55.98	SL/MS	g				gy/gn	0°	rare shell frags t/o 55.98
	55.98 – 66.23	SS mnr MS	g	sl-la	Mi	ar	lgy lgn gy	0°	rare shell frags. t/o. Generally bedding appears massive. Mica only in trace amounts. 66.23
	66.23 – 100	sdy SL/MS	g	sl-la			lgy lgn gy	0°	Very minor vf. gr SS t/o. rare shell frags t/o. Some thin SS beds display small scale low angle X-beds t/o unit. Carbonaceous matter on bedding in pt. within zone 75.05 – 79.10 m. Common scours at base of sdy SL beds.

Depth marks: 60, 70, 80, 90, 100

Sheet : 2 of 27

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 9/8/90

Formation	Depth m	Lithology: Graphic	Lithology: Textural name	Texture: Grain size	Sorting	Sedimentary structures	Composition: QFR or Grain type	Colour	Dip	Remarks
MACKUNDA FORMATION	to 102.55		sdy SL / MS		g			lgy / lgn / gy	0°	102.55
	110–150		sdy SL / MS		g		sl - la	gy / lgy / lgn	0°	core is broken and fretted. Broken shell frags. t/o. rare thin SS beds have erosive bases (scours). 132.06 - 132.22 calcareous cement with cone-in-cone at top. 135.27 - 135.46 indurated, calcareous cement + cone-in-cone at top. 139.11 - 139.31 calcareous cement and cone-in-cone at base.

Depth marks: 110, 120, 130, 140, 150

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 20,25/6/90

Formation	Depth m	Textural name	Sorting	Composition (QFR or Grain type)	Colour	Remarks
MACKUNDA FORMATION			g			4cm coquinite at base. 151.33
		Sdy SL/MS	g	sl-la	lgy/lgn/dgy	r. shell frags t/o. Disturbed graded bedding in pt. (?bioturbated). 155.68-.86m indurated ?SL ē Ca cement. 157.07m inoceramus frag. 157.97
		Sdy SL/MS	g		lgy/lgn/dgy	? bioturbated interval. 159.35
	160	Sdy SL/MS	g	sl-la	lgy/lgn/dgy	load casts in MS's in pt. Rare - few shell frags t/o. ? Carbonaceous specks on bedding. Large burrow at 167.20 (sdy SL infilled). 168.87
	170, 180	SL/MS	g		gy/lgn	Few shell frags t/o. Carb. wisps & frags 180.86-.63m. Sediment is slightly churned (?bioturbated). Rare burrows. Graded bedding uncommon. First appearance of graded bedding at base of unit. 184.95
ALLARU MUDSTONE	190, 200	MS/SL	g		gy/lgn	Discont. vf slty SS beds/lam gen. disturbed. Unit becomes siltier twds top. f. shell frags t/o. Gen. more SL than underlying unit. 24cm Calcareous band ē syneresis cracks at 190.00m. Calcareous band at 187.39m (10cm)

Sheet : 4 of 27

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 20/6/90

Formation: ALLARU MUDSTONE.

Depth m (base)	Textural name	Sorting	Colour	BASE	Remarks
202.90					As above.
207.49	slty MS	g	gy/gn	S	Discont. vf slty SS beds/lam.
209.14	MS	g	dgy ?/gn	G	8cm calc. cemented SL at top. Few shell frags t/o.
234.80	slty MS	g	gy/gn	S	Discont. vf slty SS lam (< 1cm) rare. Few shell frags t/o, esp. concentrated in calc bands twds the base. Calcareous nodule (15cm) at 222.70m. 12cm calcareous band c ?synaresis cracks at 213.15m. ?pyrite halo at 214.24m.
235.05	LS (Ca)			S	c-in-c Calcite
235.41	MS		dgy	G	obl Ca vein
244.33	slty MS	g	gy/gn		Similar character as sediment over interval 248.25 - 271.38m.
248.25	MS	g	dgy ?/gn	G	Shell frags more common than in underlying sediment. lt bn calc. replacement zones twds top 3/4 at top.
	slty MS	g	gy/gn		Calc replace zones + c-in-c Ca twds top of unit.

Depth scale: 210, 220, 230, 240, 250

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 20/6/90

Formation	Depth m	Lithology: Graphic	Lithology: Textural name	Texture: Grain size	Sorting	Sedimentary structures	Composition: Minor compon.	Fossils	Colour	Visible porosity	Dip	Remarks
ALLARU MUDSTONE	260		Slty MS		g	laminated	Ca		gy/gn			Rare shell frags t/o. Rare w rd calc nodules up to 3cm top half of unit. Top half of unit virtually devoid of sdy sediments. Discont. vf slty SS lam basal half of unit (<5%). 1bn calc thin bed at 268.4 (?sec replacement). Abd-num carb lam 269.89-.94m. 6cm vf slty SS (lgy gy) at base of unit (first appearance)
	270											271.38
	280		Slty MS		g	laminated			gy/gn			Rare thin (1-2mm) Ca lam vary in orientation from 0-90°. Sec. Ca (?+Fe) carbonate replace irregular gy + lbn 287.90-288.11m. Some of the lbn bands react c HCl, others don't possibly suggesting variable amounts of Ca + Fe in the carbonates.
	290											
	300											

Sheet : 6 of 27

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain

Date : 13,20/6/90

Formation	Depth m	Textural name	Sorting	Minor compon.	Colour	Remarks
ALLARU MUDSTONE	to 315.11	Slty MS	g		gy lgn	Essentially same as underlying unit although lbn (?SD) bands are generally only found twds the base + are rare + not as well developed (ie not as sideritic as those below). V rare shell frags. Vf slty SS's are not as common as in unit below. 315.11
	315.11–333.87	Slty MS	g		gy lgn	Few-common lbn ?SD thin beds. Top of unit marked by such a bed. Few-rare Ca bands (commonly < 2cm) + commonly displaying C-in-C. MS is greener up. Overall unit contains few-rare lam of ?ripple bedded v.f slty SS. Shell frags are generally v rare. 333.87
	333.87–335.12	MS	g	SD Ca :	dgy	hard lbn SD band twds base. Ca bnds twds base 335.12
	335.12–350	Slty MS	g		gy lgn	V. rare shell frags. R. thin beds + lam of Ca (Some c-in-c) R. lgy sdy SL lam t/o, some of which displays ripple laminations

Depth marks: 310, 320, 330, 340, 350

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 12,13/6/90

Formation	Depth m	Textural name	Sorting	Colour	Remarks
ALLARU MUDSTONE		Slty MS	g	gy /gn	few-com. lbn ?SD thin beds. Mi on bedding in addition to ?carb matter (disseminated) 353.60
	360	MS v. mnr SL	g	dgy	few lbn indurated ?tuffaceous, ?SD thin beds t/o. R. calcite (c-in-c). Core is fretted. Few lam lgy sdy SL twds base. 364.78
	370, 380	MS/ sdy SL	g	dgy/ gy /g	Generally same as underlying unit, although sdy SL is less common. Few - com lbn thin beds (same as underlying unit). C-in-c LS at 366.76, 368.56, 369.72, 372.50, 373.81, 376.00m. Shell frags at 367.71, 368.79. R. Mica t/o. 382.83
	390	MS/ sdy SL	g	dgy/ gy /gy	Rippling evident in some sdy SL lam. Innoceramus frags at 388.44, 388.63, 389.43, 390.89, 392.36, 393.10m. Few lbn thin beds indurated, ?tuff, ?SD. Ca at 383.04, 386.76 m. 394.66
	400	MS mnr slty MS	g	dgy gy	Com thin beds lbn ?tuff SL (sl calc ip) t/o unit. Bedding lam in dgy MS. Core is fretted.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 29/5,12/6/90

Formation	Depth m	Textural name	Sorting	Colour	BASE	Remarks
ALLARU MS.		MS/ mnr slty MS	g			Ca band at 401.90m Innoceramus frag at 401.41m. 1cm SL at base 402.68
ALLARU MS.		MS/ mnr slty MS	g	dgy -bk / dgy		Core very broken. Few thin bds dgy SL throughout. ?Innoceramus frag at 402.95m. GY slty MS at base. 408.24
TOOLEBUC FORMATION.	410, 420	Shelly MS	g	dgy -bk		?Innoceramus frag abundant t/o. Abundance decreases towards top. Rare shell fragments in basal 0.5m of interval. 424.92
TOOLEBUC FORMATION.	430	MS	g	dgy bk	S	Few shell frags. Py nodules up to 2cm. General lack of Innoceramus frags - generally a uniform MS. Abundant brown ?shell frags at base. 433.32
WALLUMBILLA FORMATION.	440	MS/ SL	g	dgy gy / gy lgy		SL's are sdy + variably calc i.p. Minor ?soft sed deformation ?burrow at 440.21m Rare small PY nodules on bedding. 444.69
WALLUMBILLA FORMATION.		MS	g	dgy		Rare ?shell frags. Rare PY nodules. 449.32
	450	NO				68cm CORE LOSS.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 28,29/5/90

Formation: WALLUMBILLA FORMATION

Depth (m): 460, 470, 480, 490, 500

Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Remarks
MS	g				dgy		OPEN HOLE. 450.10 Few py nodules. 452.49
MS/ mnr SL	g				dgy gy		Rare graded beds to ~ 461m. Calc lbn thin bedded SL at 453.37, 454.82 + 456.70m (com. c̄ vert. Ca veins). lbn ?diagenetic pods, sl calc, some cont. Shell frags at 459.37, 460.82, 460.95 m. Some SL beds disp. rip lam. Shell frags + ?ammonites at 459.06m R. py t/o 466.67
sdy SL/MS	g		?gl		gn gy dgy		Sdy SL less com twds top. SL calc i.p. 468.63
MS	g				dgy		Tending to slty MS at base of graded beds 470.08
MS	g				dgy		Gen. a uniform MS. Ca lam at 471.34, 471.38, 472.16 m. ?micromicaceous. Py nodules 472.83 - 473.75m, 474.50m. Ca on obliq joints twds base. 482.10
MS SL	g		gl	Ca	gy gn dgy	s	Faulted + Ca veins top 34 cm. R. py. 483.54
MS/ SL	g				dgy gy		R. ca cm lam + lenses Calc ?nod. at 486.35m. ?Gl in some SL lam. R. mica. 487.97
SL/ MS	g	?gl	Mi	Ca	gy gn dgy		Few py nodules Greenish tinge to SL. Churned intervals ?bioturbated. Sdy gl SL lam twds 492.89m. pbl CG at 492.89m. 495.05
SL/MS	g	?gl	Mi		gy dgy		burrow at 496.20m. 496.33
SL/ MS	g				gy dgy		SL sl gl. Py as lenses + nodules. SL has calc cm i.p. 498.18
MS/SL	g	?gl			dgy gy		SL com gl + i.p. pyritic.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 25,28/5/90

Formation: WALLUMBILLA FORMATION

Depth markers (m): 510, 520, 530, 540, 550

Textural name	Sorting	Minor compon.	Colour	BASE	Dip	Remarks	Base depth (m)
AA							500.43
SL/MS		gl	gy gn / dgy			Py present	501.90
MS	g		dgy gy		~H	R. py nodules, lenses in SL. R. gl in SL. Poss. C-in-C LS at 509.15m. 1bn calc SL at 506.90m (thin bed).	511.32
MS/SL	g		dgy gy				512.72
MS/v mnr SL	g		dgy			Thin beds 1bn calc SL at 515.02, 520.27, 521.17m. ?Innoceramus frags at 517.50, 520.25, 520.33, 521.16m. ?Gl present in some SL. R pyrite.	522.08
MS/SL			dgy gy				522.46
MS/mnr SL	g		dgy gy			Rare pyrite.	528.40
MS/SL			dgy gy			Rare Pyrite.	529.90
SS	g	gl	gy gn				530.18
MS/SL	g	gl mi	dgy gy			?Slump at top + into overlying unit. Few shell fossils.	533.45
MS	g		dgy			Evidence of graded bedding in pt t/o unit. R. shell fossils. R. obliq slicks; ca on some. ?Belemnite at 541.85m.	543.34
SS	f	gl	gy gn	G		?Belemnite at 546.59m. Bedding indistinct due to SSD.	546.99
MS/SL			dgy gy	S	H		547.70
sdy/SL		gl	gy		H	Slight greenish tinge.	

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 19,25/5/90

Formation: WALLUMBILLA FORMATION

Depth markers (m): 560, 570, 580, 590, 600

Textural name	Sorting	QFR or Grain type	Minor compon.	Colour	BASE	Dip	Remarks
Sdy SL					G		551.02
MS SS	g f		gl	dgy bk, gy gn	S		552.34
SL MS	g			gy bk	S		553.24
SS	g				S		553.92
MS SS	g			gy bk	S		554.89
MS SL	g			dgy, gy	G	H	Lenticular bedding, r obliq slicks, 1bn calc, hard SL band 557.17-.23 m. 557.66
MS SS	g p		gl	gy gngy	S		Lent. bedd twds top. 558.69
MS	g		gl, gl	dgy, dgy gy	G		SS dykes 562.00-562.80. MS core is fretted, bedding style difficult to distinguish. Calc. hard band 563.00 - 563.10 m, 564.09 - 564.22 m. R ca filled joints. Shell frags 568.00. Microfaults 564.72. 570.13
MS	g		gl, gl	dgy	G		Lenticular bedding i.p. twds top. ?tuff 578.28-.31 m (dist. bedd, SSD). Dist. bedd, SSD 581.95 - 582.25 m. Dist. bedd SS c bn SL clasts at 582.50 - 582.56 m. ?Gl + ca on obliq joint, minor slickensiding 583.11 - 583.39 m. Graded beds 583.39 - 584.85 m. 585.79
mdy SS	p		gl	dgy gn	G		? green mineral 586.56
MS	g, p			dgy			R. slicks, r thin v.f SS lenses. Ca on some slicks. slty matrix. 596.70
SS		q	gl	lgy	E		597.61
MS			Py	dgy			SL lenses. 598.30
SS	f	q		lgy			599.14
SS	f	q		lgy			few CL frags. t/o.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 19,20/5/90

Formation: HOORAY SANDSTONE

Depth (m)	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	Base	Remarks
to 606.94	SS	f	q			lgy gy		Beds defined by g. size variance. 606.94
606.94–609.64 (610)	CG	p	q		Ca	lgy gy	E	Co frags t/o. 608.33m w.r. q pbl. wr g pbls twds base. 609.64
609.64–614.16	SL v mnr MS			py		gy	G	Few small sc. faults Few plant frags Load casts 610.20m Few dgy MS beds (5-15cm). M. root twds b. 614.16
614.16–616.20	SS, SL	f-g	q			lgy gy	E	SL + carb lam depict SS beds. 616.20
616.20–622.01 (620)	SS	f-g	q		mnr Ar	lgy	E	ripple lam top 40cm Num wr pbls basal 40cm. 622.01
622.01–632.59 (630)	SS	f-g	q		Ar	lgy	S	R carb lam t/o. R wh Mi t/o (More com. on carb lam) Beds defined by g. size variance. SS filled burrow in SL lam at 630.54m. 632.59
632.59–634.55	SS	f-g	q			lgy		SS appears massive bedded, f. carb lam 634.55
634.55–636.12	SS	f	q	Mi	Ar	lgy		R coal frags. Mi on slty + carb lam. 636.12
636.12–637.19	SS	f	q			lgy	E	Carb lam. Pbls + rock frag at base. 637.19
637.19–639.68	SS	g	q	Mi	Ar	lgy	S	ripple x lam ip ?massive bedding A. carb lenses base 639.68
639.68–649.27 (640)	SS	g	q			lgy	S	Few coal + slty frags t/o R qtz pbls. 4cm pbl band 15cm above base. 649.27
649.27– (650)	CG							qtz + SS clasts.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 20,22/5/90

Formation	Depth (m)	Textural name	Sorting	Composition	Fossils	Colour	Base	Dip	Remarks
HOORAY SANDSTONE		CG / SS	p	Ar		lgy	s		6cm CG band twds base. 651.53
		MS / sdy SL				dgy / gy		~0°	MS carb. Num co frags in SL. Slicks in MS 652.81
		SS	g	Ar		lgy	s		Beds defined by g. size variation. X-bed truncation at 654.77m. Ripples + rip xlam 657.62 – base. 657.95
	660	SS	g			lgy	s		SS thickly bedded 659.22 – 662.79m. Num gy SL clasts 662.75 – 662.94m. Beds defined by g. size variation. 659.70 coaly wood frags. Small scale x bed at 664.67m. 665.90
		SL/SS/MS		Mi		gy / lgy / dgy	G	h	V poor φ. 8cm dgy MS at top (carb). 15cm loss at 667.35m. Burrow at 668.33m. 669.41
	670	SS				lgy		h	Mica on carb ripple X lam t/o. Ripple X lam increase twds base. 672.81
	680	SS	f-g			lgy	s		Bedding appears massive. X beds defined by g. size variation. 4 cm qtz peb CG at 680.56m. Few thin SL beds 679.78 – 682.25m. Co frags 682.50 – 683.35m. Peb. CG 683.27 – .53m. Angular SL clasts at base. 684.24
WESTBOURNE FORMATION	690, 700	MS/ slty SS				dgy / lgy		h	Thin beds of slty SS (lbn - gy) possibly tuffaceous at 686.48, 688.43 + 693.50m. Synaresis cracks (?clay filled) at 693.50m. Ripple lam evident in slty SS + SL t/o unit. Rare burrows are SS filled. Slty SS (lbn-gy) ?tuffaceous + calc 700.88 – 701.00m.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 23,24/5/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Fossils	Colour	Base	Dip	Remarks
WESTBOURNE FORMATION.	710	MS/ slty SS			Mi			dgy lgy	G	h	Scours com. t/o, some ssd, micro faults gen assoc. c̄ ssd. F. grained mi com t/o. Obvious lack of plant remains, coal, macroflora. Lbn slty vf SS, non calc c̄ vert Ca veins 709.80 - 709.88 m. (? tuffaceous). Scours + micro-faults are more common twds base. 717.94
		slty SS/ MS						lgy gy			Microfaults. SS filled burrow at 718.12 719.41
ADORI SANDSTONE.	720	SS	g	q	Mi	Ar Ca		lgy		?h	Minor SL t/o 10 cm SL at base. 723.75
	730	SS	g f-g	q				lgy	S		730.96
BIRKHEAD FORMATION.		SL						gy			slicks at base. 732.39
		SL/SS		q-sl				gy/lgy			Carb frags in SL, few in SS. 733.72
		SS/SL	g	q-sl	Mi	Ar		lgy gy			Carb X lam in SS below rooting. 735.25
		SS	g	q-sl				lgy			Ang. SL clasts at 735.58m. Poss. med scale x beds. Bedding ? massive. 738.31
	740	SS	g	q-sl				lgy			Plant remains in SL SS appears massive. 740.52
	750	SS	g	q-sl				lgy			Carb x lam 742.25 -.80 m, 749.10 m. Gen. SS appears massive SS is tight c̄ poor ϕ.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain

Date : 24-26/5/90

Formation: BIRKHEAD FORMATION

Depth (m) markers: 760, 770, 780, 790, 800

Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Fossils	Colour	BASE	Dip	Remarks
SS	g f	q-sl		Ar		/gy	G E		Carb Xlam 752.50 -.58 m. Limits of X bed sets not obvious. SS appears massive. Few coal grains. SL clasts twds base. 755.89
SS	g	q-sl				/gy	G		SS disturbed ?faulted 756.57, 756.72-.86 m. R carb ? X lam 756.31 - 757.03 m. Definate lack of obvious bed bound. SS appears massive. CO grains as minor grain constituents. 764.89
SS	g f-g	q-sl				/gy	E		CO frags upper + lower parts of unit. Thin qtz, peb. CG bands at 766.50, 766.74, 766.98, 767.13 + base. 768.80
sdy SL SS	g		Mi	Ar		gy	G		Minor v.f. SS, plant remains on bedding t/o. Block slumping top 0.8 m. num. plant remains in basal SS. 774.36
SL/SS	g					gy /gy	G	?h	Num plant remains t/o. Few obl slicks c̄ associated wh clay. 777.31
SS/SL	g					/gy gy	S		Num plant remains t/o. Carb x lam twds base of unit. 780.50
SS	p	q-sl		Ar		/gy			Abund. coal frags & SL clasts t/o. 782.86
SS/CG						/gy gy			Ang. gy SL clast CG. 783.49
SS		q-sl				/gy			Few coaly frags basal half of unit. 786.73
SS	p f	q-sl				/gy			Num. coaly frags to 787.30 m. 790.43
SS	f-g	q-sl				/gy			Few carb x lam. 792.06
SS	f-g g	q-sl				/gy	S S		Few coaly frags Ang pbl sized gy SL clast at 793.94 m. 796.45
SS	g	q-sl				/gy			R carb x lam, r ?garnet. Bedding appears massive - thickly bedded.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 27,28/5/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Remarks
BIRKHEAD FM.		SS	g	q-sl		Ar	lgy	S	Few ang gy SL clasts at 801.15m 801.50
		SS	f	q-sl			lgy	?E	SL clasts basal 30 cm. 802.29
	810	SS mnr SL	g	q-sl			lgy	S	Poor φ. Num SL clasts 804.19-804.77m. Thin beds of SL clasts at 806.19, 806.64, 807.71, & 808.34 Ripple lam twds base. 809.83
HUTTON SANDSTONE.		SS	g	q			lgy		SS appears thickly bedded. R carb plant remains. Rare garnet. 812.98
		SS	g	q			lgy		Common carb lam. 815.00
	820	SS	g	q			lgy	S	R. garnet t/o SS is med-thickly bedded. Few thin-med beds of v.f. SS c̄ carb lam. Few coaly frags 817.95-818.51m. 826.23
		CG		q			lgy	E	Abundant gt in part, r t/o 827.48
		SS CG	g f	q			lgy	S	Erosive base probable. 828.20
		SS	f	q			lgy	S	829.13
	830	CG	p	q			lgy	S	R coaly frags 829.99
		SS/SL	g		Mi		lgy gy		Plant frags on bedding. 833.05
		SS	f-g	q			lgy		carb x lam t/o R garnets. 834.72
		SS	f g	q			lgy	E	R coaly frags. 836.25
	840	SS	f-g	q			lgy	S	V rare garnets t/o SS appears thickly bedded 839.80-842.86 m 843.02
		SS	f p f	q			lgy		F. coaly frags. R. garnets t/o. 846.05
		SS	g	q			lgy		Bedding appears thick-massive. R garnet t/o 849.49
	850	SS	g				lgy		

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 28,30/5/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Dip	Remarks
HUTTON SANDSTONE		SS	g f-g p	q			/gy			SS generally thickly bedded. R. garnets t/o. Carb frags 851.50–851.84 m, + 854.63. CG basal 15 cm. 855.34
		SS	g f	q-sl	Mi		/gy	-s	h	Few carb x lam. Thin bedded f-c SS at 857.75m 857.85
	860	SS	g	q-sl			/gy			Thickly bedded. 859.78
		SS	g	q			/gy	s		7cm slty ms clast at 879.91m. SS is gen. thickly bedded. 863.03
		SL/SS	g	q-sl	Mi		gy /gy	s		Thin bedded i.p. CO frag. at base. 867.44
	870	CG/SS	p	q			/gy			conglomeratic i.p.. 870.40
		CG	p	q			/gy			Grain support. 871.16
		SS/CG	f-p	q			/gy	s		A. co frags t/o 873.18
		CG/SS	f	q			/gy	s		CO frags twds top. Grain supported co frags + carb lam basal half. 876.00
		SS	f-g	q	Mi		/gy			Com. carb lam. F. co frags. 878.08
	880	CG	f	q			/gy	E		?Thickly bedded. SL clasts at base. 880.77
		SS SL	p f-g	q	Mi	Ar	/gy cm	-s	h	ϕ in VC SS. Cm - wh clay as matrix. Notable absense of plant matter. 884.00
		SS CG	f p	q		Ar	/gy cm			Lam of coarser SS. 888.60
	890	SS	f p	q			/gy cm	E		Few thin beds of coarsar SS. SL clasts at base. 894.30
REWAN FM.		SL SS	f-g	q	Mi	Ar	/gy cm	E		SL clasts 895.97
		SL/SS	g		Mi		gy/ /gy			SS is mod bedded Py nodule at 896.83m Carb plant remains in SL twds Base 898.36
		SS	f-g	q		Ar	/gy cm	E		Ab. SD grains twds top. 899.38
	900	SS/SL	g		Mi		gy gy			SD grains twds top.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 12-14/6/90

Formation: REWAN FORMATION

Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Dip	Remarks
	SS/SL	g		Mi		lgy gy			Few SD grains up to 2cm t/o Common f-m g SD grains in gy SL at base. 905.69
	SS	f-p	q-sl		Ar	cm lgy			SS beds defined by grain size variance. 907.75
910	SS/SL	g	q-sl			cm lgy gy			SS's are non-calcareous. 910.88
	SS	p	q-sl			lgy cm	E		V poor φ, V slight Ar matrix, SS becom conglomeratic. 913.16
	SL	g		Mi		gy			914.45
	SS	p	q-sl		Ar	lgy cm	S		CG in pt. Few platy gy SL clasts twds base. 916.00
	SL	g		Mi		gy	S		SS content incr. twds base. 917.15
	SS	f p	q		Ar	lgy cm	S		V.slight Ar matrix V.slight φ, CG in pt. 919.63
920	SS	g	q-sl			lgy cm	S		Med-thick bedded V.slight Ar matrix V poor φ. 925.04
930	SS	f-p	q			lgy cm	S		Slight φ, slight Ar matrix. Py nodule at 928.46m. 930.85
	SS/SL	g	q		Ar	lgy cm	S	h	lam gy SL at top 932.68
	SS	g f	q			lgy cm	E		Platy gy SL clast at base. 934.64
	SS	g bi g	q	Mi		lgy			Ab. SL clasts twds base 937.68
	SL	g				lgy	G		939.34
940	SS	g	q	Mi	Ar	lgy	S		Slty lam 939.95-940.05m. Brown grains top 1.35m. Carb X lam at 940.69, base. 943.10
	SS	f-g	q			lgy	E		Com co frags top 0.19m. SL clasts i.p. 945.26
	SL	f-g		Mi		gy lgn	S		946.90
	SS	g	q		Ar	lgy	E		SS appears thickly bedded. 948.40
950	SL/SS	g				lgy gy		h	few SS filled burrows.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain

Date : 14,15/6/90

Formation: BETTS CREEK BEDS

Depth m: 950.05 (top); 960; 970; 980; 990; 1000

Textural name	QFR or Grain type	Minor compon.	Matrix/Cement	Flora	Colour	BASE	Dip	Remarks
SS	q-sl	Mi	Ar		lgy	S		10cm gy SL at top, thickly bedded SS elsewhere. W.R SL pbls at 952.82, 954.23 954.67 + twds base. Ang gy SL clast at 952.26m. 955.88
SS/SL	q-sl				lgy gy	S		?opposing ripples at 756.71m. 957.67
SS	q-sl				lgy	S		SS thickly bedded. Carb matter on some Xbeds twds top 959.64
SS	q		Ar Ca		lgy	S		960.91
SS	q				lgy	E		Thickly bedded. V slight φ Becoming CG i.p. 964.10
CL/cm					bk			Dull + bright banded. 965.50
MS/SL		Mi			bk dgy gy			Cm at top. Brown matter at 965.70m. 966.90
SS					lgy			Num carb rip X lam. 967.72
SL SS					gy dgy			Brown matter at 968.30m. V minor vf lgy SS lam t/o. ?bioturbated. 971.14
SS	q-sl		Cal Ar		lgy	S		Num Rip xlam 972.83 - base. Brown matter in gy SL at 972.81m 974.66
CL					bk			Dull + br banded, ?tuff MS. 975.77
SS/SL	q		Ar		lgy	S		com. carb lam vf SS's are laminated. 980.14
CL/cm MS					bk dgy			Dull c̄ br bands. Com. lbn matter in coal. ?tuffaceous MS. 982.41
					bk			Dull/inferior. 983.00
CL					bk			Dense inferior co at top. 985.13
SL/SS		Mi			gy lgy		h	?SEAT earth at top. Brown matter twds top. Bedding is sl. disturbed. 988.43
SS	q		Ar		lgy	E		Few co frags + cm clasts in vc SS. 991.78
SS	q	Mi			lgy			Com carb X lam. 993.44
SS	q				lgy	E		V sl φ. Carb matter on r. lam. Co frags 40cm from top. Pebble CG towards base. 999.07
CL					bk			Dull coal

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 15-17/6/90

Formation: BETTS CREEK BEDS (to 1044.55 m); ARAMAC C.M. (below 1044.55 m)

Depth m: 1010, 1020, 1030, 1040, 1050

Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Fossils	Colour	Base	Dip	Remarks
CL						bk			Broken core, inferior i.p. 1001.30
SL						gy dgy	S		Vert. joint t/o. Carb twds top. 1002.64
SS	g f-g f	q-sl	Mi	Ar		lgy	E		carb material on few X beds. 1006.70
SL SS	g					lgy dgy	E		CM at top. Fining up. Plant remains on bedd. Pbls at base. 1008.63
MS	g					bk			Carbonaceous 1009.06
CL						bk			inferior twds top Dull coal 1010.08
SL SS	g					dgy lgy			Thin coal twds top Burrow at 1011.50 (SS filled) 1012.22
SS	g	q-sl		Ar		lgy	S		M.g. SS is thickly bedded CL lam at 1015.67 m. 1016.51
CL						bk			Jointed top Dull coal. 1017.55
SS	g	q-sl		Ar		lgy			Jointed + slicked at base. Num carb lam top 1.6 m + abundant basal 45 cm. 1021.08
SS	f	q				lgy	E		Abundant carb lam i.p. CL frag at 1021.50 m. 1023.88
SS	g	q				lgy	S	h	CL lam at top + at 1025.40 m. Com. carb lam t/o. 1026.40
SS	f-g	q				lgy	S		Thin beds of mg SS contain carb lam. V.c. SS is med-thick bedded. 1030.14
CL CM SS SL						bk lgy	S		1031.20
MS SL	g					dgy/lgy	S		1032.02
SL SS	g		Mi	Ar		dgy/lgy	S		H bn m-c grains in SL twds base. 1033.21
SL SS	g					dgy lgy	S		Thin CL lam at top. 1034.60
MS/SL	g				Ø	dgy			1035.25
SS	g	q-sl	Mi	Ar		lgy	S		Com carb lam + traces t/o V. poor ϕ Mica on carb lam + in finer SS's 1040.25
SS	g f	q				lgy			SS thickly bedded V. sl. ϕ 1041.85
CL						bk	S		Dull, broken 1042.58
SL CG	g					dgy	E		1043.61
CL						bk			Dull 1044.00
SS	p	q		Ar		gy			1044.55
SL/SS	g					dgy lgy			?ripple X-beds at 1046.29 m.
SS	g					lgy	S		
SS	g	q		Ar		lgy			13 cm CL at top

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 17,19/6/90

Formation: ARAMAC COAL MEASURES

Depth (m) marks: 1060, 1070, 1080, 1090, 1100

Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Remarks
CL							1050.02 Inf. CL at base. 1050.48
SS/SL	g	q		Ar	lgy dgy	G	SL is lam, SS is thin bedded (med bedded i.p.). 1053.10
SL	g				dgy	E	V. mnr SS. 1055.22
SS	g f	q	Mi	Ar	lgy	E	?Churned SL at top. Mi on r. carb lam in vf-f SS. 1059.35
SS/SL	g				lgy-bk	S	1060.15
					dgy bk		40 cm dull CL. 1060.96
SS	g	q	Mi	Ar	lgy	E	Mica on rare carb lam. 1063.40
SL SS	g	q		Ar	dgy bk lgy	?E	3 cm CL at top + at 1063.96m. Disturbed lam. 1065.97
CL					bk		Dull CL. 1066.41
SL SS		q		Ar	dgy lgy	G	1068.02
CL					bk		1068.37
SS/SL		q	Mi	Ar	lgy dgy	G	SS ?flaser bedded SL is lam + SL incl tuds top. 1070.58
SS CG SS CG	g g b g b	q-sl q Li			lgy Mo lgy Mo	E	SS thickly bedded in pt, possibly flaser bedded in pt. Some igneous w.r. pebbles in CG 1074.45 - 1074.92m. Sed + igneous + few meta pbls in basal CG. 1080.49
CL					bk		Dull, lbn SL i.p. 1081.11
SL	g				gy	S	Dgy MS at top. 1082.22
SS		q-sl		Ar	lgy	E	~ nil φ. Com. mi on r. carb lam. F.-rare CL frags t/o com at base. w.r. pbls at base. 1086.64
?SL/SS					dgy/gy	S	cm at top. 1087.31
SL	g	q	Mi	Ar	lgy gy	S	11 cm dull CL at top. Com carb r.p x lam t/o. 1089.10
SS	g	q-sl			lgy cm	E	Com CL frags in CG beds. w.r. ign. pbls at base. 1092.62
SL	g		Mi		gy	G	8cm CL at top. 1094.09
CL					bk		Dull CL. Lam SL tuds top. 1095.18
SL CM SL	g		Ca Ca		gy bk dgy	G G	?Tuffaceous seds in part. 1097.47
MS			Ca		bk dbn		CM - inferior/dull CL in pt. SL tuffaceous.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 19,20/6/90

Formation: ARAMAC COAL MEASURES

Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Dip	Remarks
	mnr CL MS SL					bk gy bn bk dgy	S	<5°	IB bk MS grading to dull (high ash) or inferior coal. Abundant gy, bn, gn ms'o ? tuffaceous. Inferior CL twds base above SL. 1105.65
	MS					bk	G		1106.29
	CL					bk			Dull, inferior CL twds top, minor bn MS. 1108.31
	SL/SS	g				gy lgy	G		1109.02
1110	SS	g	Sl	Mi	Ar	lgy			Few carb Xlam Med-thickly bedded Mi on carb lam. 1111.80
	mnr SL SS	g	Sl			lgy	G		5cm CL at top. V.rare orange/red grains. SL clasts + CL frags twds base. 1117.25
	CL					bk			Dull few br bnds 1117.95
	SL SS	g		Mi	Ar	gy lgy			Thin CL lenses twds top. 1119.63
1120	SS	g	q-Sl			lgy	G		SS thickly bedded. Virtually nil φ. Abundant Mi on rare carb xlam. Ang. gy SL clasts at 1121.95m. 1125.45
1130	SS	g	q-Sl			lgy	?E		Num carb Xlam top. SS generally thickly bedded. V.rare red and green grains. 1131.95
	SS	g	q-Sl			lgy	S		8cm dull/inferior coal at top. W.r. volcanic pebbles at 1132.11m. SS is med-thickly bedded. 1139.07
	CL					bk			Dull, f. br bnds 1139.37
1140	SL SS	g	Sl			gy lgy	G		Thin coal in pt. 1140.78
1150	SS	g	q-Sl	Mi	Ar	lgy bk			Mica abundant on r. carb Xlam t/o. V.rare red/brown grains + trace pyrite. 7cm CM at 1149.77m.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : GSQ Muttaburra 1

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain Date : 21,22/6/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Dip	Remarks
ARAMAC COAL MEASURES.		SS	g	sl		Ar				Cm & SL clasts twds top 1151.13
		SS	g	sl			lgy	S		SL clasts twds top. 1152.24
		cm SS/SL	g				bk lgy gy dgy	S		cm is bioturbated. SL as thin lam dgy SL is bioturbated in part. 1155.87
		Co SL SS	g				bk gy lgy	G		17 cm dull coal at top. Fining upwards. 1157.43
	1160	SS mnr SL	g	sl	Mi	Ar	lgy	?E		SL lam are disturbed. Few carb lam. SS appears to less qtz content. 1161.65
	1170	SS	g	sl			lgy	?E		SS med-thickly bedded, few carb xlam c̄ mica. 11 cm lam SL at top. Gy SL clasts at 1164.66, 1167.42 m. CL lenses < 4mm at 1164.66, 1164.85, 1167.06 m. Gy SL clasts 0.65 & 0.19 m from base. 1171.80
		CM cl					dgy bk	G		Mnr gy SL 1172.65
		SS/SL	g				gy gy	G		1173.79
		SL	g				gy	G		1174.45
		SS/SL	g				gy gy	S	<5°	1175.21
		SS	g	sl	Mi	Ar	lgy	S		SS is generally thickly bedded. Visible φ is Nil. ?Erosive base. 1179.63
	1180	SL	g				gy dgy	G		12 cm dull inferior CL 13 cm from top. 1181.11
		SS mnr SL	g	sl	Mi	Ar	lgy dgy	S		Microfault at 1183.90 m. Num SS filled burrows. Com thin-discont. dgy SL lam below bioturbated zone. 14 cm lam dgy SL at base. 1187.27
	1190	SS	g	sl			lgy	S		Thick-massive bedding. Few silty MS clasts basal 0.35 m. 1191.20
		SL/SS	g				dgy gy	G		1192.57
		SS	g	sl	Mi	Ar	lgy			?Root traces top 25 cm. Bed boundaries not distinct, thickly bedded. 1196.92
	1200	SS	g	sl			lgy lgn			Thick-massive bedding.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain   Date : 22,23/6/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Flora	Colour	BASE	Dip	Remarks
ARAMAC C.M.		SS	g	sl	Mi	Ar		lgy lgn	E		W.r. vf SS clast at 1202.82 m. 1cm pbl band at 1203.95m. 13 cm pbl CG at base 1206.76
ARAMAC C.M.	1210	SS CG	g f p	sl lt/la				lgy lgn	E		Med - thickly bedded. Dbn MS 1211.54 - 1211.59m. Virtually nil ϕ. 1212.36
JOCHMUS FORMATION (UPPER)		SL	g					gy/lgn	?E		Ang gy lgn clasts (SL) basal 14 cm. 1214.91
		SL SS	g	sl	Mi	Ar		gy/gy/lgn	G		Root traces, massive - thick bedded. 1216.66
		SL/SS	g					"	S	<5°	1217.30
	1220	SL mnr MS	g	la		Ar	x ?x	gy/lgn	?E		CM 31cm from top Root trace below cm. 1221.53
		SL SS	g	la		Ar		lgy gy lgn	?E		Microfaulted i.p. 1223.80
		SL	g					gy/lgn	G		Minor SS 1225.13
	1230	SS	g f	la f	Mi	Ar		lgy lgn	E		Med - thick bedded. Lam of carb wisps at 1235.38m. Virtually nil ϕ. 1230.05
		SL SS	g	la				lgy lgn	G		1232.17
		SS	g	la				lgy/lgn	?E		Thick - massive bedding carb lam 32 cm from base. 1234.67
		SL	g					gy dgy lgn	S		1237.08
	1240	SS	g	la f				lgy lgn	S		Trace orange/bn grains nil ϕ, thick - massive bedding ?Erosive base. 1240.62
		mdy SL	g					dgy/lgn	G		1241.93
		SS	g	la f	Mi			lgy/lgn	G		Thickly bedded. 1244.53
	1250	SS	f g	la f				lgy lgn			Trace or/bn grains Gy/gn SL pbl sized angular clast at 1249.11m. Med - thickly bedded

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

Hole : **GSQ Muttaburra 1**

Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

Logged by : T.J.Brain

Date : 23-25/6/90

Formation	Depth m	Textural name	Sorting	QFR or Grain type	Minor compon.	Matrix/Cement	Colour	BASE	Dip	Remarks
		SS	f-g	la f			lgy lgn	S		CL lam, lenses 1250.45 – 1250.62 m. SL clasts at 1250.50, 1254.08 m. 1254.53
		MS	g			Si	gy gn	G		Rd zeolites. 1255.16
		TF(MS) SL	g		Ze		rd lgy cm	S	0°	Rd colour fades twds top. 1cm cm TF at base. Dist. bedding i.p. 1258.35
	1260	MS	g		Ze		lgy gn rd	S		?lensoidal lam depicted by colour variation at 1259.39 m. 1260.97
		SS	g	la f		Ar	lgy	G		Thickly bedded Rd colour i.p.. Carb lam 1264.43 m. Tuffaceous matrix i.p. 1264.49
	1270	SL	g			Si	lgy (MS dgy)	G		Massive c̄ thin lenticular bedding i.p. Rd grains in some vf. SS. Com. carb flecks t/o. 1271.48
EDIE TUFF MEMBER		SS	g	la f	Mi	Ar	lgy	E		Sl rd mottling. SL clasts base 1272.70
		SL	g			Si	lgy gy lgn (rd i.p)	G		Rd tinge twds top. SL clasts 1274.93 m. Bedding not well defined. Rd grains 1274.62 – .93 m. 1277.05
	1280	SS	g	la f		Ar	lgy	S E		thickly bedded. SL clasts at base. 1279.70
		SS	g				lgy	S		1280.31
		SL SS	g	la f		Ar	lgy gy	G ?E	0°	Carb matter i.p. Lent. lam 1282.09–.27 m. Rd colouration 1281.59 – .67 m. 1283.27
		SL SS/SL	g f			Si	dgy lgy lrd	?E		Plant frags, Rdish lam i.p. Num CL frags twds base. 1286.72
		SL SS	g f		Ze	Ar	gy rd	S		1287.92
	1290	SL	g			Si	gy gn rd i.p	G		Bedding poorly developed (churned i.p) Tuffaceous at 1289.80 m. 1292.02
		SS/SL	g				gy gn	E		Rd tinge top 54 cm. 1293.24
		MS/SL	g		Ze Mi	Ar	dgy gn	G G		1294.79
JOCHMUS FM (L)	1300	SS	f-g	la f			lgy			Massive bedding. Bn + wh mica.

GSQ STRATIGRAPHIC DRILLING LITHOLOGIC LOG

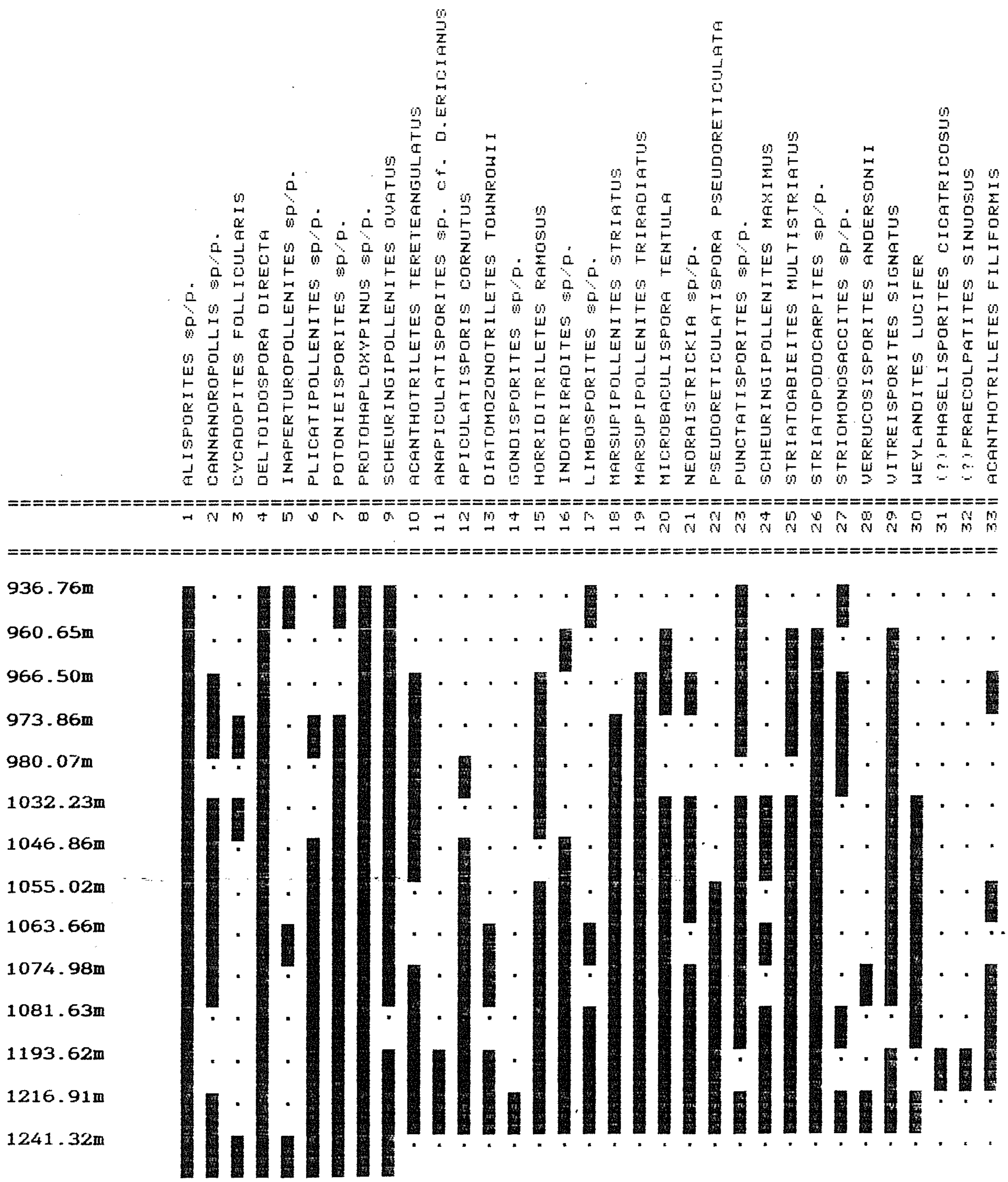
Hole : **GSQ Muttaburra 1**

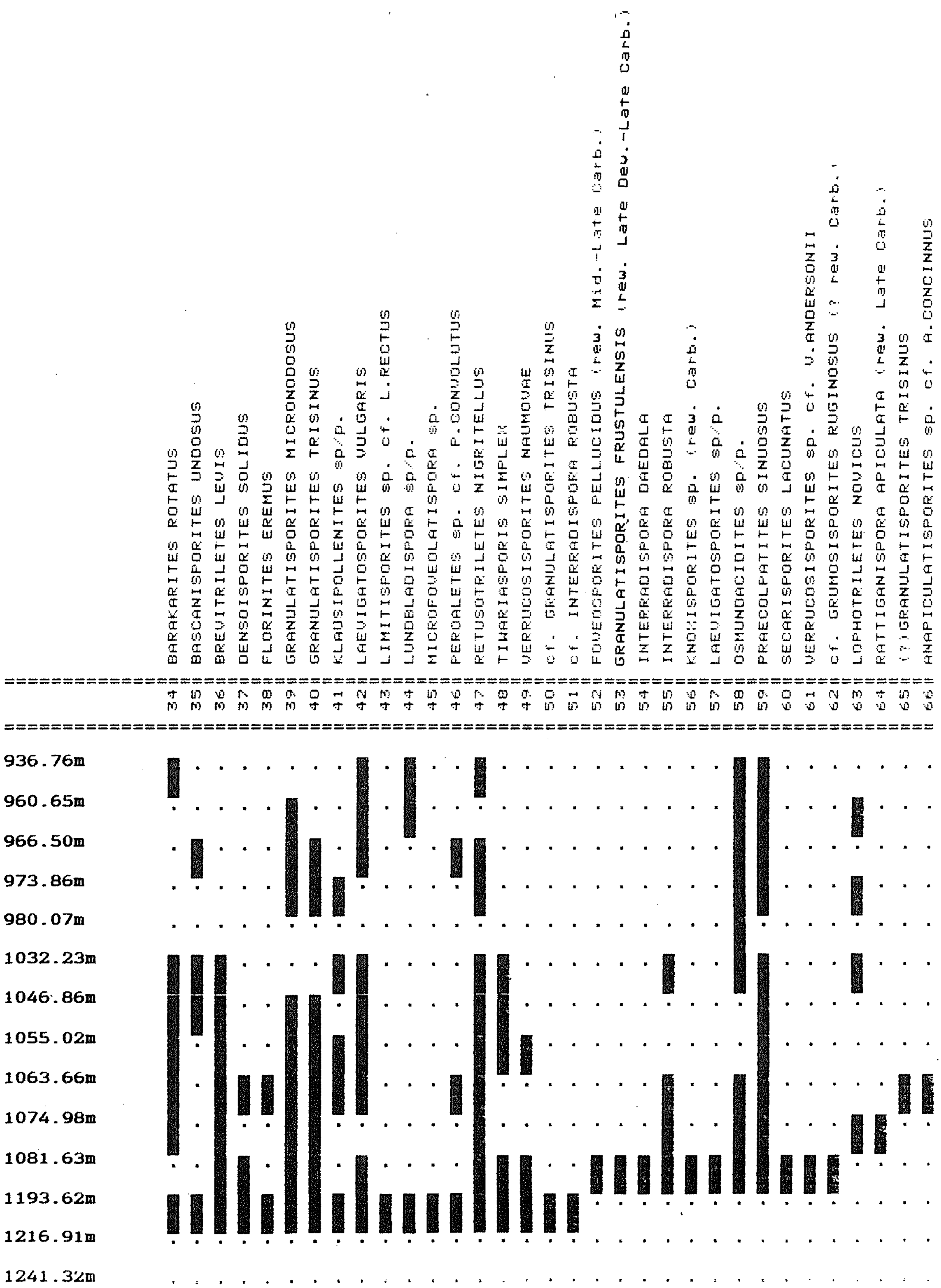
Locality : "Warrandaroo" ESSO seismic line W80A-17, sp 4150

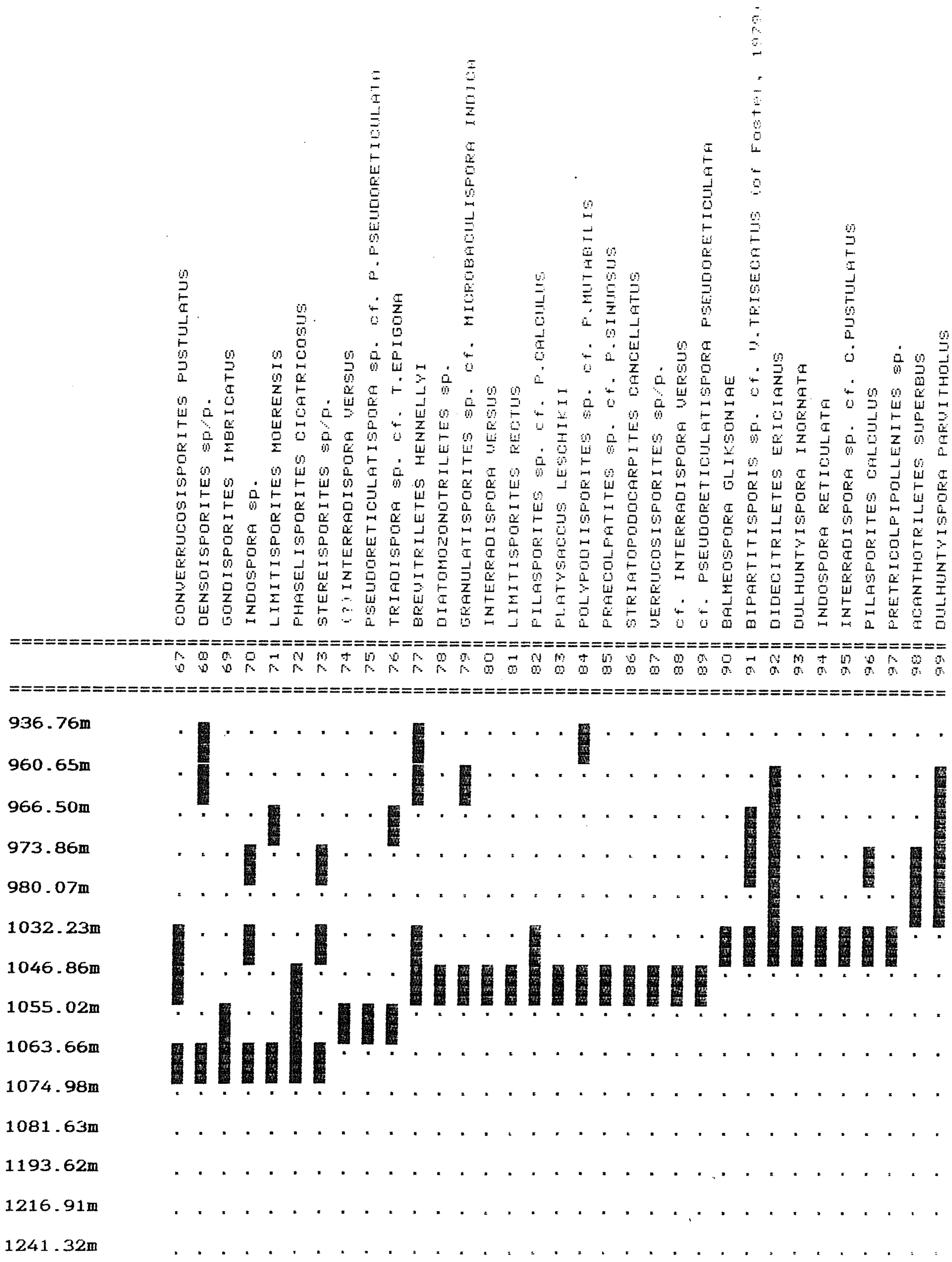
Logged by : T.J.Brain   Date : 25/6/90

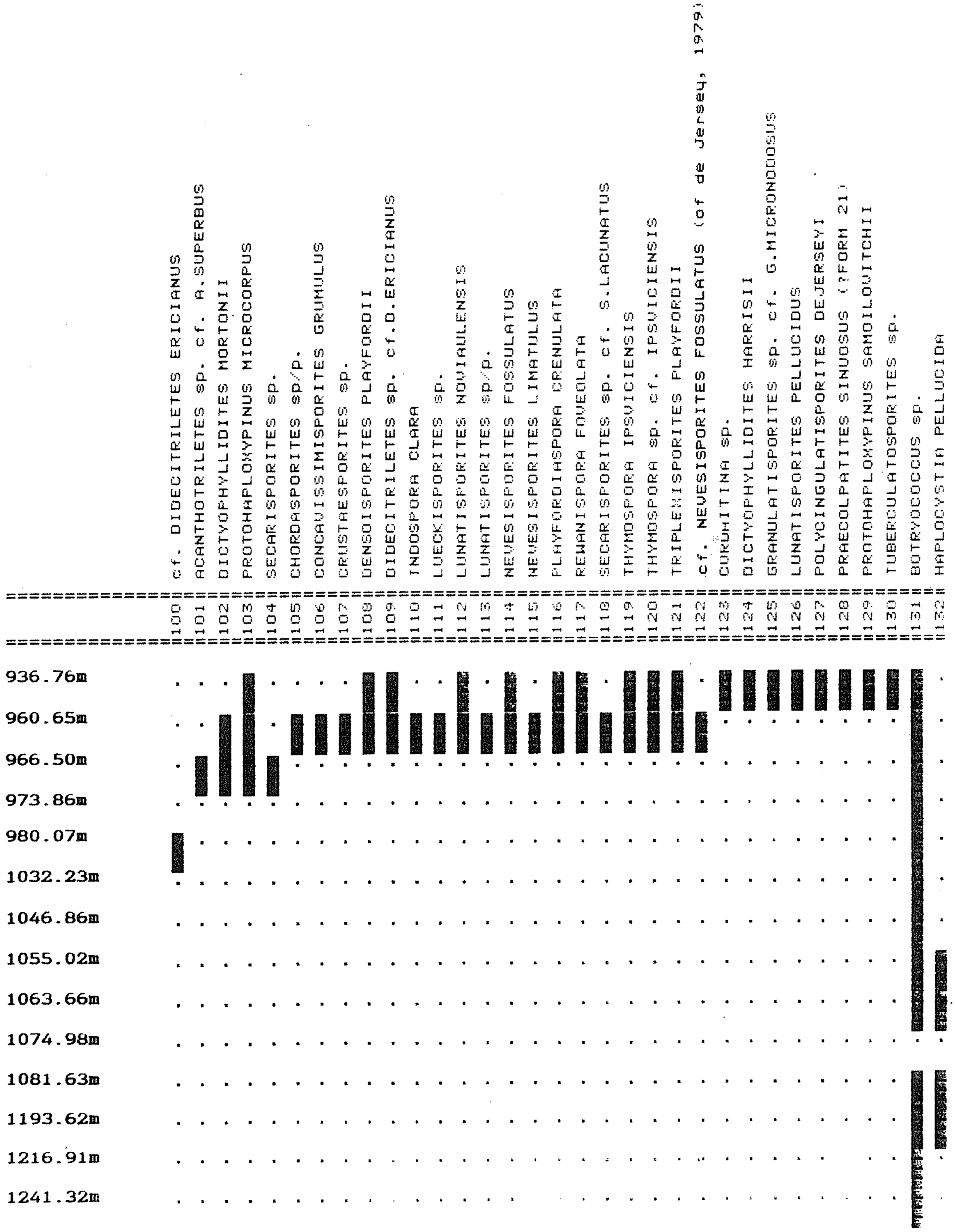
Formation	Depth m	Graphic	Textural name	Grain size (mud, silt, vf, f, m, c, vc, granule, pebble, cobble)	Sorting	Sedimentary structures (Bedding: laminated, thin, medium, flaser, wavy-lenticular, graded; X-bed: small, medium, large, low-angle; Current lineation, Ripplemarks, Soft sed. deform., Erosive structure, Churned, Burrows/trails, Chemical)	Composition (QFR or Grain type, Minor compon., Matrix/Cement)	Fossils (Flora, Fauna)	Colour	Visible porosity	BASE	Dip	Remarks
JOCHMUS FM											?E		1300.71
			SL/SS		g	' . !			gy/lgy			h	carb lam 1300.93m carb frags on bed. 1301.69
													10 cm core loss.
													TOTAL DEPTH 1301.79 m
	1310												

APPENDIX 2: Palynomorph range chart of presence/absence by lowest appearance in GSQ Muttaburra 1.
(Galilee Basin section)

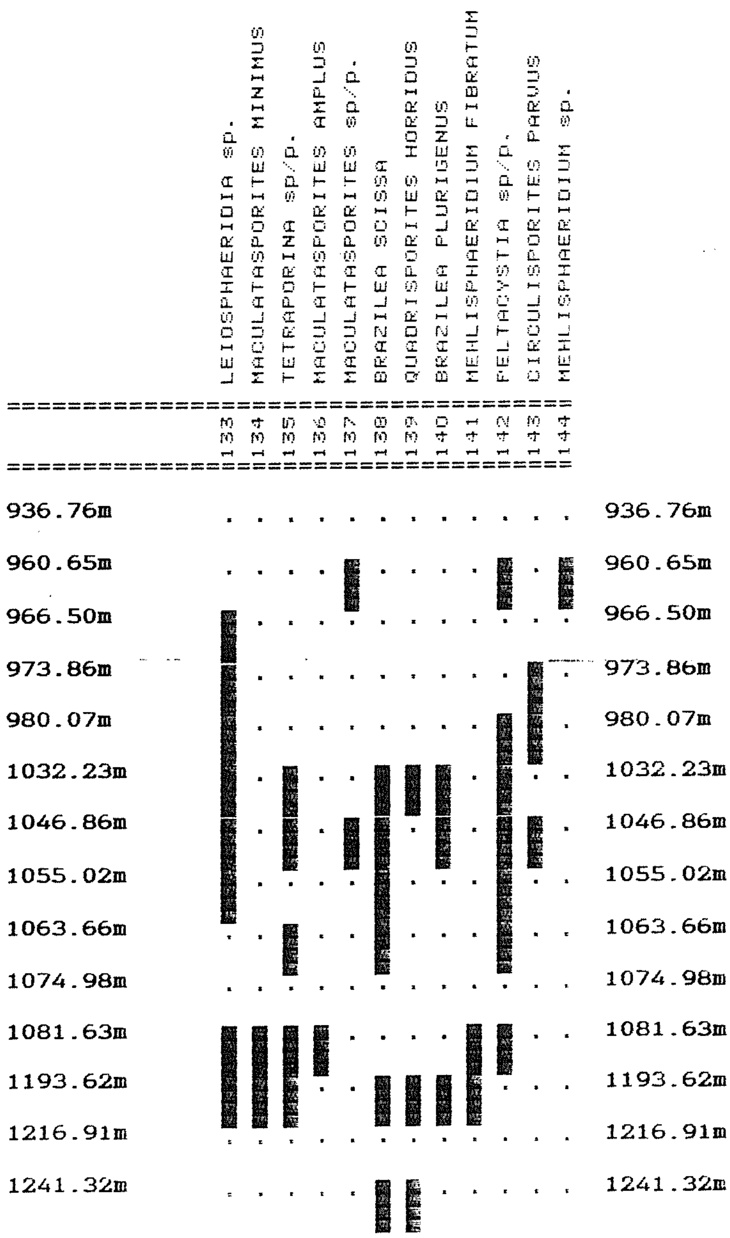

1 ALISPORITES sp/p.
2 CANNANOROPOLLIS sp/p.
3 CYCADOPITES FOLLICULARIS
4 DELTOIDOSPORA DIRECTA
5 INAPERTUROPOLLENITES sp/p.
6 PLICATIPOLLENITES sp/p.
7 POTONIEISPORITES sp/p.
8 PROTOHAPLOXYPINUS sp/p.
9 SCHEURINGIPOLLENITES OVATUS
10 ACANTHOTRILETES TERETEANGULATUS
11 ANAPICULATISPORITES sp. cf. D.ERICIANUS
12 APICULATISPORIS CORNUTUS
13 DIATOMOZONOTRILETES TOWNROWII
14 GONDISPORITES sp/p.
15 HORRIDITRILETES RAMOSUS
16 INDOTRIRADITES sp/p.
17 LIMBOSPORITES sp/p.
18 MARSUPIPOLLENITES STRIATUS
19 MARSUPIPOLLENITES TRIRADIATUS
20 MICROBACULISPORA TENTULA
21 NEORAISTRICKIA sp/p.
22 PSEUDORETICULATISPORA PSEUDORETICULATA
23 PUNCTATISPORITES sp/p.
24 SCHEURINGIPOLLENITES MAXIMUS
25 STRIATOABIEITES MULTISTRIATUS
26 STRIATOPODOCARPITES sp/p.
27 STRIOMONOSACCITES sp/p.
28 VERRUCOSISPORITES ANDERSONII
29 VITREISPORITES SIGNATUS
30 WEYLANDITES LUCIFER
31 (?)PHASELISPORITES CICATRICOSUS
32 (?)PRAECOLPATITES SINUOSUS
33 ACANTHOTRILETES FILIFORMIS
936.76m
960.65m
966.50m
973.86m
980.07m
1032.23m
1046.86m
1055.02m
1063.66m
1074.98m
1081.63m
1193.62m
1216.91m
1241.32m


34 BARAKARITES ROTATUS
35 BASCANISPORITES UNDOSUS
36 BREVITRILETES LEVIS
37 DENSOISPORITES SOLIDUS
38 FLORINITES EREMUS
39 GRANULATISPORITES MICRONODOSUS
40 GRANULATISPORITES TRISINUS
41 KLAUSIPOLLENITES sp/p.
42 LAEVIGATOSPORITES VULGARIS
43 LIMITISPORITES sp. cf. L.RECTUS
44 LUNDBLADISPORA sp/p.
45 MICROFOVEOLATISPORA sp.
46 PERDALETES sp. cf. P.CONVOLUTUS
47 RETUSOTRILETES NIGRITELLUS
48 TIWARIASPORIS SIMPLEX
49 VERRUCOSISPORITES NAUMOVAE
50 cf. GRANULATISPORITES TRISINUS
51 cf. INTERRADISPORA ROBUSTA
52 FOVEOSPORITES PELLUCIDUS (rew. Mid.-Late Carb.)
53 GRANULATISPORITES FRUSTULENSIS (rew. Late Dev.-Late Carb.)
54 INTERRADISPORA DAEDALA
55 INTERRADISPORA ROBUSTA
56 KNOXISPORITES sp. (rew. Carb.)
57 LAEVIGATOSPORITES sp/p.
58 OSMUNDACIDITES sp/p.
59 PRAECOLPATITES SINUOSUS
60 SECARISPORITES LACUNATUS
61 VERRUCOSISPORITES sp. cf. V.ANDERSONII
62 cf. GRUMOSISPORITES RUGINOSUS (? rew. Carb.)
63 LOPHOTRILETES NOVICUS
64 RATTIGANISPORA APICULATA (rew. Late Carb.)
65 (?)GRANULATISPORITES TRISINUS
66 ANAPICULATISPORITES sp. cf. A.CONCINNUS
936.76m
960.65m
966.50m
973.86m
980.07m
1032.23m
1046.86m
1055.02m
1063.66m
1074.98m
1081.63m
1193.62m
1216.91m
1241.32m


67 CONVERRUCOSISPORITES PUSTULATUS
68 DENSOISPORITES sp/p.
69 GONDISPORITES IMBRICATUS
70 INDOSPORA sp.
71 LIMITISPORITES MOERENSIS
72 PHASELISPORITES CICATRICOSUS
73 STEREISPORITES sp/p.
74 (?) INTERRADISPORA VERSUS
75 PSEUDORETICULATISPORA sp. cf. P.PSEUDORETICULATA
76 TRIADISPORA sp. cf. T.EPIGONA
77 BREVITRILETES HENNELLYI
78 DIATOMOZONOTRILETES sp.
79 GRANULATISPORITES sp. cf. MICROBACULISPORA INDICA
80 INTERRADISPORA VERSUS
81 LIMITISPORITES RECTUS
82 PILASPORITES sp. cf. P.CALCULUS
83 PLATYSACCUS LESCHIKII
84 POLYPODIISPORITES sp. cf. P.MUTABILIS
85 PRAECOLPATITES sp. cf. P.SINUOSUS
86 STRIATOPODOCARPITES CANCELLATUS
87 VERRUCOSISPORITES sp/p.
88 cf. INTERRADISPORA VERSUS
89 cf. PSEUDORETICULATISPORA PSEUDORETICULATA
90 BALMEOSPORA GLIKSONIAE
91 BIPARTITISPORIS sp. cf. V.TRISECATUS (of Foster, 1979)
92 DIDECITRILETES ERICIANUS
93 DULHUNTYISPORA INORNATA
94 INDOSPORA RETICULATA
95 INTERRADISPORA sp. cf. C.PUSTULATUS
96 PILASPORITES CALCULUS
97 PRETRICOLPIPOLLENITES sp.
98 ACANTHOTRILETES SUPERBUS
99 DULHUNTYISPORA PARVITHOLUS
936.76m
960.65m
966.50m
973.86m
980.07m
1032.23m
1046.86m
1055.02m
1063.66m
1074.98m
1081.63m
1193.62m
1216.91m
1241.32m



100 cf. DIDECITRILETES ERICIANUS
101 ACANTHOTRILETES sp. cf. A.SUPERBUS
102 DICTYOPHYLLIDITES MORTONII
103 PROTOHAPLOXYPINUS MICROCORPUS
104 SECARISPORITES sp.
105 CHORDASPORITES sp/p.
106 CONCAVISSIMISPORITES GRUMULUS
107 CRUSTAESPORITES sp.
108 DENSOISPORITES PLAYFORDII
109 DIDECITRILETES sp. cf.D.ERICIANUS
110 INDOSPORA CLARA
111 LUECKISPORITES sp.
112 LUNATISPORITES NOVIAULENSIS
113 LUNATISPORITES sp/p.
114 NEVESISPORITES FOSSULATUS
115 NEVESISPORITES LIMATULUS
116 PLAYFORDIASPORA CRENULATA
117 REWANISPORA FOVEOLATA
118 SECARISPORITES sp. cf. S.LACUNATUS
119 THYMOSPORA IPSVICIENSIS
120 THYMOSPORA sp. cf. IPSVICIENSIS
121 TRIPLEXISPORITES PLAYFORDII
122 cf. NEVESISPORITES FOSSULATUS (of de Jersey, 1979)
123 CUROHITINA sp.
124 DICTYOPHYLLIDITES HARRISII
125 GRANULATISPORITES sp. cf. G.MICRONODOSUS
126 LUNATISPORITES PELLUCIDUS
127 POLYCINGULATISPORITES DEJERSEYI
128 PRAECOLPATITES SINUOSUS (?FORM 21)
129 PROTOHAPLOXYPINUS SAMOILOVITCHII
130 TUBERCULATOSPORITES sp.
131 BOTRYOCOCCUS sp.
132 HAPLOCYSTIA PELLUCIDA
936.76m
960.65m
966.50m
973.86m
980.07m
1032.23m
1046.86m
1055.02m
1063.66m
1074.98m
1081.63m
1193.62m
1216.91m
1241.32m


133 LEIOSPHAERIDIA sp.
134 MACULATASPORITES MINIMUS
135 TETRAPORINA sp/p.
136 MACULATASPORITES AMPLUS
137 MACULATASPORITES sp/p.
138 BRAZILEA SCISSA
139 QUADRISPORITES HORRIDUS
140 BRAZILEA PLURIGENUS
141 MEHLISPHAERIDIUM FIBRATUM
142 PELTACYSTIA sp/p.
143 CIRCULISPORITES PARVUS
144 MEHLISPHAERIDIUM sp.
936.76m
960.65m
966.50m
973.86m
980.07m
1032.23m
1046.86m
1055.02m
1063.66m
1074.98m
1081.63m
1193.62m
1216.91m
1241.32m

SPECIES LOCATION INDEX

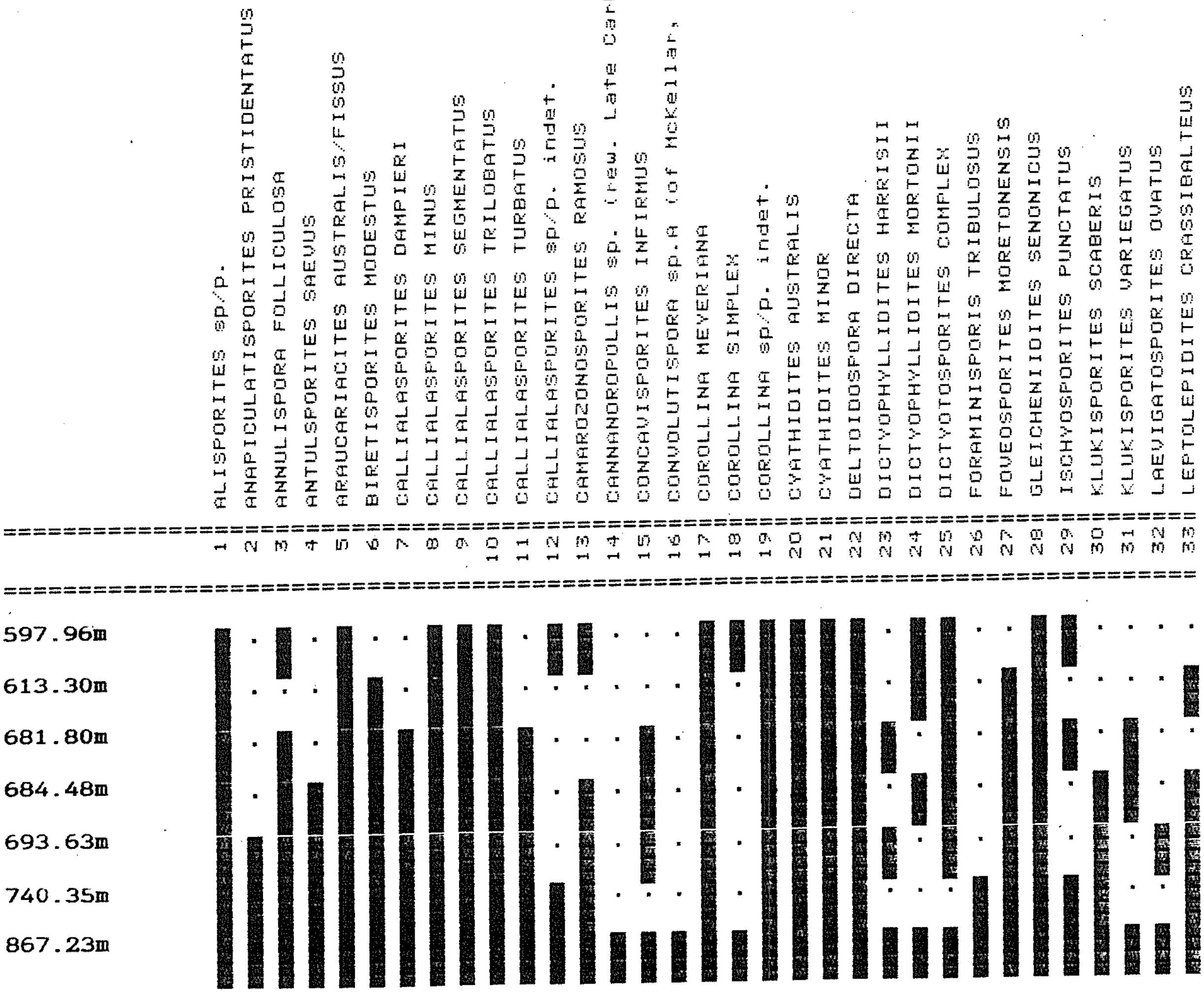
Index numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
65	(?) GRANULATISPORITES TRISINUS
74	(?) INTERRADISPORA VERSUS
31	(?) PHASELISPORITES CICATRICOSUS
32	(?) PRAECOLPATITES SINUOSUS
33	ACANTHOTRILETES FILIFORMIS
98	ACANTHOTRILETES SUPERBUS
10	ACANTHOTRILETES TERETEANGULATUS
101	ACANTHOTRILETES sp. cf. A.SUPERBUS
1	ALISPORITES sp/p.
66	ANAPICULATISPORITES sp. cf. A. CONCINNUS
11	ANAPICULATISPORITES sp. cf. D. ERICIANUS
12	APICULATISPORIS CORNUTUS
90	BALMEOSPORA GLIKSONIAE
34	BARAKARITES ROTATUS
35	BASCANISPORITES UNDOSUS
91	BIPARTITISPORIS sp. cf. V. TRISECATUS (of Foster, 1979)
131	BOTRYOCOCCUS sp.
140	BRAZILEA PLURIGENUS
138	BRAZILEA SCISSA
77	BREVITRILETES HENNELLYI
36	BREVITRILETES LEVIS
2	CANNANOROPOLLIS sp/p.
105	CHORDASPORITES sp/p.
143	CIRCULISPORITES PARVUS
106	CONCAVISSIMISPORITES GRUMULUS
67	CONVERRUCOSISPORITES PUSTULATUS
123	CORDAITINA sp.
107	CRUSTAESPORITES sp.
3	CYCADOPITES FOLLICULARIS
4	DELTOIDOSPORA DIRECTA
108	DENSOISPORITES PLAYFORDII
37	DENSOISPORITES SOLIDUS
68	DENSOISPORITES sp/p.
13	DIATOMOZONOTRILETES TOWNROWII
78	DIATOMOZONOTRILETES sp.
124	DICTYOPHYLLIDITES HARRISII
102	DICTYOPHYLLIDITES MORTONII
92	DIDECITRILETES ERICIANUS
109	DIDECITRILETES sp. cf. D. ERICIANUS
93	DULHUNTYISPORA INORNATA
99	DULHUNTYISPORA PARVITHOLUS
38	FLORINITES EREMUS
52	FOVEOSPORITES PELLUCIDUS (rew. Mid. -Late Carb.)
69	GONDISPORITES IMBRICATUS
14	GONDISPORITES sp/p.
53	GRANULATISPORITES FRUSTULENSIS (rew. Late Dev.-Late Carb.)
39	GRANULATISPORITES MICRONODOSUS
40	GRANULATISPORITES TRISINUS
125	GRANULATISPORITES sp. cf. G. MICRONODOSUS
79	GRANULATISPORITES sp. cf. MICROBACULISPORA INDICA
132	HAPLOCYSTIA PELLUCIDA
15	HORRIDITRILETES RAMOSUS
5	INAPERTUROPOLLENITES sp/p.

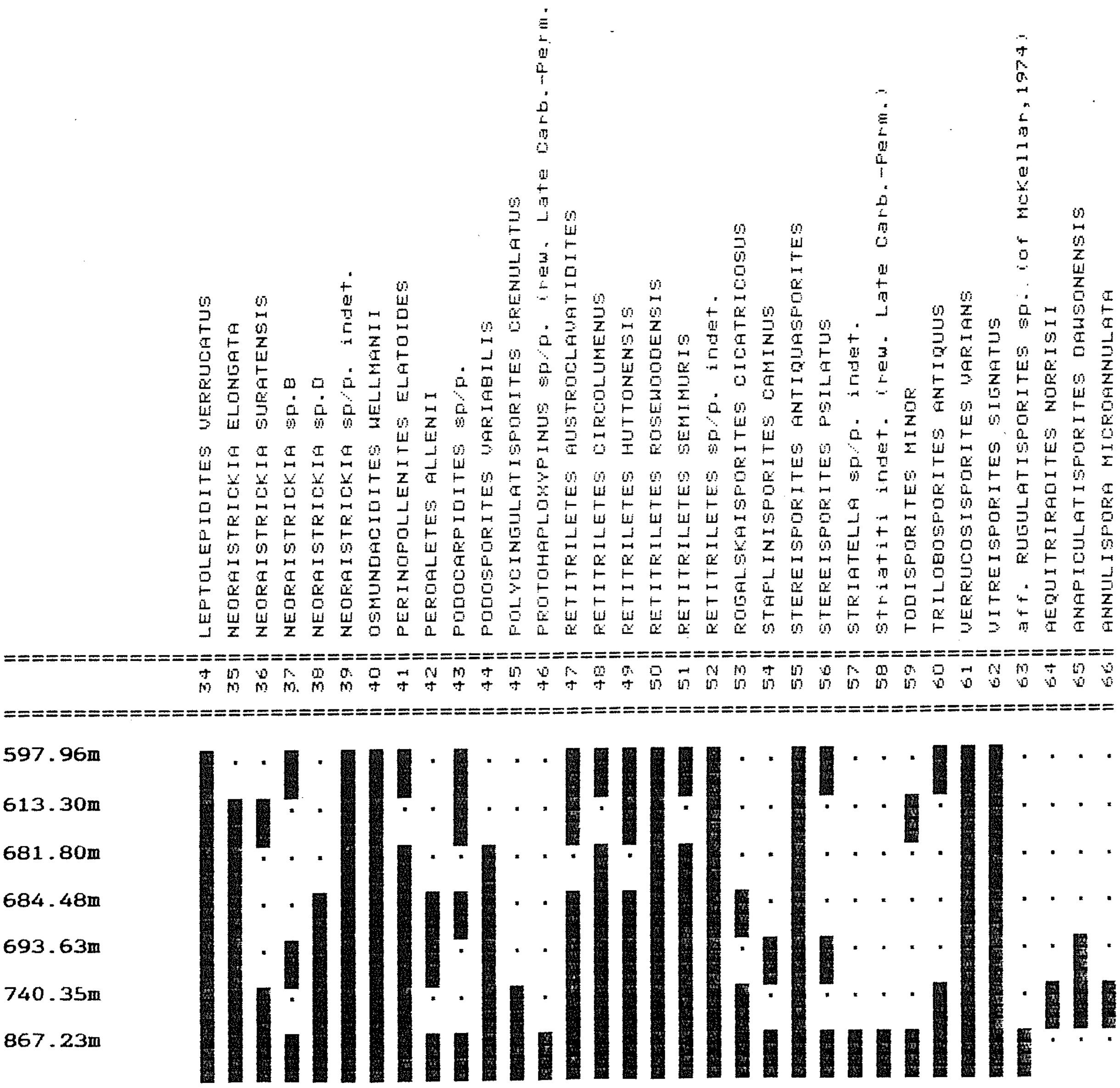
INDEX NUMBER	SPECIES
110	INDOSPORA CLARA
94	INDOSPORA RETICULATA
70	INDOSPORA sp.
16	INDOTRIRADITES sp/p.
54	INTERRADISPORA DAEDALA
55	INTERRADISPORA ROBUSTA
80	INTERRADISPORA VERSUS
95	INTERRADISPORA sp. cf. C. PUSTULATUS
41	KLAUSIPOLLENITES sp/p.
56	KNOXISPORITES sp. (rew. Carb.)
42	LAEVIGATOSPORITES VULGARIS
57	LAEVIGATOSPROITES sp/p.
133	LEIOSPHAERIDIA sp.
17	LIMBOSPORITES sp/p.
71	LIMITISPORITES MOERENSIS
81	LIMITISPORITES RECTUS
43	LIMITISPORITES sp. cf. L. RECTUS
63	LOPHOTRILETES NOVICUS
111	LUECKISPORITES sp.
112	LUNATISPORITES NOVIAULENSIS
126	LUNATISPORITES PELLUCIDUS
113	LUNATISPRRITES sp/p.
44	LUNDBLADISPORA sp/p.
136	MACULATASPORITES AMPLUS
134	MACULATASPORITES MINIMUS
137	MACULATASPORITES sp/p.
18	MARSUPIPOLLENITES STRIATUS
19	MARSUPIPOLLENITES TRIRADIATUS
141	MEHLISPHAERIDIUM FIBRATUM
144	MEHLISPHAERIDIUM sp.
20	MICROBACULISPORA TENTULA
45	MICROFOVEOLATISPORA sp.
21	NEORAISTRICKIA sp/p.
114	NEVESISPORITES FOSSULATUS
115	NEVESISPROITES LIMATULUS
58	OSMUNDACIDITES sp/p.
142	PELTACYSTIA sp/p.
46	PEROALETES sp. cf. P. CONVOLUTUS
72	PHASELISPORITES CICATRICOSUS
96	PILASPORITES CALCULUS
82	PILASPORITES sp. cf. P. CALCULUS
83	PLATYSACCUS LESCHIKII
116	PLAYFORDIASPORA CRENULATA
6	PLICATIPOLLENITES sp/p.
127	POLYCINGULATISPORITES DEJERSEYI
84	POLYPODIISPORITES sp. cf. P. MUTABILIS
7	POTONIEISPORITES sp/p.
59	PRAECOLPATITES SINUOSUS
128	PRAECOLPATITES SINUOSUS (?FORM 21)
85	PRAECOLPATITES sp. cf. P. SINUOSUS
97	PRETRICOLPIPOLLENITES sp.
103	PROTOHAPLOXYPINUS MICROCORPUS
129	PROTOHAPLOXYPINUS SAMOILOVITCHII
8	PROTOHAPLOXYPINUS sp/p.
22	PSEUDORETICULATISPORA PSEUDORETICULATA

INDEX NUMBER	SPECIES
75	PSEUDORETICULATISPORA sp. cf. P. PSEUDORETICULATA
23	PUNCTATISPORITES sp/p.
139	QUADRISPORITES HORRIDUS
64	RATTIGANSPORA APICULATA (rew. Late Carb.)
47	RETUSORTILETES NIGRITELLUS
117	REWANISPORA FOVEOLATA
24	SCHEURINGIPOLLENITES MAXIMUS
9	SCHEURINGIPOLLENITES OVATUS
60	SECARISPORITES LACUNATUS
104	SECARISPORITES sp.
118	SECARISPORITES sp. cf. S. LACUNATUS
73	STEREISPORITES sp/p.
25	STRIATOABIEITES MULTISTRIATUS
86	STRIATOPODOCARPIES CANCELLATUS
26	STRIATOPODOCARPIES sp/p.
27	STRIOMONOSACCITES sp/p.
135	TETRAPORINA sp/p.
119	THYMOSPORA IPSVICIENSIS
120	THYMOSPORA sp. cf. IPSVICIENSIS
48	TIWARIASPORIS SIMPLEX
76	TRIADISPORA sp. cf. T. EPIGONA
121	TRIPLEXISPORITS PLAYFORDII
130	TUBERCULATOSPRORITES sp.
28	VERRUCOSISPORITES ANDERSONII
49	VERRUCOSISPORITES NAUMOVAE
61	VERRUCOSISPORITES sp. cf. V. ANDERSONII
87	VERRUCOSISPORITES sp/p.
29	VITREISPORITS SIGNATUS
30	WEYLANDITES LUCIFER
100	cf. DIDECITRILETES ERICIANUS
50	cf. GRANULATISPORITES TRISINUS
62	cf. GRUMOSISPORITES RUGINOSUS (? rew. Carb.)
51	cf. INTERRADISPORA ROBUSTA
88	cf. INTERRADISPORA VERSUS
122	cf. NEVESISPORITS FOSSULATUS (of de Jersey, 1979)
89	cf. PSEUDORETICULATISPORA PSEUDORETICULATA

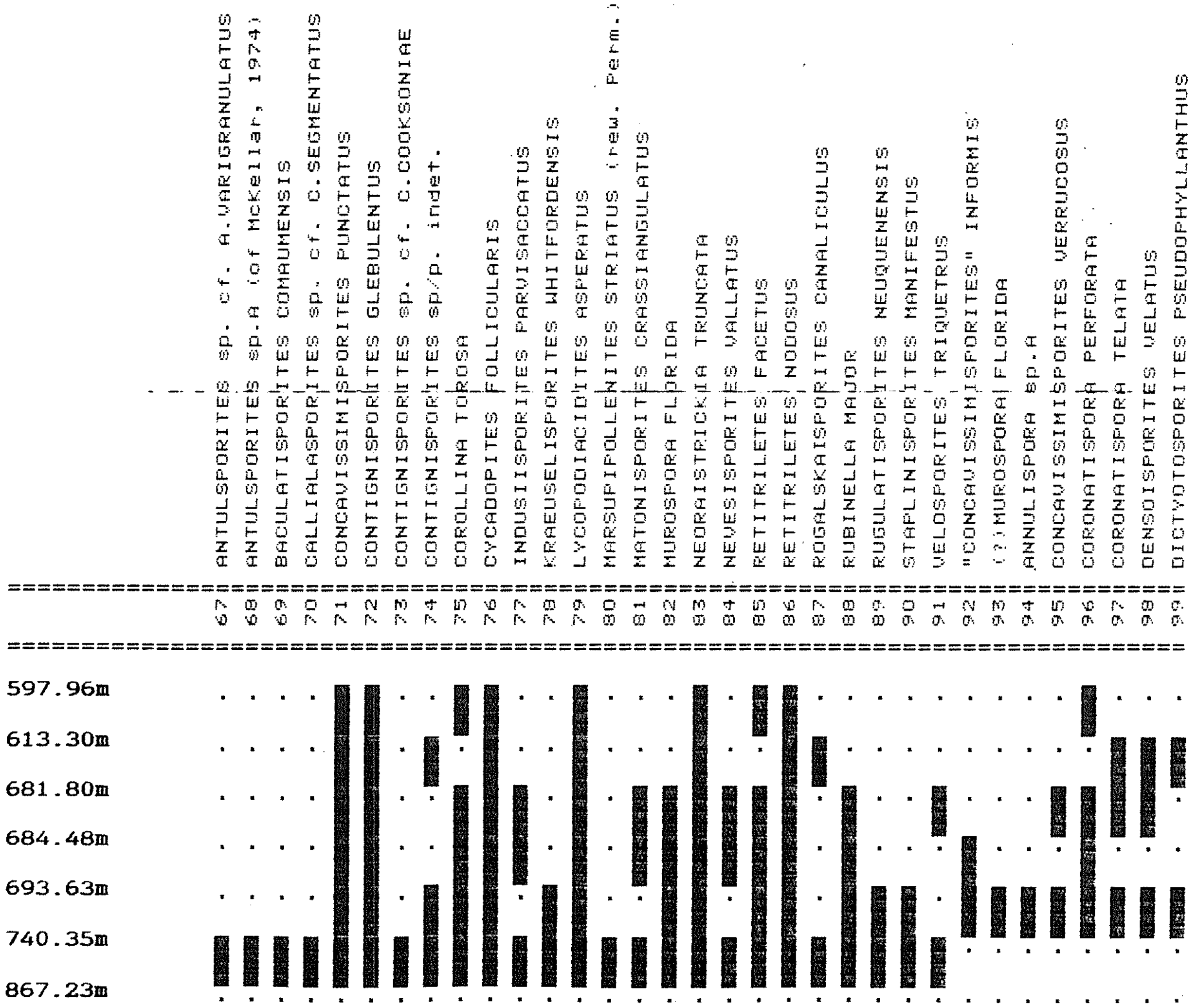
APPENDIX 3: Palynomorph range chart of presence/absence by lowest appearance in GSQ Muttaburra 1.
(Eromanga Basin section)

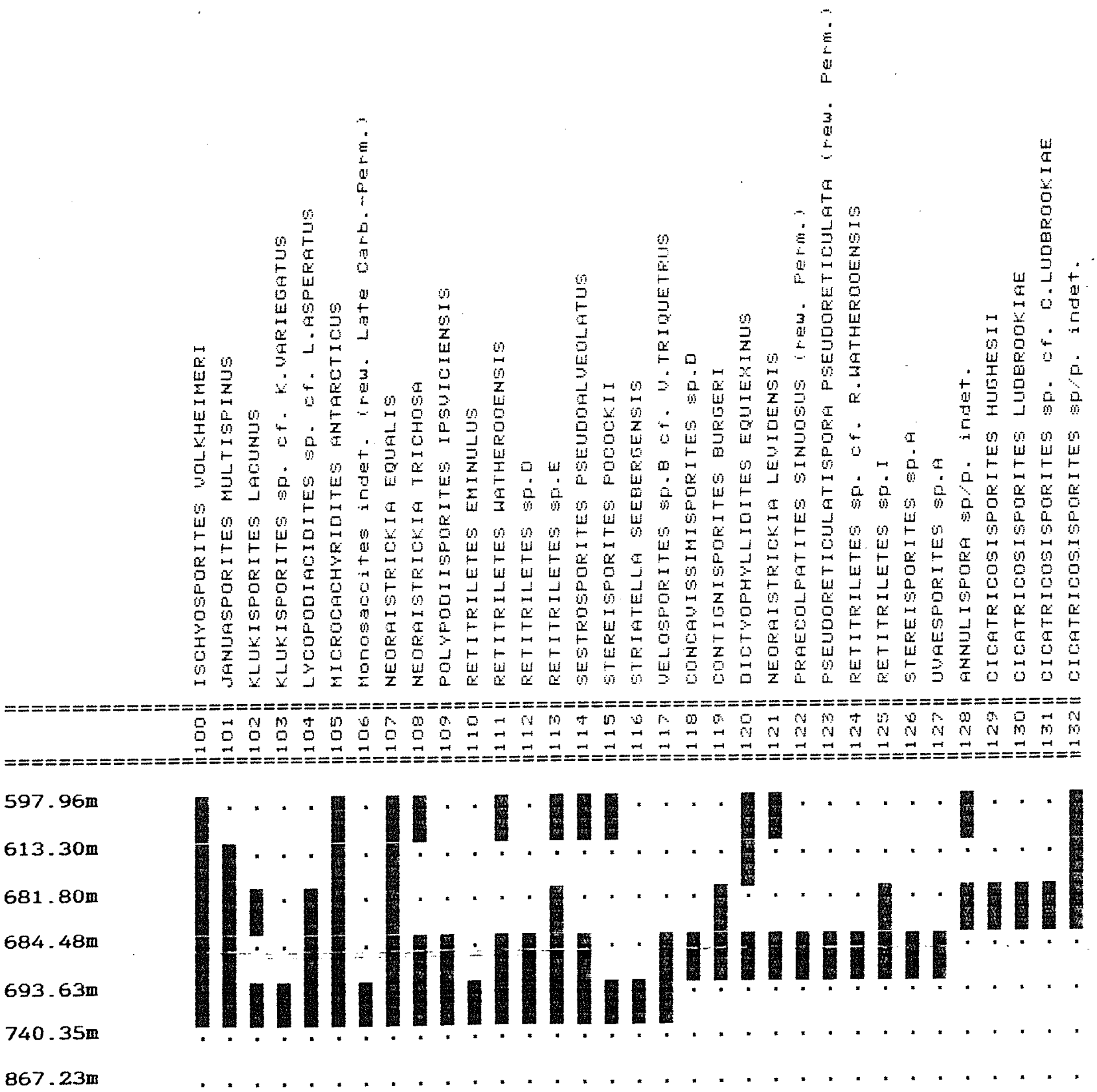


1 ALISPORITES sp/p.
2 ANAPICULATISPORITES PRISTIDENTATUS
3 ANNULISPORA FOLLICULOSA
4 ANTULSPORITES SAEVUS
5 ARAUCARIACITES AUSTRALIS/FISSUS
6 BIRETISPORITES MODESTUS
7 CALLIALASPORITES DAMPIERI
8 CALLIALASPORITES MINUS
9 CALLIALASPORITES SEGMENTATUS
10 CALLIALASPORITES TRILOBATUS
11 CALLIALASPORITES TURBATUS
12 CALLIALASPORITES sp/p. indet.
13 CAMAROZONOSPORITES RAMOSUS
14 CANNANOROPOLLIS sp. (rew. Late Carb.-Perm.)
15 CONCAVISPORITES INFIRMUS
16 CONVOLUTISPORA sp.A (of McKellar, 1974)
17 COROLLINA MEYERIANA
18 COROLLINA SIMPLEX
19 COROLLINA sp/p. indet.
20 CYATHIDITES AUSTRALIS
21 CYATHIDITES MINOR
22 DELTOIDOSPORA DIRECTA
23 DICTYOPHYLLIDITES HARRISII
24 DICTYOPHYLLIDITES MORTONII
25 DICTYOTOSPORITES COMPLEX
26 FORAMINISPORIS TRIBULOSUS
27 FOVEOSPORITES MORETONENSIS
28 GLEICHENIIDITES SENONICUS
29 ISCHYOSPORITES PUNCTATUS
30 KLUKISPORITES SCABERIS
31 KLUKISPORITES VARIEGATUS
32 LAEVIGATOSPORITES OVATUS
33 LEPTOLEPIDITES CRASSIBALTEUS
597.96m
613.30m
681.80m
684.48m
693.63m
740.35m
867.23m

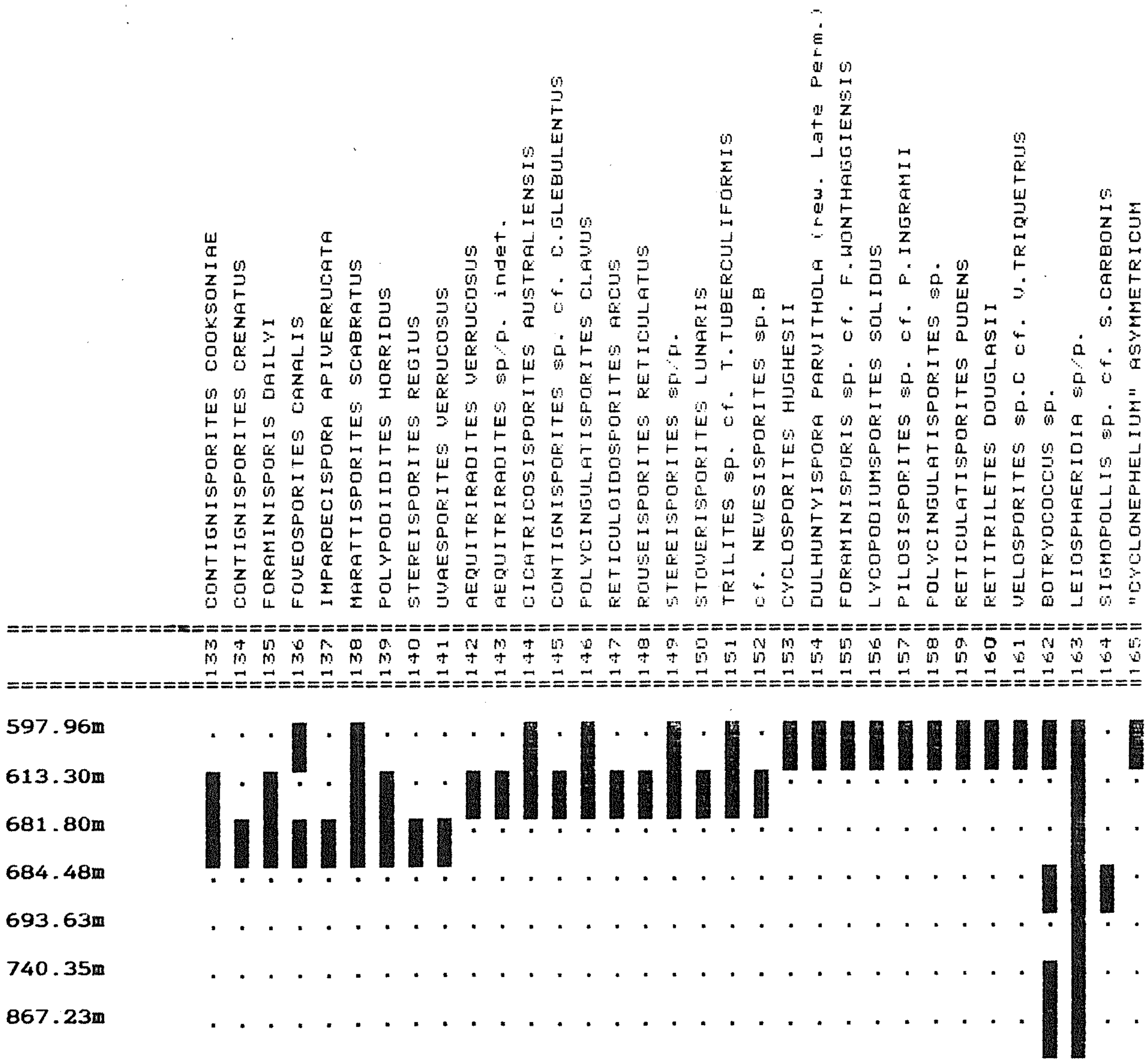


34 LEPTOLEPIDITES VERRUCATUS
35 NEORAISTRICKIA ELONGATA
36 NEORAISTRICKIA SURATENSIS
37 NEORAISTRICKIA sp.B
38 NEORAISTRICKIA sp.D
39 NEORAISTRICKIA sp/p. indet.
40 OSMUNDACIDITES WELLMANII
41 PERINOPOLLENITES ELATOIDES
42 PEROALETES ALLENII
43 PODOCARPIDITES sp/p.
44 PODOSPORITES VARIABILIS
45 POLYCINGULATISPORITES CRENULATUS
46 PROTOHAPLOXYPINUS sp/p. (rew. Late Carb.-Perm.)
47 RETITRILETES AUSTROCLAVATIDITES
48 RETITRILETES CIRCOLUMENUS
49 RETITRILETES HUTTONENSIS
50 RETITRILETES ROSEWOODENSIS
51 RETITRILETES SEMIMURIS
52 RETITRILETES sp/p. indet.
53 ROGALSKAISPORITES CICATRICOSUS
54 STAPLINISPORITES CAMINUS
55 STEREISPORITES ANTIQUASPORITES
56 STEREISPORITES PSILATUS
57 STRIATELLA sp/p. indet.
58 Striatiti indet. (rew. Late Carb.-Perm.)
59 TODISPORITES MINOR
60 TRILOBOSPORITES ANTIQUUS
61 VERRUCOSISPORITES VARIANS
62 VITREISPORITES SIGNATUS
63 aff. RUGULATISPORITES sp. (of McKellar,1974)
64 AEQUITRIRADITES NORRISII
65 ANAPICULATISPORITES DAWSONENSIS
66 ANNULISPORA MICROANNULATA
597.96m
613.30m
681.80m
684.48m
693.63m
740.35m
867.23m


67 ANTULSPORITES sp. cf. A.VARIGRANULATUS
68 ANTULSPORITES sp.A (of McKellar, 1974)
69 BACULATISPORITES COMAUMENSIS
70 CALLIALASPORITES sp. cf. C.SEGMENTATUS
71 CONCAVISSIMISPORITES PUNCTATUS
72 CONTIGNISPORITES GLEBULENTUS
73 CONTIGNISPORITES sp. cf. C.COOKSONIAE
74 CONTIGNISPORITES sp/p. indet.
75 COROLLINA TOROSA
76 CYCADOPITES FOLLICULARIS
77 INDUSIISPORITES PARVISACCATUS
78 KRAEUSELISPORITES WHITFORDENSIS
79 LYCOPODIACIDITES ASPERATUS
80 MARSUPIPOLLENITES STRIATUS (rew. Perm.)
81 MATONISPORITES CRASSIANGULATUS
82 MUROSPORA FLORIDA
83 NEORAISTRICKIA TRUNCATA
84 NEVESISPORITES VALLATUS
85 RETITRILETES FACETUS
86 RETITRILETES NODOSUS
87 ROGALSKAISPORITES CANALICULUS
88 RUBINELLA MAJOR
89 RUGULATISPORITES NEUQUENENSIS
90 STAPLINISPORITES MANIFESTUS
91 VELOSPORITES TRIQUETRUS
92 "CONCAVISSIMISPORITES" INFORMIS
93 (?)MUROSPORA FLORIDA
94 ANNULISPORA sp.A
95 CONCAVISSIMISPORITES VERRUCOSUS
96 CORONATISPORA PERFORATA
97 CORONATISPORA TELATA
98 DENSOISPORITES VELATUS
99 DICTYOTOSPORITES PSEUDOPHYLLANTHUS
597.96m
613.30m
681.80m
684.48m
693.63m
740.35m
867.23m



100 ISCHYOSPORITES VOLKHEIMERI
101 JANUASPORITES MULTISPINUS
102 KLUKISPORITES LACUNUS
103 KLUKISPORITES sp. cf. K.VARIEGATUS
104 LYCOPODIACIDITES sp. cf. L.ASPERATUS
105 MICROCACHYRIDITES ANTARCTICUS
106 Monosaccites indet. (rew. Late Carb.-Perm.)
107 NEORAISTRICKIA EQUALIS
108 NEORAISTRICKIA TRICHOSA
109 POLYPODIISPORITES IPSVICIENSIS
110 RETITRILETES EMINULUS
111 RETITRILETES WATHEROOENSIS
112 RETITRILETES sp.D
113 RETITRILETES sp.E
114 SESTROSPORITES PSEUDOALVEOLATUS
115 STEREISPORITES POCOCKII
116 STRIATELLA SEEBERGENSIS
117 VELOSPORITES sp.B cf. V.TRIQUETRUS
118 CONCAVISSIMISPORITES sp.D
119 CONTIGNISPORITES BURGERI
120 DICTYOPHYLLIDITES EQUIEXINUS
121 NEORAISTRICKIA LEVIDENSIS
122 PRAECOLPATITES SINUOSUS (rew. Perm.)
123 PSEUDORETICULATISPORA PSEUDORETICULATA (rew. Perm.)
124 RETITRILETES sp. cf. R.WATHEROOENSIS
125 RETITRILETES sp.I
126 STEREISPORITES sp.A
127 UVAESPORITES sp.A
128 ANNULISPORA sp/p. indet.
129 CICATRICOSISPORITES HUGHESII
130 CICATRICOSISPORITES LUDBROOKIAE
131 CICATRICOSISPORITES sp. cf. C.LUDBROOKIAE
132 CICATRICOSISPORITES sp/p. indet.
597.96m
613.30m
681.80m
684.48m
693.63m
740.35m
867.23m


133 CONTIGNISPORITES COOKSONIAE
134 CONTIGNISPORITES CRENATUS
135 FORAMINISPORIS DAILYI
136 FOVEOSPORITES CANALIS
137 IMPARDECISPORA APIVERRUCATA
138 MARATTISPORITES SCABRATUS
139 POLYPODIIDITES HORRIDUS
140 STEREISPORITES REGIUS
141 UVAESPORITES VERRUCOSUS
142 AEQUITRIRADITES VERRUCOSUS
143 AEQUITRIRADITES sp/p. indet.
144 CICATRICOSISPORITES AUSTRALIENSIS
145 CONTIGNISPORITES sp. cf. C.GLEBULENTUS
146 POLYCINGULATISPORITES CLAVUS
147 RETICULOIDOSPORITES ARCUS
148 ROUSEISPORITES RETICULATUS
149 STEREISPORITES sp/p.
150 STOVERISPORITES LUNARIS
151 TRILITES sp. cf. T.TUBERCULIFORMIS
152 cf. NEVESISPORITES sp.B
153 CYCLOSPORITES HUGHESII
154 DULHUNTYISPORA PARVITHOLA (rew. Late Perm.)
155 FORAMINISPORIS sp. cf. F.WONTHAGGIENSIS
156 LYCOPODIUMSPORITES SOLIDUS
157 PILOSISPORITES sp. cf. P.INGRAMII
158 POLYCINGULATISPORITES sp.
159 RETICULATISPORITES PUDENS
160 RETITRILETES DOUGLASII
161 VELOSPORITES sp.C cf. V.TRIQUETRUS
162 BOTRYOCOCCUS sp.
163 LEIOSPHAERIDIA sp/p.
164 SIGMOPOLLIS sp. cf. S.CARBONIS
165 "CYCLONEPHELIUM" ASYMMETRICUM
597.96m
613.30m
681.80m
684.48m
693.63m
740.35m
867.23m

	166 APTEA ATTADALICA	167 APTEODINIUM sp.	168 BATIACASPHAERA MACROGRANULATA	169 BATIACASPHAERA sp.	170 BATIOLADINIUM MICROPODUM(?)	171 CALLAIOSPHAERIDIUM sp.	172 CASSICULOSPHAERIDIA DELICATA	173 CASSICULOSPHAERIDIA MAGNA(?)	174 CHLAMYDOPHORELLA AMBIGUA	175 CHLAMYDOPHORELLA NYEI	176 CIRCULODINIUM COLLIVERI	177 CLEISTOSPHAERIDIUM sp.	178 DINGODINIUM CERVICULUM	179 DISSILIODINIUM sp.	180 FROMEA AMPHORA	181 GARDODINIUM TRABECULOSUM	182 GONYAULACYSTA DIAPHANIS	183 GONYAULACYSTA EDWARDSII	184 GONYAULACYSTA HELICOIDEA	185 HETEROSPHAERIDIUM HETERACANTHUM	186 HETEROSPHAERIDIUM sp.	187 HYSTRICHODINIUM sp.	188 HYSTRICHOGONYAULAX sp.	189 KALLOSPHAERIDIUM ROMAENSIS	190 KALYPTEA MONOCERAS	191 LEPTODINIUM sp.	192 MEIOUROGONYAULAX sp.	193 MUDERONGIA AUSTRALIS	194 MUDERONGIA TETRACANTHA	195 MUDERONGIA sp.	196 ODONTOCHITINA OPERCULATA	197 OLIGOSPHAERIDIUM ANTHOPHORUM	198 OLIGOSPHAERIDIUM DICTYOPHORUM
597.96m	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
613.30m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
681.80m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
684.48m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
693.63m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
740.35m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
867.23m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Depth	199 PAREODINIA CERATOPHORA	200 PARVULODINIUM sp.	201 PTERODINIUM sp.	202 SCRINIODINIUM sp.	203 SENTUSIDINIUM APTIENSE	204 SENTUSIDINIUM HYSTRIX-PILOSA group	205 SPINIFERITES RAMOSUS	206 TRICHODINIUM INTERMEDIUM	207 TRICHODINIUM sp.	208 cf. APTEODINIUM GRANULATUM	209 cf. ASCODINIUM sp.	210 cf. CRIBROPERIDINIUM ASAROTUM	211 cf. CRIBROPERIDINIUM PERFORANS	212 cf. DINGODINIUM JURASSICUM	213 cf. FUSIFORMACYSTA sp.	214 cf. LEPTODINIUM SIMPLEX	215 BALTISPHAERIDIUM sp/p.	216 CIRCULISPORITES PARVUS	217 MICRHYSTRIDIUM sp/p.	218 PTEROSPERMELLA AUSTRALIENSIS	219 VERYHACHIUM sp/p.	Depth
597.96m	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	.	■	■	■	597.96m
613.30m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	613.30m
681.80m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	681.80m
684.48m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	684.48m
693.63m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	693.63m
740.35m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	■	■	■	.	.	740.35m
867.23m	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	867.23m

SPECIES LOCATION INDEX

Index numbers are the columns in which species appear.

INDEX NUMBER	SPECIES
92	"CONCAVISSIMISPORITES" INFORMIS
165	"CYCLONEPHELIUM" ASYMMETRICUM
93	(?) MUROSPORA FLORIDA
64	AEQUITRIRADITES NORRISII
142	AEQUITRIRADITES VERRUCOSUS
143	AEQUITRIRADITES sp/p. indet.
1	ALISPORITES sp/p.
65	ANAPICULATISPORITES DAWSONENSIS
2	ANAPICULATISPORITES PRISTIDENTATUS
3	ANNULISPORA FOLLICULOSA
66	ANNULISPORA MICROANNULATA
94	ANNULISPORA sp.A
128	ANNULISPORA sp/p. indet.
4	ANTULSPORITES SAEVUS
67	ANTULSPORITES sp. cf. A. VARIGRANULATUS
68	ANTULSPORITES sp.A. (of Mckellar, 1974)
166	APTEA ATTADALICA
167	APTEODINIUM sp.
5	ARAUCARIACITES AUSTRALIS/FISSUS
69	BACULATISPORITES COMAUMENSIS
215	BALTISPHAERIDIUM sp/p.
168	BATIACASPHAERA MACROGRANULATA
169	BATIACASPHAERA sp.
170	BATIOLADINIUM MICROPODUM(?)
6	BIRETISPORITES MODESTUS
162	BOTRYOCOCCUS sp.
171	CALLAIOSPHAERIDIUM sp.
7	CALLIALASPORITES DAMPIERI
8	CALLIALASPORITES MINUS
9	CALLIALASPORITES SEGMENTATUS
10	CALLIALASPORITES TRILOBATUS
11	CALLIALASPORITES TURBATUS
70	CALLIALASPORITES sp. cf. C. SEGMENTATUS
12	CALLIALASPORITES sp/p. indet.
13	CAMAROZONOSPORITES RAMOSUS
14	CANNANORPOLLIS sp. (rew. Late Carb.-Perm.)
172	CASSICULOSPHAERIDIA DELICATA
173	CASSICULOSPHAERIDIA MAGNA(?)
174	CHLAMYDOPHORELLA AMBIGUA
175	CHLAMYDOPHORELLA NYEI
144	CICATRICOSISPORITES AUSTRALIENSIS
129	CICATRICOSISPORITES HUGHESSII
130	CICATRICOSISPORITES LUDBROOKIAE
131	CICATRICOSISPORITES sp. cf. C. LUDBROOKIAE
132	CICATRICOSISPORITES sp/p. indet.
216	CICULISPORITES PARVUS
176	CIRCULODINIUM COLLIVERI
177	CLEISTOSPHAERIDIUM sp.
15	CONCAVISPORITES INFIRMUS
71	CONCAVISSIMISPORITES PUNCTATUS
95	CONCAVISSIMISPORITES VERRUCOSUS
118	CONCAVISSIMISPORITES sp.D
119	CONTIGINISPORITES BURGERI

INDEX NUMBER	SPECIES
133	CONTIGNISPORITES COOKSONIAE
134	CONTIGNISPORITES CRENATUS
72	CONTIGNISPORITES GLEBULENTUS
73	CONTIGNISPORITES sp. cf. C. COOKSONIAE
145	CONTIGNISPORITES sp. cf. C. GLEBULENTUS
74	CONTIGNISPORITES sp/p. indet.
16	CONVOLUTISPORA sp.A. (of McKellar, 1974)
17	COROLLINA MEYERIANA
18	COROLLINA SIMPLEX
75	COROLLINA TOROSA
19	COROLLINA sp/p. indet.
96	CORONATISPORA PERFORATA
97	CORONATISPORA TELATA
20	CYATHIDITES AUSTRALIA
21	CYATHIDITES MINOR
76	CYCADOPITES FOLLICULARIS
153	CYCLOSPORITES HUGHESII
22	DELTOIDOSPORA DIRECTA
98	DENSOISPORITES VELATUS
120	DICTYOPHYLLIDITES EQUIEXINUS
23	DICTYOPHYLLIDITES HARRISII
24	DICTYOPHYLLIDITES MORTONII
25	DICTYOPHYLLIDITES COMPLEX
99	DICTYOTOSPORITES PSEUDOPHYLLANTHUS
178	DINGODINIUM CERVICULUM
179	DISSILIODINIUM sp.
154	DULHUNTYISPORA PARVITHOLA (rew. Late Perm.)
135	FORAMINISPORIS DAILYI
26	FORAMINISPORIS TRIBULOSUS
155	FORAMINISPORIS sp. cf. F. WONTHAGGIENSIS
136	FOVEOSPORITES CANALIS
27	FOVEOSPORITES MORETONENSIS
180	FROMEA AMPHORA
181	GARDODINIUM TRABECULOSUM
28	GLEICHENIIDITES SENONICUS
182	GONYAULACYSTA DIAPHANIS
183	GONYAULACYSTA EDWARDSII
184	GONYAULACYSTA HELICOIDEA
185	HETEROSPHAERIDIUM HETERACANTHUM
186	HETEROSPHAERIDIUM sp.
187	HYSTRICHODINIUM sp.
188	HYSTRICHOGONYAULAX sp.
137	IMPARDECISPORA APIVERRUCATA
77	INDUSIISPORITES PARVISACCATUS
29	ISCHYOSPORITES PUNCTATUS
100	ISCHYOSPORITES VOLKHEIMERI
101	JANUASPORITES MULTISPINUS
189	KALLOSPHAERIDIUM ROMAENSIS
190	KALYPTEA MONOCERAS
102	KLUKISPORITES LACUNUS
30	KLUKISPORITES SCABERIS
31	KLUKISPORITES VARIEGATUS
103	KLUKISPORITES sp. cf. K. VARIEGATUS
78	KRAEUSELISPORITES WHITFORDENSIS
32	LAEVIGATOSPORITES OVATUS

INDEX NUMBER	SPECIES
163	LEIOSPHAERIDIA sp/p.
191	LEPTODINIUM sp.
33	LEPTOLEPIDITES CRASSIBALTEUS
34	LEPTOLEPIDITES VERRUCATUS
79	LYCOPODIACIDITES ASPERATUS
104	LYCOPODIACIDITES sp. cf. L. ASPERATUS
156	LYCOPODIUMSPORITES SOLIDUS
138	MARATTISPORITES SCABRATUS
80	MARSUPIPOLLENITES STRIATUS (rew. Perm.)
81	MATONISPORITES CRASSIANGULATUS
192	MEIOUROGONYAULAX sp.
217	MICRYHSTRIDIUM sp/p.
105	MICROCACHYRIDITES ANTARCTICUS
193	MUDERONGIA AUSTRALIS
194	MUDERONGIA TETRACANTHA
195	MUDERONGIA sp.
82	MUROSPORA FLORIDA
106	Monosaccites indet. (rew. Late Carb.-Perm.)
35	NEORAISTRICKIA ELONGATA
107	NEORAISTRICKIA EQUALIS
121	NEORAISTRICKIA LEVIDENSIS
36	NEORAISTRICKIA SURATENSIS
108	NEORAISTRICKIA TRICHOSA
83	NEORAISTRICKIA TRUNCATA
37	NEORAISTRICKIA sp.B
38	NEORAISTRICKIA sp.D
39	NEORAISTRICKIA sp/p. indet.
84	NEVESISPORITES VALLATUS
196	ODONTOCHITINA OPERCULATA
197	OLIGOSPHAERIDIUM ANTHOPHORUM
198	OLIGOSPHAERIDIUM DICTYOPHORUM
40	OSMUNDACIDITES WELLMANII
199	PAREODINIA CERATOPHORA
200	PARVULODINIUM sp.
41	PERINOPOLLENITES ELATOIDES
42	PEROALETES ALLENII
157	PILOSISPORITES sp. cf. P. INGRAMII
43	PODOCARPIDITES sp/p.
44	PODOSPORITES VARIABILIS
146	POLYCINGULATISPORITES CLAVUS
45	POLYCINGULATISPORITES CRENULATUS
158	POLYCINGULATISPORITES sp.
139	POLYPODIIDITES HORRIDUS
109	POLYPODIISPORITES ISPVICIENSIS
122	PRAECOLPATITES SINUOSUS (rew. Perm.)
46	PROTOHAPLOXYPINUS sp/p. (rew. Late Carb.-Perm.)
123	PSEUDORETICULATISPORA PSEUDORETICULATA (rew. Perm.)
201	PTERODINIUM sp.
218	PTEROSPERMELLA AUSTRALIENSIS
159	RETICULATISPORITES PUDENS
147	RETICULOIDOSPORITES ARCUS
47	RETITRILETES AUSTROCLAVATIDITES
48	RETITRILETES CIRCOLUMENUS
160	RETITRILETES DOUGLASII
110	RETITRILETES EMINULUS

INDEX NUMBER	SPECIES
85	RETITRILETES FACETUS
49	RETITRILETES HUTTONENSIS
86	RETITRILETES NODOSUS
50	RETITRILETES ROSEWOODENSIS
51	RETITRILETES SEMIMURIS
111	RETITRILETES WATHEROOENSIS
124	RETITRILETES sp. cf. R. WATHEROOENSIS
112	RETITRILETES sp.D
113	RETITRILETES sp.E
125	RETITRILETES sp.I
52	RETITRILETES sp/p. indet.
87	ROGALSKAISPORITES CANALICULUS
53	ROGALSKAISPORITES CICATRICOSUS
148	ROUSEISPORITES RETICULATUS
88	RUBINELLA MAJOR
89	RUGULATISPORITES NEUQUENENSIS
202	SCRINIODIUM sp.
203	SENTUSIDINIUM APTIENSE
204	SENTUSIDINIUM HUSTRIC-PILOSA group
114	SESTROSPORITES PSEUDOALVEOLATUS
164	SIGMOPOLLIS sp. cf. S. CARBONIS
205	SPINIFERITES RAMOSUS
54	STAPLINISPORITES CAMINUS
90	STAPLINISPORITES MANIFESTUS
55	STEREISPORITES ANTIQUASPORITES
115	STEREISPORITES POCOCKII
56	STEREISPORITES PSILATUS
140	STEREISPORITES REGIUS
126	STEREISPORITES sp.A
149	STEREISPORITTES sp/p.
150	STOVERISPORITES LUNARIS
116	STRIATELLA SEEBERGENSIS
57	STRIATELLA sp/p. indet
58	Striatiti indet. (rew. Late Carb.-Perm.)
59	TODISPROITES MINOR
206	TRICHODINIUM INTERMEDIUM
207	TRICHODINIUM sp.
151	TRILITES sp. cf. T. TUBERCULIFORMIS
60	TRILOBOSPROITES ANTIQUUS
141	UVAESPORITES VERRUCOSUS
127	UVAESPORITES sp.A
91	VELOSPROITES TRIQUETRUS
117	VELOSPORITES sp.B cf. V. TRIQUETRUS
161	VELOSPORITES sp.C. cf. V. TRIQUETRUS
61	VERRUCOSISPORITES VARIANS
219	VERYHACHIUM sp/p.
62	VITREISPORITES SIGNATUS
63	aff. RUGULATISPORITES sp. (of McKellar, 1974)
208	cf. APTEODINIUM GRANULATUM
209	cf. ASCODINIUM sp.
210	cf. CRIBROPERIDINIUM ASAROTUM
211	cf. CRIBROPERIDINIUM PERFORANS
212	cf. DINGODINIUM JURASSICUM
213	cf. FUSIFORMACYSTA sp.
214	cf. LEPTODIIUM SIMPLEX
152	cf. NEVESISPORITES sp.B

APPENDIX 4: Guidelines for evaluating vitrinite reflectance and pyrolysis data.

TOTAL ORGANIC CARBON (TOC)

TOC CONCENTRATION Mass %	RICHNESS
0.1 - 0.5	Lean (non-source)
0.5 - 1.0	Fair (marginal)
1.0 - 2.0	Average (good)
2.0 - 4.0	Above average (rich)
> 4.0	Excellent

* From Ower & Cooper (1982) and ANALABS (1983)

VOLATILE HYDROCARBONS (S1)

S1 (mg HC/g rock)	CLASSIFICATION
0.0 - 0.2	Poor
0.2 - 0.4	Fair
0.4 - 0.8	Good
0.8 - 1.6	Very good
> 1.6	Excellent

* From unpublished ANALABS (WA) guide: Theory and methods

HYDROCARBON GENERATING POTENTIAL

S2 (mg HC/g rock)	CLASSIFICATION
0.0 - 2.5	Poor
2.5 - 5.0	Fair
5.0 - 10.0	Good
> 10.0	Very good

* From Peters (1986)

POTENTIAL YIELD (S1+S2)

S1+S2 (mg HC/g rock)	CLASSIFICATION
0.00 - 1.00	Poor
1.00 - 2.00	Marginal
2.00 - 6.00	Moderate
6.00 - 10.00	Good
10.00 - 20.00	Very good
> 20.00	Excellent

* From unpublished Analabs (W.A.) guide: Theory and Methods

QUALITY INDEX (S2/S3)

S2/S3	TYPE OF HYDROCARBON
0 - 3	Gas
3 - 5	Gas and Oil
> 5	Oil

* From Peters (1986)

HYDROGEN INDEX (HI)

HI (mg HC/g Rock)	TYPE OF HYDROCARBON
0 - 150	Gas
150 - 300	Gas and Oil
> 300	Oil

* From Peters (1986)

PRODUCTION INDEX (PI)

PI	LEVEL OF MATURITY
< 0.1	Immature
0.1 - 0.4	Mature
> 0.4	Over Mature

* From unpublished Analabs (W.A.) guide: Theory and Methods

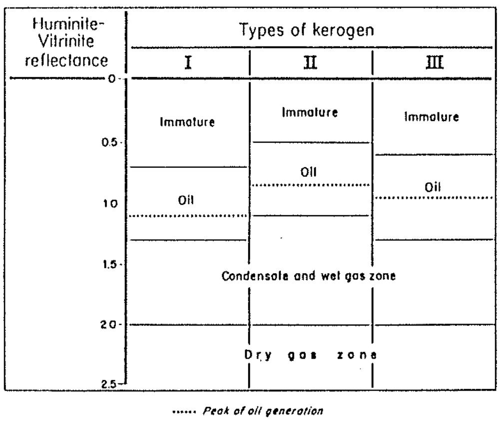
Kerogen Classification Scheme (Ower & Cooper, 1982):

Type I = alginite
Type II = liptinite
Type IIIa = vitrinite
Type IIIb = inertinite

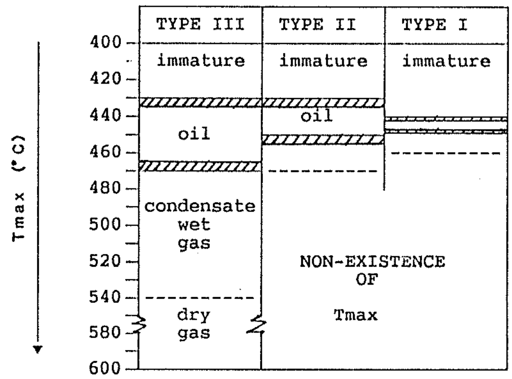
MATURATION LEVEL

VITRINITE REFLECTANCE Rv %	STAGES OF KEROGEN EVOLUTION FOR TYPE II
0.4-0.5	Inception of catagenesis (oil generation)
0.7	Inception of peak oil generation
0.9-1.1	Peak oil concentration in source, major oil migration from source
1.5	Top of wet gas zone
2.0	Top of dry gas zone
3.0	Top of rock metamorphism, hydrocarbon limit

* From Ower & Cooper (1982)



Maturation zones in terms of vitrinite reflectance and kerogen types (Tissot & Welte, 1978)



Maturation zones in terms of Tmax and kerogen types (Espitalie & others, 1985)

APPENDIX 5: Conventional core analysis

Amdel Core Services Pty Ltd
Brisbane

AMDEL CORE SERVICES

26 September 1990

Department of Resource Industries
GPO Box 194
BRISBANE QLD 4000

Attention: T A Noon

REPORT: 002/116

CLIENT REFERENCE:	Order No 49304
MATERIAL:	Muttaburra #1
LOCALITY:	GSQ
WORK REQUIRED:	Conventional Core Analysis

Please direct technical enquiries regarding this work to the signatory below (phone (07) 355 7033), under whose supervision the work was carried out.

BILL DERKSEMA
Laboratory Supervisor
on behalf of Amdel Core Services Pty Ltd

Please Reply To: P.O. Box 109 Eastwood SA 5063 Australia
Telephone: 61-8-372 2834 Facsimile: 61-8-372 2861

Amdel Core Services Pty Ltd
(Incorporated in South Australia)

26 September 1990

Department of Resource Industries
GPO Box 194
BRISBANE QLD 4000

Attention: T A Noon

FINAL DATA REPORT - CONVENTIONAL CORE ANALYSIS

REPORT: 002/116 - MUTTABURRA #1

Selected samples from Muttaburra #1, Department of Resource Industries were received at Amdel Core Services, Brisbane Laboratory.

The following report includes tabular data of permeability to air, helium injection porosity, and density determinations. Data presented graphically includes a porosity versus permeability to air plot.

The data contained in this report has been derived by the following methods:

1. PLUG CUTTING & DRYING

Two 1" diameter plugs were taken using tap water as the bit lubricant. One plug was taken parallel to the bedding plane and the second plug in the vertical direction with respect to core orientation. Samples were trimmed square and offcuts retained. The plugs were dried in a controlled humidity environment at temperatures not exceeding 100°C and stored in an airtight plastic container and allowed to cool to room temperature.

2. PERMEABILITY TO AIR

A plug sample is used for this measurement and is placed in a Hassler cell to which a confining pressure of 200 psig (1380 kpa) is applied; this pressure is used to prevent bypassing of air around the sides of the sample when the measurement is made. A known pressure is then applied to the upstream sample face and the differential pressure (between the upstream and downstream faces) is monitored at the downstream face. Permeability is then calculated using Darcy's Law.

3. HELIUM INJECTION POROSITY

The porosity of a clean dry core plug is determined as follows: it is first placed in a matrix cup where the grain volume is measured by helium injection: a known volume of helium at a known pressure is expanded into the matrix cup which contains the core plug; the resulting pressure is recorded and the unknown volume (that is, the volume of the grains) is determined using Boyle's Law. The bulk volume is determined by mercury immersion. The difference between the grain volume and the bulk volume is the pore volume and from this the porosity is calculated as the volume percentage of pores with respect to the bulk volume.

4. APPARENT GRAIN DENSITY

The apparent grain density is derived from the measurements described in Section 3, above, and is the ratio of the weight of the core plug divided by the grain volume determined as in paragraph 3.

5. ROLLING AVERAGE

These averages of both Helium injection porosity and permeability are obtained by using a "rolling" three (3) point method. In the case of porosity a weighted arithmetic average is used:

$$\phi\ av_{(i+1)} = [\phi_i + 2\phi_{(i+1)} + \phi_{(i+2)}]\ /4$$

In the case of permeability a weighted geometric average is used:

$$K\ av_{(i+1)} = 10^{[(\log_{10} K_i + 2\log_{10} K_{(i+1)} + \log_{10} K_{(i+2)})\ /4]}$$

At any sample point, excluding the first and last, a rolling average is obtained by using the value at the specified sample point, the value before it and the value of the sample point after it. In the cases of the first and last sample points, only 2 sample points are used.

Using porosity as an example, the average of the first data point is obtained from the formula:

$$\phi\ av_{(i)} = [2\phi_i + \phi_{(i+1)}]\ /3$$

The average at the final data point is obtained by:

$$\phi \text{ av}_{(f)} = [\phi_{(f-1)} + 2\phi_{(f)}] /3$$

The same method is used for permeability averages. At any break in the data the rolling averages are "re-started".

<u>Data Key:</u>

ϕ	=	porosity
K	=	permeability
i	=	initial
av	=	average
f	=	final

On completion of analysis, the core samples and 1" plugs were re-packed into their original boxes.

We have enjoyed working for DRI on this project and look forward to working with you again in the near future.

Yours faithfully,

BILL DERKSEMA
Laboratory Supervisor

CONVENTIONAL CORE ANALYSIS

Company: DEPT OF RESOURCE INDUSTRIES
Well: MUTTABURRA NO 1
Field: GSQ
Location: QUEENSLAND
Country: AUSTRALIA

Report: 002/116
Date: 14/9/90
Core Intervals: Various

Sample Number	Depth (m)	Porosity (%)		Density		Permeability (md)		Summation of Fluids			Remarks
		He Inj	Roll Av	Nat	Grain	Ka	Roll Av Ka	Por %	Oil %	Water %	
1627		21.9	21.9		2.56	121	111				
1628		21.8	20.9		2.59	94	33				
1629		17.9	18.5		2.65	1.1	2.7				
1630		16.2	17.0		2.64	0.43	0.70				
1631		17.7	17.9		2.65	1.1	1.0				
1632		19.9	19.6		2.64	2.1	2.3				
1633		20.6	20.2		2.64	6.3	7.5				
1634		19.7	19.9		2.65	39	31				
1635		19.5	20.1		2.65	90	148				
1636		21.7	20.2		2.65	1507	333				
1637		18.1	19.4		2.64	60	64				
1638		19.8	19.5		2.69	3.0	20				
1639		20.3	19.4		2.65	309	108				
1640		17.2	18.3		2.66	472	269				
1641		18.2	16.5		2.65	76	57				
1642		12.2	16.6		2.66	3.8	24				
1643		23.8	20.6		2.65	301	75				
1644		22.6	24.0		2.65	90	344				
1645		27.0	25.7		2.65	5729	1367				
1646		26.3	25.6		2.65	1181	1309				
1647		22.6	25.1		2.65	367	620				
1648		28.9	24.5		2.72	926	94				
1649		17.5	21.5		2.67	0.25	4.7				
1650		22.2	20.9		2.66	8.3	2.1				
1651		21.6	22.2		2.65	1.1	3.1				
1652		23.5	22.0		2.65	9.2	13				
1653		19.6	20.7		2.65	309	26				
1654		20.2	21.1		2.64	0.54	17				
1655		24.3	24.1		2.65	1013	175				
1656		27.5	26.0		2.65	1686	975				
1657		24.7	24.9		2.66	314	873				
1658		22.7	23.8		2.65	3501	1783				
1659		25.2	22.5		2.65	2629	3399				
1660		16.9	19.7		2.65	5521	4311				

VF = Vertical Fracture; HF = Horizontal Fracture; MP = Mounted Plug; SP = Short Plug;
C# = Top of Core; B# = Bottom of Core; OWC = Probable Oil/Water Contact;
Tr = Probable Transition Zone; GC = Probable Gas Cap;

CONVENTIONAL CORE ANALYSIS

Company: DEPT OF RESOURCE INDUSTRIES
Well: MUTTABURRA NO 1
Field: GSQ
Location: QUEENSLAND
Country: AUSTRALIA

Report: 002/116
Date: 14/9/90
Core Intervals: Various

Sample Number	Depth (m)	Porosity (%)		Density		Permeability (md)		Summation of Fluids			Remarks
		He Inj	Roll Av	Nat	Grain	Ka	Roll Av Ka	Por %	Oil %	Water %	
1627V						24					
1628V						58					
1629V						0.39					
1630V						0.25					
1631V						1.2					
1632V						0.75					
1633V						6.3					
1634V						13					
1635V						19					
1636V						189					
1637V						46					
1638V						2.1					
1639V						30					
1640V						80					
1641V						7.0					
1642V						1.1					
1643V						154					
1644V						27					
1645V						1976					
1646V						784					
1647V						314					
1648V						269					
1649V						0.24					
1650V						4.0					
1651V						1.1					
1652V						6.1					
1653V						321					
1654V						0.54					
1655V						224					
1656V						2302					
1657V						178					
1658V						1562					
1659V						429					
1660V						4558					

VF = Vertical Fracture; HF = Horizontal Fracture; MP = Mounted Plug; SP = Short Plug;
C# = Top of Core; B# = Bottom of Core; OWC = Probable Oil/Water Contact;
Tr = Probable Transition Zone; GC = Probable Gas Cap;

CORE PLUG DESCRIPTION

Company:	DEPT OF RESOURCE INDUSTRIES	Report:	002/116
Well:	MUTTABURRA NO 1	Date:	14/9/90
Field:	GSQ	Core Interval:	Various
Location:	QUEENSLAND		
Country:	AUSTRALIA		

Sample Number	Depth	Description
1627		Sst: lt gry, f-med gr, sbang-sbrndd, prly cmt, tr Mic, Biot, lse fri
1627V		As in plug 1627
1628		Sst: lt gry, med gr, sbang-sbrndd, prly cmt, tr Mic, lse fri
1628V		As in plug 1628
1629		Sst: lt med gry, vf-f gr, sbang-ang, wl cmt wh Cly Mtrx, tr Mic, frm hd
1629V		As in plug 1629
1630		Sst: lt gry, vf f gr, sbang-ang, wl cmt wh Cly mtrx hd
1630V		Sst: as in plug 1630
1631		Sst: lt gry, vf-f gr, sbang-ang, mod-wl cmt wh Cly Mtrx, frm hd
1631V		Sst: as in plug 1631
1632		Sst: lt gry, vf-f gr sbang-ang, firm hd
1632V		As in plug 1632
1633		Sst: lt gry, vf-f gr, occ med gr, sbang-ang, mod cmt, hd
1633V		As in plug 1633
1634		Sst: lt gr, vf-f gr, mod prly cmt, wh Cly Mtrx
1634V		As in 1634
1635		Sst: lt gry, f-med gr, occ crs gr, sbang-ang mod cmt, wh Cly Mtrx, frm-fri
1635V		Sst: as in plug 1635
1636		Sst: lt brn-gry, f-med-crs, sbang ang, prly srt prly cmt, fri-frm

Sample Number	Depth	Description
1636V		Sst: as in 1636
1637		Sst: lt brn-gry, med-crs gr, sbang-ang, prly srt mod-prly cmt, firm-fri
1637V		As in plug 1637
1638		Sst: lt gry, vf-fn gr, sbang-ang mod w cmt, wh Cly Mtrx tr Mic, tr Lit, frm-hd
1638V		Sst: as in plug 1638
1639		Sst: lt brn-gry, f-med gr, sbang-ang, prl srt, mod cmt, frm
1639V		As in plug 1639
1640		Sst: lt brn-gry, f-med gr, occ crs gr, sbang-ang prly srt, mod w cmt, fri-frm
1640V		Sst: as in plug 1640
1641		Sst: lt brn-gry, vf-med gr, sbang-ang prly srt, mod-w cmt hd
1641V		AS in plug 1641
1642		Sst: lt gr, tn, vf-f gr occ med gr, sbang-ang prly srt, wl cmt, hd
1642V		As in plug 1642
1643		Sst: lt brn-gr, f-med gr, sbang-ang, mod-wl srt prly cmt, frm hd
1643V		Sst: as in plug 1643
1644		Sst: lt gry, vf-f gr, sbang-ang, mod-wl srt w cmt, wh Cly Matrx, hd
1644V		Sst: as in plug 1644
1645		Sst: lt brn-gry, trnls clr, med-crs gr, occ v crs gr sbang-ang, prly srt, mnr Cly Mtrx, lse fri
1645V		Sst: as in plug 1645
1646		Sst: lt br-gry, f-med gr, sbang-ang, mod-w srt mod-wl cmt, frm hd
1646V		Sst: as in plug 1646
1647		Sst: lt gry, f-med gr, sbang-ang, mod srt, mod cmt, frm hd
1647V		Sst: as in plug 1647
1648		Sst: med gry-grnsh, sbang-ang, f-med gr, mod srt, gry Cly Mtrx, frm hd
1648V		Sst: as in plug 1648
1649		Sst: lt gry, vf-f-gr, sbang-ang, wl srt, abd wh Cly Mtrx hd

Sample Number	Depth	Description
1649V		Sst: as in plug 1649
1650		Sst: lt gry, vf-f gr, sbang-ang, w srt wl cmt, hd
1650V		Sst: as in plug 1650
1651		Sst: lt gry, vf-f gr, sbang-ang, mod srt, w cmt abd wh Cly Mtrx, hd
1651V		Sst: as in plug 1651
1652		Sst: lt gry, vf-f gr, sbang-ang, mod srt mod-w cmt, wh Cly Mtrx hd
1652V		Sst: as in plug 1652
1653		Sst: lt brn-gry, f-med-crs gr, prly srt, mod cmt, mnr wh Cly Mtrx, frm
1653V		Sst: as in plug 1653
1654		Sst: lt gr, vf-f gr, slty, sbang-ang, wl cmt abd wh Cly Mtrx v hd
1654V		Sst: as in plug 1654
1655		Sst: lt brn-gry, vf-f gr, occ med gr, sbang-ang mod-w srt, mod-prly cmt, fri hd
1655V		Sst: as in plug 1655
1656		Sst: lt gry-tn, fn-med gr, sbang-ang, w srt, mnr wh Mtrx, frm fri
1656V		Sst: as in plug 1656
1657		Sst: lt gry, f-med gr, sbang-ang mod w srt
1657V		As in plug 1657 mod-wl cmt, frm hd
1658		Sst: lt brn-gry, clr, f-med-crs gr, occ v crs, sbang-ang prly srt, prly cmt, frm-fri
1658V		Sst: as in plug 1658
1659		Sst: lt brn-gry clr, fn-med gr sbang-ang mod-w srt, mnr wh Cly Mtrx, fri-frm
1659V		As in plug 1559
1660		Sst: lt brn gry, clr, med crs v crs gr, prly srt, prly cmt, frm-fri
1660V		Sst: as in plug 1660

POROSITY vs PERMEABILITY

Company: Department of Resource Industries
Well : Muttaburra No.1