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NEW DATA ON MESOZOIC SEDIMENTARY SEQUENCES IN THE CLARENCE-MORETON BASIN, FROM BMR WARWICK 6 AND 7 STRATIGRAPHIC DRILL HOLES, NEW SOUTH WALES.

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NEW DATA ON THE MESOZOIC SEDIMENTARY SUCCESSION IN THE CLARENCE-MORETON BASIN, FROM BMR WARWICK 6 AND 7 STRATIGRAPHIC DRILL HOLES, NEW SOUTH WALES

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INTRODUCTION

BMR Warwick 6 and 7 were continuously cored stratigraphic drill holes on the western margin of the Clarence-Moreton Basin (Figs. 1, 2 and 3). BMR Warwick 6 commenced drilling near the top of the Marburg Subgroup and reached TD near the base of the Heifer Creek Sandstone Member of the Koukandowie Formation. BMR Warwick 7 was sited to the west of BMR Warwick 6 and spudded near the base of the Heifer Creek Sandstone Member of the Koukandowie Formation and terminated in the Gatton Sandstone.

The objectives of the drilling were to:

1. Establish the lithostratigraphic succession in the Marburg Subgroup on the poorly exposed western flank of the Clarence-Moreton Basin.

2. Place the stratigraphic succession in a geochronological framework so that it could be correlated with other basin sequences.

3. Determine the source rock potential of the sequence.

4. Determine the thickness and extent of porous and permeable units in the sequence, especially the Heifer Creek Sandstone Member.

5. Identify prominent reflectors on company seismic data, tie to other well sequences, and assess their significance and implications for regional basin stratigraphy and structure.

WELL HISTORY

GENERAL DATA

DRILLER:	DEPARTMENT OF WATER RESOURCES
DRILLING EQUIPMENT:	HOLE PIONEER P25C DRILL RIG
RATED CAPACITY:	400 METERS WITH 88.9 mm O.D HQ DRILL PIPE
DRILL PIPE:	HQ 88.9 mm OD
CASING:	HW 114.3 mm OD
CORE SIZE:	HQ3 65.5 mm DIA

DRILLING TIME:	WARWICK NO 6
START:	SHIFT TO SITE 2ND FEBRUARY 1988
FINISHED:	15TH FEBRUARY 1988
TOTAL DEPTH:	199.37 METRES

DRILLING TIME:	WARWICK NO 7
START:	SHIFT TO SITE 15TH FEBRUARY 1988
FINISHED:	19TH FEBRUARY 1988
TOTAL DEPTH:	146.55 METRES

DRILLING DATA

AREA:	CLARENCE-MORETON BASIN
TITLE HOLDER:	ENDEAVOUR RESOURCES LTD., CLAREMONT PETROLEUM NL, BASCO ENERGY INC., CHARTERHALL OIL AUST. PTY LTD.
PETROLEUM TITLE:	PEL 258
WATER SUPPLY:	PUMPED AND TRUCKED TO DRILL SITES FROM BILLABONG ALONG WASHPOOL GULLY, 500m N OF WARWICK NO. 6 DRILLHOLE.

WELL DATA

BMR WARWICK NO. 6

LOCATION: LAT. 20° 54′ 00"
LONG. 152° 39′ 34"

AUST. MAP GRID
REFERENCE: 46681E 680307N, MALLANGANEE 9440 - 111-S GRID
ZONE S6J, SQUARE MP.

TOTAL DEPTH: T.D. 199.37m, FROM RIG FLOOR AT 0.9m.

ELEVATION: 150 m APPROXIMATELY, A.S.L.

DRILLING COMMENCED: APPROXIMATELY 5 FEBRUARY 1988

DRILLING CEASED: 13 FEBRUARY 1988

STATUS: ABONDONED, OPEN HOLE, HW CASING IN HOLE. CASING 1 m ABOVE GROUND LEVEL, TOPPED WITH WATER RESOURCES DEPARTMENT TRIANGULAR MARKER. LOCKED CAP ON CASING - KEYS HELD BY BMR; NSW DEPARTMENT OF MINERAL RESOURCES (ARMIDALE); KYOGLE SHIRE COUNCIL (LANDOWNER).

WELL DATA

BMR WARWICK NO. 7

LOCATION: LAT. 28° 54' 40"
LONG. 152° 35' 42"

AUST. MAP GRID REFERENCE: 46050E 680078N, MALLANGANEE 9440-11-S
GRID ZONE 56J, SQUARE MP.

TOTAL DEPTH: T.D. 146.55 mm, FROM RIG FLOOR AT 0.9 m.

ELEVATION: 265 m APPROXIMATELY A.S.L.

DRILLING COMMENCED: APPROXIMATELY 15 FEBRUARY 1988

DRILLING CEASED: 18 FEBRUARY 1988

STATUS: ABAONDONED, OPEN HOLE, HW CASING IN HOLE. CASING 1 m ABOVE GROUND LEVEL, TOPPED WITH TRIANGULAR MARKER. LOCKED CAP ON CASING : KEYS HELD BY BMR, NSW DEPARTMENT OF MINERAL RESOURCES (ARMIDALE); AND LANDOWNER (B. & K. FINDLEY, C/- 30 LUMSDAINE AVENUE, EAST RYDE, NSW, 2113).

GEOLOGY

Previous Investigations

The drilling of BMR Warwick 6 and 7 (Figs. 1, 2 and 3) formed part of a program of regional geological investigation of the Clarence-Moreton Basin. The objective is to establish a better understanding of the evolution and history of the Basin, principally through sedimentological research. The basin synthesis is being undertaken principally by the BMR, in collaboration with the Geological Surveys of NSW and Queensland, the Division of Exploration Geoscience CSIRO, and the Geology Department, University of Melbourne.

Prior to this work, at present in progress, the only basin wide study in New South Wales was the regional geological investigation by McElroy (1962).

Company Petroleum exploration has gained some impetus over recent years (Ties et al., 1985) and a network of seismic lines exists over lease areas. Two deep exploration wells have been drilled in the latest round of petroleum exploration.

Other investigators have mainly described small local areas and no comprehensive account of the whole basin-wide geology has been compiled.

Mayne (1977) and Willis (1985) list relevant previous references to the geology and geophysics of the basin.

REGIONAL GEOLOGY AND NEW STRATIGRAPHIC FRAMEWORK

The Clarence-Moreton Basin contains continental sediments up to 3.5 km thick, ranging in age from Rhaetian to Tithonian. Thus the sedimentary succession spans a time interval of about 75 Ma. Significant periods of non-deposition and erosion probably occur in the sedimentary sequence, but no evidence of basin wide, extensive, regional angular unconformities have been recognised. The basin sequence in Queensland has been documented by 26 fully cored stratigraphic holes, and more recently four stratigraphic holes have been drilled in New South Wales, three by BMR (BMR Maclean 1, and BMR Warwick 6 and 7 described herein) and one by NSW MD (DM Pillar Valley 2) to solve specific stratigraphic problems. (Wells and O'Brien, 1985; Etheridge et al., 1985).

Current geological investigations (Wells and O'Brien, in prep.) in the basin have indicated that the stratigraphic nomenclature established in Queensland (Day et al., 1974) can be applied, with some modification to most of the basin. A new lithostratigraphic framework for the Clarence-Moreton Basin has recently been synthesised by Wells et al., (in press) and a scheme that is applicable to both the NSW and Queensland parts of the basin has been devised (Fig. 6). The revised scheme applies mainly to the Bundamba Group, the primarily non-coal bearing sequence between the mid Jurassic Walloon Coal Measures, and the Late Triassic Ipswich Coal Measures and their equivalents (Red Cliff, Evans Head and possibly Nymboida Coal Measures).

The upper parts of the Clarence-Moreton sequence, including the Grafton Formation, Kangaroo Creek Sandstone, and Walloon Coal Measures, were not studied in detail in the course of the recent BMR Program, and no major lithofacies changes have either been recognised or described. BMR Warwick 6 spudded very close to the base of the Walloon Coal Measures and hence none of these formations were intersected.

The Marburg 'Formation' has been redefined as the Marburg Subgroup and subdivided into two major sedimentary sequences. The upper sequence of mixed lithologies is defined as the Koukandowie Formation and the lower, predominantly lithic and felspathic sandstone, as the Gatton Sandstone. The new stratigraphic framework shown in Figure 6 indicates the lithological subdivisions of these two major sequences within the Marburg Subgroup. Two members, the Heifer Creek Sandstone and the older Ma Ma Creek Member, occur in the Koukandowie Formation.

The Koreelah Conglomerate Member and Calamia Member,are two newly defined units that have been described from the Gatton Sandstone.

STRUCTURE

The sedimentary succession on the western margin of the Clarence-Moreton Basin is poorly exposed but in most outcrops is gently tilted eastwards, generally between 3 and 8^{o}. On a seismic section along the Bruxner Highway a broad fold can be discerned with its axis close to the township of Mallanganee. However reversals of dip in this part of the basin are the exception rather than the rule.

The sedimentary sequence shows an onlapping relationship with the basement rocks along the basins western margin. The Gatton Sandstone of the Marburg Subgroup overlaps the older formations of the Clarence-Moreton Basin, chiefly the Woogaroo Subgroup, to rest unconformably on the basement. The Gatton Sandstone becomes increasingly coarse grained as the western basement outcrops are approached and a conglomerate (the Koreelah Conglomerate Member of the Gatton Sandstone) occurs along the western basin margin. Remnants of the Laytons Range Conglomerate are present near Tabulam but the overlying Raceview Formation and Ripley Road Sandstone are, with only one possible exception, not present along the western basin margin. The exception is an isolated small inlier of quartzose sandstone tentatively identified with the Ripley Road Sandstone about 10 km north of Baryulgil. These outcrops occur stratigraphically beneath the Gatton Sandstone and are underlain by the Laytons Range Conglomerate; only the lower contact is visible.

DRILL SITE GEOLOGY

BMR Warwick 6 and 7 were drilled on the western flank of the Clarence-Moreton Basin near the Bruxner Highway between Casino and Tabulam.

The oldest exposed formation of the Clarence-Moreton Basin sedimentary succession are remnants of conglomerate tentatively identified as the

Laytons Range Conglomerate preserved in small inliers. The best exposures of the probable Laytons Range Conglomerate include cliffs along the Timbarra River near Tabulam about 1 km upstream from its junction with the Clarence River.

The Koreelah Conglomerate Member, a local basal conglomerate of the Gatton Sandstone, overlaps the Laytons Range Conglomerate. The Koreelah Conglomerate Member grades laterally and vertically into the Gatton Sandstone of the Marburg Subgroup. The unconformable contact of the Koreelah Conglomerate Member with the Triassic Bruxner Adamellite (Moreton Geological map, GSQ, 1980) forms the greater part of the western margin of the Clarence-Moreton Basin.

The presence of inliers of the older units in places along the western basin margin demonstrates the presence of major time breaks and unconformities in the sedimentary succession in this region.

The stratigraphic framework of the sequence above the Koreelah Conglomerate Member was not known precisely because of the poor and discontinuous exposures. A thick bedded, quartz-lithic, silty sandstone sequence exposed in discontinuous road cuttings above the conglomerate was identified as Gatton Sandstone and the sporadic outcrops of the mixed sandstone/shale sequence above was tentatively identified with the Koukandowie Formation. The lithological succession in the Koukandowie Formation and its contact with the Gatton Sandstone are difficult to determine from the discontinuous outcrop, and similarly the power boundary of the Gatton Sandstone is obscured. Most outcrops and road cuttings comprise the more resistant medium and coarse grained sandstone and thin conglomerate interbeds, but none of the finer grained sediments are exposed.

A resistant quartzose sandstone occurring in the lower part of the Koukandowie Formation was tentatively identified with the Heifer Creek Sandstone Member. By contrast the Heifer Creek Sandstone member occupies the upper part of the formation in the type section in the Laidley Sub-basin. The position of the Ma Ma Creek Member in the western marginal sequence was also problematical mainly because of the extremely poor outcrop and the chamositic oolite marker bed which is commonly interbedded in, and characterises the member (Cranfield et al., 1976) was not found. Surface samples from the sequence are mostly too oxidised to yield palynomorphs suitable for dating, so that the chronstratigraphic framework in this region was unknown.

The Koukandowie Formation is overlain by the Walloon Coal Measures but the precise position of the contact in outcrop is uncertain.

STRATIGRAPHY AND LITHOLOGY OF BMR WARWICK 6 AND 7

The interpreted stratigraphic succession penetrated in BMR Warwick 6 and 7 is shown in Table 1, detailed lithological logs are shown in Figures 4 and 5 and Table 2 list the depths of all analysed samples.

Wells et al., (in press) established the main criteria used to distinguish the boundaries between formations and members in the Marburg Subgroup and their criteria were followed in subdividing the lithological succession in Warwick 6 and 7. The principal, and most satisfactory method used to distinguish major unit boundaries, is sandstone composition.

These criteria, used in conjunction with lithological associations, are sufficient to define the formation and member boundaries in the Marburg Subgroup.

The principal rock types, and their approximate percentages, in the stratigraphic intervals can be summarised as follows:-

WARWICK NO. 6

0 - 157 .7 Koukandowie Formation - undivided (sand/shale ratio 1.6)

Sandstone (60%) - light grey and grey, quartz-lithic, very fine to very coarse grained, mostly medium grained, moderately well sorted with a clay matrix and occasional siltstone interbeds, fine carbonaceous laminae, and mostly cross-laminated. The coarser grained sandstone beds are poorly sorted with subangular grains and commonly grade into conglomerate. The fine grained sandstone commonly contains mica, carbonaceous and coaly laminae, minor thin claystone laminae and mud chips.

Claystone (37%) - grey brown, parallel and irregular laminations, commonly with inter-laminated fine sandstone and siltstone.

Conglomerate (3%) - polymictic, rounded to angular, poorly sorted, coarse grained sandstone matrix, lithic and coal clasts, erosive base.

157.7 - 199.37 Heifer Creek Sandstone Member (sand/shale ratio 21.5)

Sandstone (90%) - light grey to white, coarse to very coarse grained, friable, quartzose and quartz-lithic, porous with little clayey matrix; high angle, tabular cross-beds, beds 0.5 - 1 m thick, scattered pebbles, minor coal partings, in multistory bodies in part. Sandstone grains are subangular, moderately poorly sorted.

Conglomerate (6%) - granule, quartzose, subrounded to angular clasts of felsic volcanics, metasediments, siltstone, chert, coal spars.

Claystone (4%) - minor fine to very fine grained, parallel and ripple cross-laminated, occurs as thin lenticular laminae in dark grey siltstone.

WARWICK NO. 7

0 - 5.4 m Heifer Creek Sandstone Member

Sandstone - quartzose, medium grained, cross-laminated, minor pebble conglomerate at base.

5.4 - 30.81 Koukandowie Formation Undivided (sand/shale ratio 1.3)

Conglomerate (1%) - granule

Sandstone (56%) - fine, medium and coarse grained, light grey to grey, quartz-lithic, cross-laminated, micaceous in part with carbonaceous laminae and grains.

Claystone (43%) - grey, faintly laminated, thin fine grained sandstone interbeds bioturbated; thin, ripple cross-laminated, fine grained sandstone laminae.

A typical fining up sequence in this interval of undivided Koukandowie formation comprises:-

2.7 m Claystone, faintly laminated, with thin (< 5 cm) fine grained sandstone interbeds.

1.5 m Laminated and ripple cross-laminated, fine grained sandstone at base fining up into very fine grained sandstone and grey siltstone.

1.8 m Sandstone, lithic, grey, coarse grained, with fine grained chaffy sandstone interbeds about 10 cm thick.

0.2 m Conglomerate, granule.

30.81 - 72.16 Ma Ma Creek Member (sand/shale ratio 2.1)

Sandstone (63%) - fining up sequences 10 m thick, with granule conglomerate intervals at base. Cross-bedded, quartzose and quartz-lithic, occasional carbonaceons laminae and mica, pebbles and clay pellets, kaolinitic matrix weathered to yellow-brown clay. Large angular clasts of grey siltstone occur in very coarse grained, quartz-lithic sandstone.

Conglomerate (7%) - clasts to 5 cm across, predominantly pebble size, including large irregular carbonaceous fragments, volcanics, white quartz and fine grained metasediments.

Claystone/Siltstone (30%) - dark grey bioturbated, abundant rootlets cross-laminated, carbonaceous laminae.

72.16 - 146.55 Gatton Sandstone (sand/shale ratio 12.4)

Sandstone (86%) - grey, medium to very coarse grained, quartz-lithic and quartzo-feldspathic, cross-laminated, pyritic and calcareous in part. Thin porous intervals.

Conglomerate (7%) - granule and pebble, poorly sorted, coal spars and clay clasts common, mostly in thin interbeds but very common over lower 12 m interval - probably gradational contact with Koreelah Conglomerate Member.

Mudstone (7%) - one interval of mudstone 5.5 m thick (102.2 - 107.4 m). Fine grained sandstone laminae and thin interbeds with ripple cross laminated, low angle laminae and chaffy laminae, erosional bases. Some 5 cm coarse grained sandstone beds with erosional bases and mud chips.

DISCUSSION

The succession of lithostratigraphic units established in the Marburg Subgroup in Warwick 6 and 7 drill holes differs significantly in several aspects from that established in the northern part of the basin where the type sections of the units have been defined. The Heifer Creek Sandstone Member occurs at the top of the Koukandowie Formation in the Clifden-Gatton Road section in the northern part of the basin but in Warwick 6 the top of the member is about 160 m below the base of the Walloon Coal Measures. This relationship implies that the Heifer Creek Sandstone Member may be diachronous. Examination of basin transects in the southern part of the Clarence-Moreton Basin show that the member occurs at the base of the Koukandowie Formation and in most places is separated from the Gatton Sandstone by the Towallum Basalt.

In its type section the Ma Ma Creek Sandstone Member of the Koukandowie Formation comprised approximately equal proportions of sandstone and claystone/siltstone and includes an important marker bed of chamositic oolite. In Warwick 7, the interval identified as Ma Ma Creek Member, although containing claystone/siltstone intervals up to 9 m thick, is composed dominantly (approximately 65%) of sandstone in thick upward fining sequences. The chamositic oolite was not found in Warwick 7, and has not been recorded from other well sections in the southern part of the basin. The absence of oolite and the abundance of sandstone indicates that Warwick 7 intersected a section of the Ma Ma Creek Member in which fluvial deposits, as distinct from lacustrine fine grained deposits, predominate.

The coarser grained conglomeratic sandstone and conglomerate in the Gatton Sandstone over the basal 12 m in Warwick 7 are considerably thicker than normally found in the formation (cf. Fig. 12, Wells et al., in press). This probably represents a transition zone to the Koreelah Conglomerate Member. This observation is consistent with the presence of a coarse grained conglomerate facies at the base of the Gatton Sandstone along the western basin margin where it overlaps basement rocks.

SEDIMENTOLOGY

The Koukandowie Formation and Gatton Sandstone in BMR Warwick 6 and 7 contain abundant wood fragments, thin coaly horizons, rootlet beds and rare palaeosols. Sandstone bodies typically display large-scale cross-beds that indicate unidirectional palaeocurrents. These features are diagnostic of fluvial deposition so the sediments are therefore interpreted as river channel floodplain deposits with the main variations being the proportion of floodplain facies and thickness of channel sandstone bodies.

Above 120.5 m in Warwick 6, the Koukandowie Formation consists mostly of mudstone and fine to medium sandstone bodies up to 5 m thick with rare beds of coarse sandstone. The sandstone bodies are commonly parallel laminated or ripple cross-laminated and some are disturbed by rootlets suggesting that they are crevasse splay or small floodplain channel deposits. Most mudstone beds are silty with fine sandstone laminae, some of which are ripple cross-laminated. Mudcracks are present in a few beds. This suggests that the mudstone beds were mostly deposited on floodplains with high sediment input and moving water. A few laminated or intensely bioturbated claystone beds were probably deposited in ephemeral floodplain lakes. Below 120.5 m, the Koukandowie Formation, including the Heifer Creek Sandstone Member, is mostly medium to coarse grained, large-scale cross-bedded sandstone probably deposited in low-sinuosity, bedload channels.

In Warwick 7, floodplain sediments are also abundant in the Heifer Creek Sandstone Member and the underlying Ma Ma Creek Member. The Ma Ma Creek Member floodplain mudstones are generally finer than those above and the Ma Ma Creek Member sandstone bodies display clear fining-up cycles starting with mud-chip conglomerates at the base passing up into cross-bedded, medium sandstone then into rooted fine sandstone and siltstone and finally bioturbated carbonaceous shale. These sequences suggest deposition by sinuous, mixed or suspended load streams. Their presence means that Ma Ma Creek Member in Warwick 7 contains a higher proportion of sandstone than in many other outcrop and well sections.

This probably does not indicate a systematic lithological difference but a chance occurence of more lenticular channel sandstone bodies in this section.

The Ma Ma Creek Member overlies the Gatton Sandstone with a sharp boundary at 72.6 m. The Gatton Sandstone is predominantly cross-bedded medium to coarse sandstone and granule conglomerate deposited by low-sinuosity, braided channels. The only floodplain deposit is a 5.5 m thick mudstone interval which has abundant fine sandstone interbeds indicating a high energy floodplain.

The depositional styles of the Koukandowie Formation and the Gatton Sandstone in BMR Warwick 6 and 7 appear to be similar to those in the rest of the Logan Sub-basin. However, the Heifer Creek Sandstone Member contains a higher proportion of fine-grained facies in Warwick 6 and 7 than in sections from the northern part of the basin.

IMPLICATIONS FOR PETROLEUM EXPLORATION

The interpretation of vitrinite reflectance data (Powell et al., in prep.) and fission track dating (Gleadow & O'Brien, in prep.), obtained from a comprehensive basin wide suite of samples suggest that BMR Warwick 6 and 7 stratigraphic holes were drilled in an area where the intersected sediments and their contained source rocks could lie in a zone of oil generation.

The vitrinite reflectance and Tmax data (from Rock Eval.) (Table 3, and Powell et al., op cit.) indicate a progressive increase in source rock maturity from west to east. Fission track ages of apatites (Gleadow & O'Brien, op cit.) also indicate higher basin temperatures in the east. The reset ages in this area suggest that maximum temperatures and burial depths were reached in the late Cretaceous. Subsidence curves for the basin (Powell et al., in prep.) indicate greater burial depths for the sedimentary succession in the eastern part of the basin than in the west.

A comparison of the frequency of fine grained facies and total organic carbon in the formations penetrated in the drill holes indicates that the undifferentiated Koukandowie Formation contains the richest and most abundant source rocks. Basin wide it is only surpassed by the Walloon Coal Measures in source rock quality and abundance.

Rock-Eval pyrolysis (REV) (Powell et al., in Wells & O'Brien, in prep.) data show that the coals and carbonaceous shales of the Clarence-Moreton Basin contain oil-prone terrestrial organic matter that are as rich and in some cases richer, than their equivalents in contemporaneous sediments of the Eromanga Basin.

Hence it was not entirely unexpected that the source rock analyses (Rock Eval & TOC) (Table 3) indicated that mature petroleum source rocks were present over some intervals intersected in both Warwick 6 and 7.

All samples obtained from Warwick 6 well were from the Koukandowie Formation and the TOC analyses indicated the presence of excellent oil source rocks with the best indications being obtained in the samples at 27.2, 42.0 and 51.8 m. Other results from Rock Eval confirmed the evaluation of the sediments in these three intervals that occur in the oil zone.

Samples from Warwick 7 were obtained from the Ma Ma Creek Member of the Koukandowie Formation, and the Gatton Sandstone. The samples occur in the oil zone and the best source rocks occur at 56.5 m in the Ma Ma Creek member. TOC indicates an oil source rock in the Gatton Sandstone (a mudstone sample from 104.7 m) but other, <u>in tandem</u>, Rock-Eval indices show poor to fair source rock quality.

Hydrogen index vs oxygen index plots are shown in Figure 8, and hydrogen index vs Tmax plot in Figure 9. These analyses indicate the undifferentiated Koukandowie Formation contains rich source rocks that show immature to oil zone maturation with Type I and II kerogen.

Petrophysical analyses (Table 6) on core samples from Warwick 6 and 7 indicate the presence of favourable porous and permeable zones. Permeabilities of up to 227 md (H) and 75 md (V) and porosities up to 19% were recorded in the Heifer Creek Sandstone Member. Permeabilities of up to 961 md (H) and 9 md (V) and 26% porosity were recorded in the Gatton Sandstone.

The core from BMR Warwick 5A was sampled with the intention of comparing the petrophysical characteristics of the Kangaroo Creek Sandstone with the Heifer Creek Sandstone. However either the position of Warwick 5/5A on the Warwick 1:250.000 geological map is incorrect (see Table 2), or the grid references in the report (Exon et al., 1974) have been transposed, so that the stratigraphic identification of the core is uncertain.

PALYNOSTRATIGRAPHY OF BMR WARWICK DDH 6 AND 7

Forty-three samples, 28 from Warwick DDH 6 and 15 from Warwick DDH 7 (Table 2) were submitted for palynological analysis to test the suggested stratigraphy. All but one sample yielded a palynomorph assemblage and the state of preservation in each was surprisingly good. This report is transcribed from McMinn (1988).

BIOSTRATIGRAPHIC RESULTS

The palynomorph assemblages (Tables 4 and 5) described herein are compared with the zonation of Price et al. (1985). Price et al. (1985) also gave correlation charts of their zonation with various stratigraphies including that of the Clarence-Moreton Basin. They divided the Marburg 'Formation' into four members, which in ascending order were the Gatton Sandstone Member, the Winwill Conglomerate member, the Ma Ma Creek Member and the Heifer Creek Sandstone Member (Figs. 6 & 11).

BMR Warwick DDH 6

Samples down to a depth of 40.96 m contain Retitriletes circolumenus and can therefore be referred to the PJ4 zone (Fig. 11). Samples between 40.96 m and 182.25 m lack R. circolumenus but contain Camarozonosporites ramosus and are therefore equivalent to the underlying PJ3.3.2 zone. The lowest sample, at 188.52 m, lacks C. ramosus and therefore can probably be assigned to the underlying PJ3.3.1 zone. Each of these zones is confined to the 'Heifer Creek Sandstone Member' of Price et al. (1985) and thus the Koukandowie Formation of Wells et al. (in prep.). The palynological ages determined for this sequence are therefore consistent with the application of stratigraphic units by Wells et al. (in prep.).

BMR Warwick DDH 7

Palynomorph assemblages taken from samples to a depth of 20.56 m contain Camarozonosporites ramosus and are therefore equivalent to the PJ3.3.2 zone (Fig. 11). Samples from 31.27 m and 32.60 m lack C. ramosus but contain Klukisporites lacunus and are therefore equivalent to the zone PJ3.3.1. The interval between 32.60 m and 70.33 m contains Staplinisporites manifestus but lacks K. lacunus and is therefore equivalent to the PJ3.2 zone. There is a 32 m sample gap below this level and the lowest samples, which are between 102.42 m and 111.22 m contain assemblages equivalent to the PJ1 zone. Thus the PJ2.2 to PJ3.1 zones have not been recognised in this well but as there is a significant sample gap it is not possible to determine whether this results from the sample distribution or from a depositional/erosional hiatus.

Wells et al. (1988) indicate that BMR Warwick DDH 7 spudded in the

Koukandowie Formation and terminated in the Gatton Sandstone. Price et al. (1985), however, determined that deposition of the Marburg Subgroup, with the Gatton Sandstone at its base, began in PJ2.1. The PJ1 age at the base of this well therefore implies that either the basal sediments are equivalent to the Ripley Road Sandstone (a position inconsistent with the geological interpretation) or that the Gatton Sandstone/Ripley Road Sandstone boundary is diachronous. As the difference in geological time between the assemblages from the sedimentary successions in Queensland compared to New South Wales is minor the latter suggestion seems the more likely. The presence of the zone PJ3.3.2 in this well implies that there is some stratigraphic overlap with the adjacent well, BMR Warwick DDH 6.

KEROGEN ANALYSIS

An approximate kerogen analysis (Fig. 7) was made by a visual inspection of the kerogen components in each assemblage. Those components considered more favourable for oil generation are grouped in the Source Potential Index (S.P.I.). This is composed of exinite (mostly spores and pollen) and the amorphous kerogen components. Combaz (1980) suggested three groups of kerogen-based palynofacies, an oil prone (sapropelic) kerogen, a gas prone (lignitic) kerogen and an intermediate mixed oil and gas prone (liptinic) kerogen. The oil prone facies is typically dominated by the amorphous components whereas the liptinic facies is more typically dominated by the terrestrially derived components such as 'biodegraded terrestrial' and exinite.

Sapropelic kerogen (as indicated by peaks in the S.P.I.) has a discontinuous distribution in BMR Warwick DDH 6 and 7 but several samples, particularly in the upper Koukandowie Formation, do have high to very high values. If the biodegraded terrestrial component is added to the S.P.I. values most of the sequence is found to have liptinic source potential.

The three peaks corresponding to high S.P.I. from samples in Warwick No. 7 at about 21 m, 56 m and 102 m were also analysed by Rock-Eval & TOC. The sample at about 56 m shows good source rock potential with 7.74% TOC and corresponding good Rock-Eval indicators. The sample at 102 m has 1.64% TOC, and 1.29% TOC at 21 m, but otherwise both have poor source rock indications. Samples at 33 m (1.31% TOC) and 105 m (1.08% TOC) show low S.P.I. values so there does not appear to be an exact correspondence between S.P.I. and source rock analyses.

There were no samples analysed by Rock-Eval/TOC corresponding to the high S.P.I. values obtained from samples at approximately 97 m and 112 m in Warwick 6 and hence no direct comparison can be made.

SPORE-POLLEN DISCOLORATION

The spore-pollen discoloration in BMR Warwick DDH 6 and 7 is in the orange range, TAI 2.0, implying an equivalent vitrinite reflectance of 0.5 - 0.6. This indicates a thermally mature temperature regime.

CONCLUSIONS

The stratigraphic drilling on the western flank of the Clarence-Moreton Basin has:

- elucidated the stratigraphic succession in an area of little outcrop.

The lithostratigraphy can be compared with units in the northern portion of the basin where most of the type sections have been established. There are three main differences between the two stratigraphic successions. At the drill site the quartzose Heifer Creek Sandstone Member occurs much lower in the Koukandowie Formation; the Ma Ma Creek Member is composed dominantly of sandstone and the chamositic oolite marker bed is not present; and the basal portion of the Gatton Sandstone intersected in the stratigraphic hole is conglomeratic which undoubtedly represents a gradation to the Koreelah Conglomerate Member:

- demonstrated the presence of permeable and porous sediments in both the Heifer Creek Sandstone member and the Gatton Sandstone.

Analyses of selected samples from both the Heifer Creek Sandstone Member and the Gatton Sandstone has demonstrated the presence of porous and permeable sediments in both formations. Porosities in the Koukandowie Formation range from 15.4 to 19% and permeabilities from 2.84 to 227 md in Warwick 6, and in the Gatton Sandstone 12.0 to 25.9%, and 0.943 to 961 md respectively in Warwick 7:

- shown the presence of oil prone source rocks in the Koukandowie Formation.

Analyses of selected samples has shown the presence of oil prone source rocks in the Koukandowie Formation in BMR Warwick 6 (from samples analysed at 27.2 m, 42.0 m, and 51.8 m) and in the Ma Ma Creek Member of the Koukandowie Formation in BMR Warwick 7 (from a sample analysed at 56.5 m):

- yielded a well preserved sequence of palynomorphs that indicate an age range from PJ_4 to PJ_1, and allowed a biostratigraphic framework to be erected.

This framework allowed direct comparisons and age correlations with established zones in the northern Clarence-Moreton Basin.

Palynomorphs from $PJ_{2.1}$ to $PJ_{3.1}$ zones were not found,* but they may be represented in an interval about 32 m thick which was not sampled, and analysis of samples from this interval are in progress.

* Footnote An alternative view presented by Burger (in prep.) suggests another scheme for the zonation of the assemblages and indicates that there may be no significant time break in this interval.

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TABLE 1 - INTERVALS AND STRATIGRAPHIC SEQUENCES IN BMR WARWICK 6 and 7

BMR Warwick 6

0 - 199.37 m (T.D.)	Koukandowie Formation
157.7 - 199.37 m (T.D.)	Heifer Creek Sandstone Member

BMR Warwick 7

0 - 72.16 m	Koukandowie Formation
0 - 5.4 m	Heifer Creek Sandstone Member
30.81 - 72.16	Ma Ma Creek Member
72.16 - 146.55 (T.D.)	Gatton Sandstone

TABLE 2 ANALYSED SAMPLES

THIN SECTION

	BMR Warwick No. 6.	BMR Warwick No. 7.
Depth (m)	32.22	117.21
	52.18	132.50
	143.9 - 144.10	135.86
	165.68	137.55
	173.15	
	173.75	
	195.03 - 195.13	

POROSITY/PERMEABILITY

	BMR Warwick No. 5A. *
	Large Core
Depth (ft)	226' 9" - 227"

	BMR Warwick No. 6.	Plugs
Depth (m)	143.71 - 143.81	144.10 - 143.90
	165.67 - 165.78	165.68 - 165.60
	173.03 - 173.15	173.15
	173.63 - 173.78	195.03 - 195.13
	196.0 - 196.08	

* Footnote: The identification of the stratigraphic unit in BMR Warwick 5A is uncertain. Either the sites of BMR Warwick 5, 5A and BMR Warwick 3 have been transposed on the Warwick 1:250.000 Geological Map (1st Edition, 1972), or alternatively the grid references given in the report (Exon et a., 1974) have been transposed.

BMR Warwick No. 7	Plugs
117.23 - 117.31	117.15 - 117.4
132.58 - 132.73	
135.86 - 136.07	
137.35 - 137.54	

PALYNOLOGY

	BMR Warwick No. 6	BMR Warwick No. 7
Depth (m)	87.04	8.36
	90.38	12.07
	96.82	14.90
	98.64	16.76
	105.30	20.56
	112.02	31.27
	120.44	32.60
	127.56	47.72
	132.57	56.45
	149.52	56.75
	156.61	69.10
	174.37	70.33
	178.55	70.57
	182.25	72.00
	188.52	79.55
		89.25
		102.14
		102.42

103.64

107.35

111.22

111.42

142.20

SOURCE ROCK ANALYSIS (ROCK EVAL)

	BMR Warwick No. 6	BMR Warwick No. 7
Depth (m)	27.10 - 27.29	15.06
	27.97 - 29.93	21.78
	34.35	30.87
	40.72	32.56
	42.00	47.90
	46.72	56.45
	51.60 - 51.90	70.22
	60.24	71.97
	132.43	102.39
	156.54	104.74

XRD

BMR Warwick No. 6

91.34

INORGANIC CHEMICAL ANALYSIS

BMR Warwick No. 7

Core # 50, 132.58 - 132.7 m (Part II)

TABLE 3 - SOURCE ROCK ANALYSES

BASIN/AREA CLARENCE-MORETON WELL/LOCALITY WARWICK NO. 6

KOUKANDOWIE FORMATION

ID	DEPTH M	TMAX DEG C	S1	S2 KG per TONNE	S3	S1+S2	S2/S3	PI	TOC %	HI	OI
4365	27.2	435	10.61	131.52	1.16	142.13		.07	33.10	397	4
4366	28.0	446	.63	15.63	.39	16.26	40.08	.04	3.69	424	11
4367	34.4	434	.15	1.49	2.39	1.64	.62	.09	1.11	134	215
4368	40.7	444	.46	5.72	.19	6.18	30.11	.07	1.83	313	10
4369	42.0	435	7.45	134.96	.67	142.41		.05	35.10	385	2
4370	46.7	443	.46	7.07	.25	7.53	28.28	.06	2.40	295	10
4371	51.8	437	1.35	25.46	.35	26.81	72.74	.05	6.74	378	5
4372	60.2	443	.11	.90	3.08	1.01	.29	.11	.77	117	400
4373	132.4	443	.14	1.96	.08	2.10	24.50	.07	1.01	194	8
4374	156.5	451	.26	2.93	.16	3.19	18.31	.08	1.71	171	9

BASIN/AREA CLARENCE-MORETON WELL/LOCALITY WARWICK NO. 7

KOUKANDOWIE FORMATION-MA MA CREEK MEMBER

ID	DEPTH M	TMAX DEG C	S1	S2 KG per TONNE	S3	S1+S2	S2/S3	PI	TOC %	HI	OI
4375	15.1	437	.02	.56	.02	.58	28.00	.03	.41	137	5
4376	21.8	443	.07	1.06	0.00	1.13		.06	1.29	82	0
4377	30.9	440	0.00	.27	0.00	.27		0.00	.34	79	0
4378	32.6	437	.02	.35	0.00	.37		.05	1.31	27	0
4379	47.9	439	.13	1.72	0.00	1.85		.07	.68	253	0
4380	56.5	441	1.45	47.86	.17	49.31		.03	7.74	618	2
4381	70.2	442	.07	.73	1.45	.80	.50	.09	.91	80	159
4382	72.0	441	.07	.98	.07	1.05	14.00	.07	1.09	90	6

GATTON SANDSTONE

ID	DEPTH M	TMAX DEG C	S1	S2 KG per TONNE	S3	S1+S2	S2/S3	PI	TOC %	HI	OI
4383	102.4	439	.10	1.70	0.00	1.80		.06	1.64	104	0
4384	104.7	442	.19	2.39	.29	2.58	8.24	.07	1.08	221	27

TABLE 6 CORE ANALYSES

WARWICK 5A, 6 & 7 Ambient

Sample	Bulk Volume	Bulk Dry Density	Apparent Grain Density
WARWICK 5			
1	21.91	2.25	2.67
WARWICK 6			
2	18.52	2.19	2.70
3	22.76	2.24	2.66
4	49.31	2.18	2.66
5	52.07	2.25	2.67
6	21.82	2.27	2.71
WARWICK 7			
7	46.07	2.19	2.67
8	35.77	2.10	2.69
9	52.02	2.41	2.73
10	45.69	1.98	2.67

TABLE 6 (CONT.)

WARWICK 5A, 6 & 7 Ambient

Sample	Depth	Permeability (md)	Porosity (%)
WARWICK 5			
1	226.10 ft	5.65	15.7
WARWICK 6			
2	143.97 m	6.42	19.0
3	165.75 m	160	15.9
4	173.06 m	227	18.3
5	173.73 m	23.6	15.4
6	196.02 m	2.84	16.0
WARWICK 7			
7	117.29 m	9.81	18.0
8	132.63 m	52.3	21.7
9	135.94 m	0.943	12.0
10	137.40 m	961	25.9

TABLE 6 (CONT.)

WARWICK 5A, 6 & 7		Ambient	
Sample	Depth	Permeability (md)	Porosity (%)
WARWICK 5			
1V	226.11 ft	6.27	
WARWICK 6			
2V	143.93 m	1.58	
3V	165.70 m	74.5	
4V	173.12 m	34.3	
5V	173.67 m	14.4	
6V	196.05 m	9.58	
WARWICK 7			
9V	135.88 m	8.86	

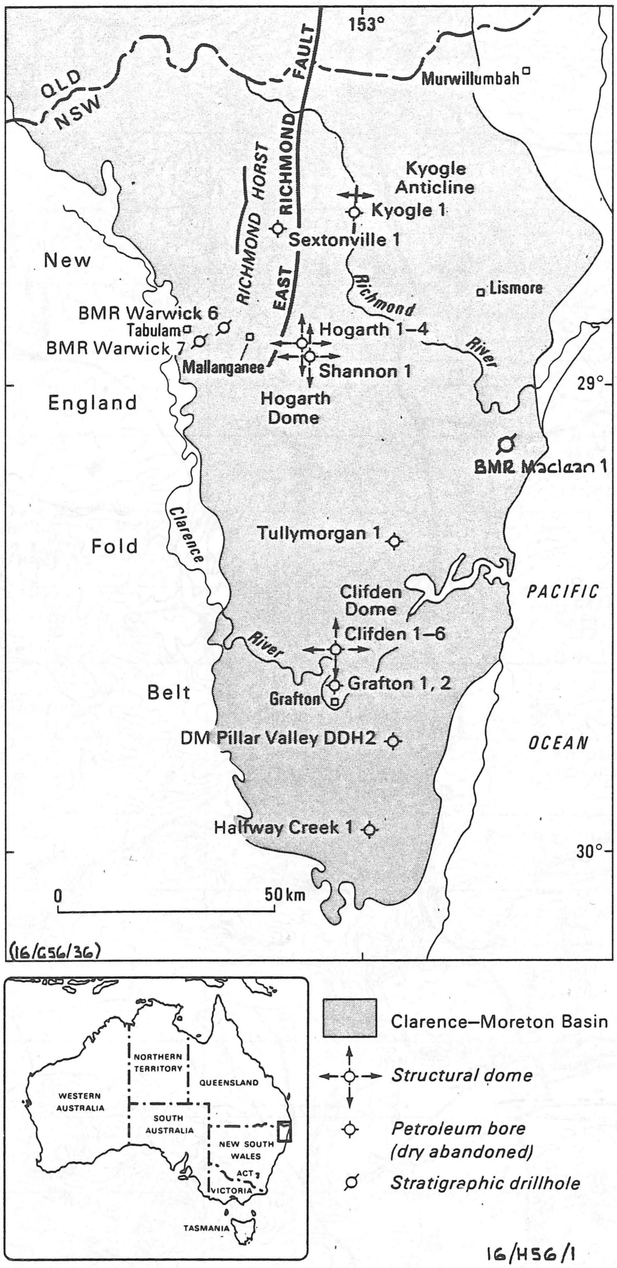

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Fig. 1. Locality map

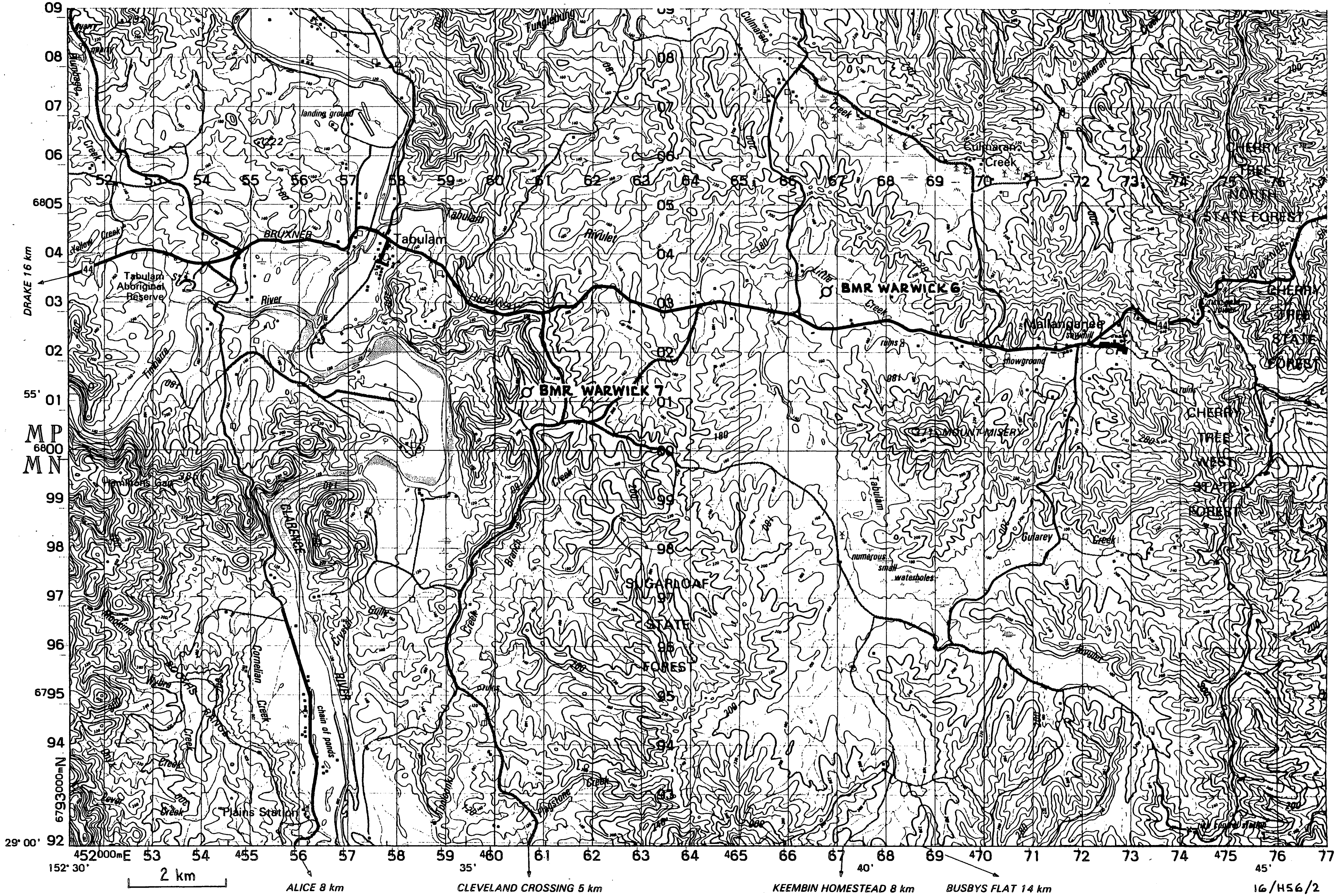

Fig. 2. Detailed location of BMR Warwick 6 and 7

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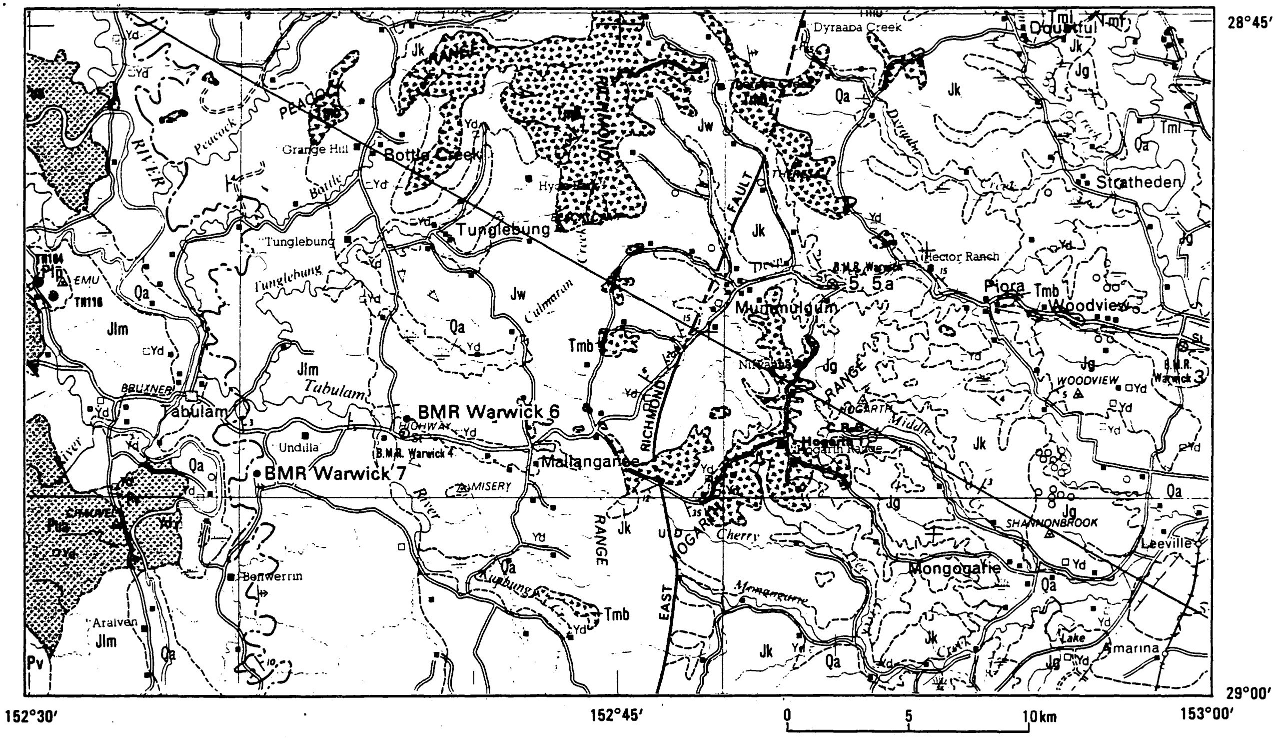

Reference

——— Geological boundary

Fault (D, U indicate relative movement down, up)
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries, folds are dotted, faults are shown by short dashes

⁄40 Strike and dip of strata

\+ Horizontal strata

6 Fossil locality—general.

◉ TH 124 Macrofossil locality and field collection number

--—— Fossil wood horizon

Quarry

Ma Marble

Oil well, dry hole, abandoned

⊗St Stratigraphic hole

○ Shallow water bore

Dam on stream

Swamp

Highway

Road

Vehicle track

Telephone line

Built up area

■ "Montrosa" Homestead

▪ Building, hut or outstation

□ Yd Yard

• 204 Elevation in metres

△ Trigonometrical station

CAINOZOIC	QUATERNARY		Qa	Alluvium: sand, silt, mud, gravel.
	TERTIARY MIOCENE	Lamington Volcanics	Tml	Sub-alkali basalt, minor tuff and agglomerate.
			Tmb	Basalt.
MESOZOIC	UPPER JURASSIC	Grafton Formation	Jg	Lithic sandstone, siltstone, mudstone
		Kangaroo Creek Sandstone	Jk	Quartzose to feldspathic sublabile sandstone
	MIDDLE JURASSIC	Walloon Coal Measures	Jw	Fine labile sandstone, siltstone, mudstone, coal calcareous in part. Plant fossils.
	LOWER JURASSIC	Marburg Subgroup	Jlm	Feldspathic to feldspathic sublabile sandstone, pebbly in part; lesser siltstone, mudstone. Basal pebbly arkose in west
PALAEOZOIC	UPPER PERMIAN		Pua	Adamellite, granite, diorite, granodiorite
	LOWER to UPPER PERMIAN	Drake Volcanics	Pv	Agglomerate, crystal and crystal lithic tuff; minor flows and interbedded sediments
	LOWER PERMIAN	Paddys Flat Formation	Plp	Sandstone, mudstone, conglomerate; minor volcanics and limestone

16/H56-2/1
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Fig. 3 Geological Sketch Map

Graphic log

DRILLHOLE: BMR ~~#~~ WARWICK No.6.

Sheet 1 of 8

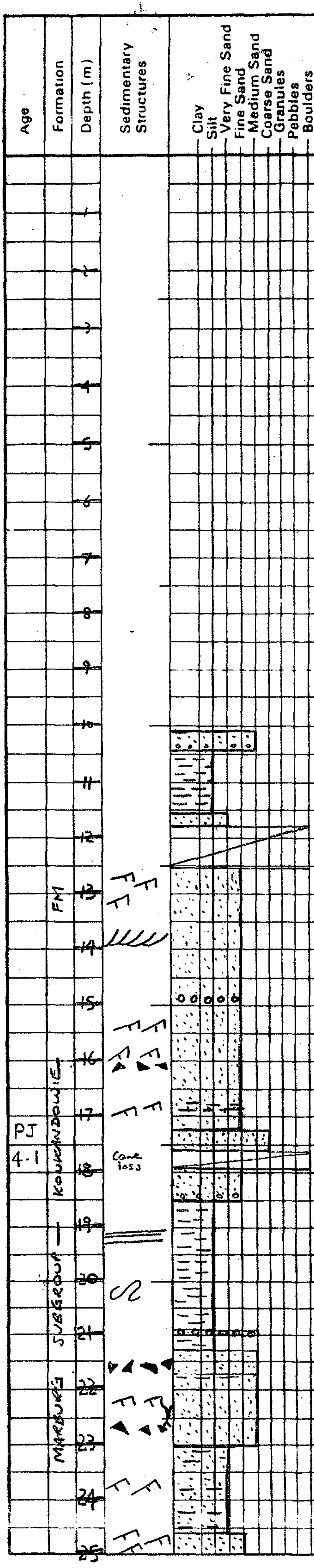
Fig. 4.

Description

N.B. Cores not shown on log.

0 – 25m

Depth from rig floor = 0.9m



Not logged

Weathered, friable, qtz-lithic, coal partings, shale partings, gy, m-f. gr.

Weathered, siltstone/claystone, minor (5%) fine sst., lt. br to lt. gy., thin-bedded to laminated. Horizons of weathered ?ironstone (granules, pebbles in clay matrix) at 10.5-10.8.

gy, pyritic,

Core loss

lt. gy. f-m. gr. sst., qtz-lithic, some mica, ?silty matrix, low-angle x-laminated to flat-bedded, dark carb. to coaly laminae and x-bed partings.

Minor thin claystone (1-5cm), mudchips, minor (<5% coarse sst. - fine congl.).

Gy., med.- coarse qtz-lithic sst., subrounded-subangular grains, mod. sorted, clay matrix, x-bedded at base.

Gy., f-m. gr. qtz-lithic sst., mudstone & carb. mudstone laminae at top with fine-scale x-laminae; pebble congl. at base & other intervals, minor coal partings.

Gy-br laminated siltstone-claystone, carb., thin fine sst. intervals, minor coal partings, irregularly contorted stratification 19.70 - 20.46m.

M-c sst., qtz-lithic, minor pebble hzn. towards top, minor coal fragments

As above

M.gr. qtz-lithic sst, some c.gr., claystone & lithic pebble clasts, poorly trough x-bedded

M-f. gr. qtz-lithic sst., some coarse gr., carb. laminae, ~~[illegible]~~, sst. mod. sorted, grains subangular - subrounded. Siltstone-claystone clasts. Thin lithic pebble horizons. Occ. siltstone interbeds. High-angle x-beds, to low-angle x-lamination; Base erosive?

Gy., f-v.f. sst. (55%), lithic-qtz., fine carb. laminae, small-scale low-angle x-lamination. Interbedded/interlaminated with gy-br. claystone - ~~[illegible]~~ siltstone (45%). Some irregularly contorted stratification. Base sharp & regular.

Lt gy. f. gr. qtz-lithic sst., clay matrix, mod. well sorted, subangular grains, ~~30-2/35~~ ↓

16/H56/9 (1/8)

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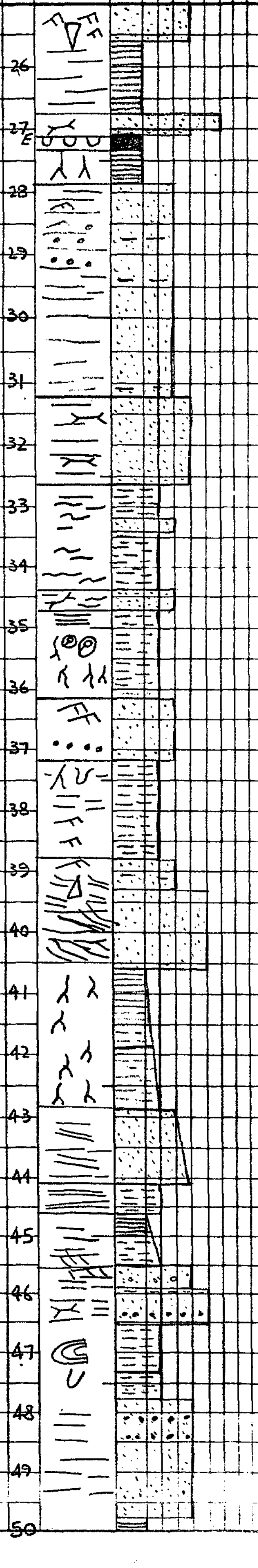
DRILLHOLE: BMR WARWICK No 6 Sheet 2 of 8

25 - 50m

Age | Formation | Depth (m) | Sedimentary Structures | Clay | Silt | Very Fine Sand | Fine Sand | Medium Sand | Coarse Sand | Granules | Pebbles | Boulders | Description | Dip | Photograph | Colour

Depth from floor = 0.9m



Variably x-bedded, from regular mod. angle x-beds at top, to irregular wavey low-angle x-lamination. Small to med. scale sets. Minor claystone clasts. Base gradational, regular

25.61

Gy-br. claystone, laminated - places with f. sst. / siltstone, some thin interbeds of fine sst. pebbly horizons, carb. veining at 26.47m. Irregular thin interbeds of fine qtz-lithic sst. (some with pebbles) at top. Base sharp, regular.

26.75

C. to v.c. lithic qtz sst., poorly sorted, subangular grains, grades to granule - pebble congl. (30%) at top, polymictic, rounded to angular clasts, poorly sorted, c ss matrix, lithic & coal clasts. Base erosive.

27.0

F-m. gy-gr. lithic sst. + claystone. Coal + ? soil hzn. at top + 20mm core loss at base.

27.29

Dk. gy-bl. carb. clayst. + coal; 110mm lt. gy. friable claystone at base. Grad. base.

27.84

Gy. v.f. sst., abundant carb. laminations, with interbeds & interlaminations of dk. gr. claystone (~10%) and gy. siltstone (~15%), minor coal partings; irregularly contorted stratification, occ. mudchips, bedding flat & irregular.

31.22

F. to m. sst., lt. gy, carb. laminations, occ. coal fragments. Sst. qtz-lithic. Minor (2-5%) claystone interbeds towards top. Sharp, irregular erosive base.

32.66

Gy.-br. laminated siltst. - clayst. - f. sst., parallel & irregular laminations, some carbonaceous

33.23

Gy. v.f. sst, vertically jointed, fine parallel silty laminae, carbonate on joints. Base reg., grad.

33.40

Dk. gy to gy.-br. siltst., irregularly laminated, abundant carb. laminations, coal partings, plant fragments. Some fine sst., claystone laminations, irreg. lam. contortions. Base sharp but scalloped.

34.44

F. grained lithic sst. ~~[illegible]~~, irreg. laminae of siltst., coal fragments. Base gradational

34.69

Lt. gy. siltstone, coal fragments, carb. laminations in part. Occ. thin f-m gr. lithic sst interbed. Thin laminated claystone at base. Base gradational, irregular.

36.16

Lt. gy, v.f. to fine gr. lithic-qtz sst., in part with carb. & silty laminae, occ. coal partings & fragments, irregular contorted bedding towards base. Base gradational, irregular.

37.23

Lt. & dk gr laminated siltstone, f. sst. interbeds, some c̄ erosional bases. Base of siltst. regular but scalloped

38.80

Gy. v.f. sst., lithic-qtz, laminae and thin beds of gy. laminated siltst. (20%), some carb. laminae, fine coal fragments. Base sharp, irregular, scalloped.

39.33

Mid-gy. m. gr. qtz-lithic sst., minor carb. laminae, occ. coaly fragments, scattered rounded to angular claystone clasts towards base. Sst partly vertically jointed c̄ carb. & pyrite on joints. Sst. has carbonate cement. Base sharp, regular (? erosive).

40.58

Dk. gy claystone, scattered coaly fragments, gradational down to lt. grey claystone, no coaly frags. Gradational to →

non-laminated and laminated, dk - lite gy. siltst.

Base is semi-regular & gradational.

42.93

Lt. gy. f. to v.f. gr. qtz-lithic sst, regular to wavey carb. lamination & small-scale x-lamination, low-angle, some parallel laminated. Base irregular, diffuse, ? erosive, with load cast.

44.11

Dk. gy, to gy-br. laminated siltst. (55%) some carb. laminae. F-to v.f. qtz-lithic sst. interbeds (45%), parallel & x-laminations, some carb. Base sharp, irregular, ? erosive

44.60

Lt. gy. claystone, minor (15%) v.f. sst. Base gradational.

45.03

Gy. siltst. with interlaminated v.f. sst., laminae irregular, some carb. Lithic, mudstone & coal fragments towards base. Base is semi-regular, sharp to diffuse.

45.52

Gy. fine gr. qtz-lithic sst. parallel to x-laminated, ~~[illegible]~~, minor coal fragments. Base is regular, scalloped, load casts. V.c. sandst. to fine pebble horizons.

45.92

Gy. m-c sst., qtz-lithic, f. gr. congl. horizons towards base, some mudchips. Poorly parallel laminated in part, some carb. laminae. Coal spars, minor siltst. interbeds. Claystone + coal 2 cms at top. Base is regular, microfaulted, minor load cast.

46.53

Dk. gy clayey siltst. to br. siltst., f. sst. interbeds & laminations. Parallel laminated, contorted laminations towards base. Base c̄ sst. sharp, regular.

47.29

Gy-br. siltstone (~50%), f. to v.f. sst. laminae & interbeds (~50%). Siltst. parallel to shallow x-laminated. Sst. interbeds c̄ ? erosive bases, low-angle x-lamination. Base diffuse. 10cm sst. at top.

47.75

Lt. gy. fine gr. qtz-lithic sst, selective intervals of carb. cement, some m. gr. sst. also. Mudclast congl. towards top. Minor coal spars. Parallel laminated, minor x-lamination. Base is sharp, regular, parallel to high-angle x-sets in unit below, not erosive

49.75

PJ
4.1

FW

KOUKANDOWIE

MARBURG SUBGROUP

PJ
3.3.2

~~30-2/35~~ 16/H56/9 (2/8)

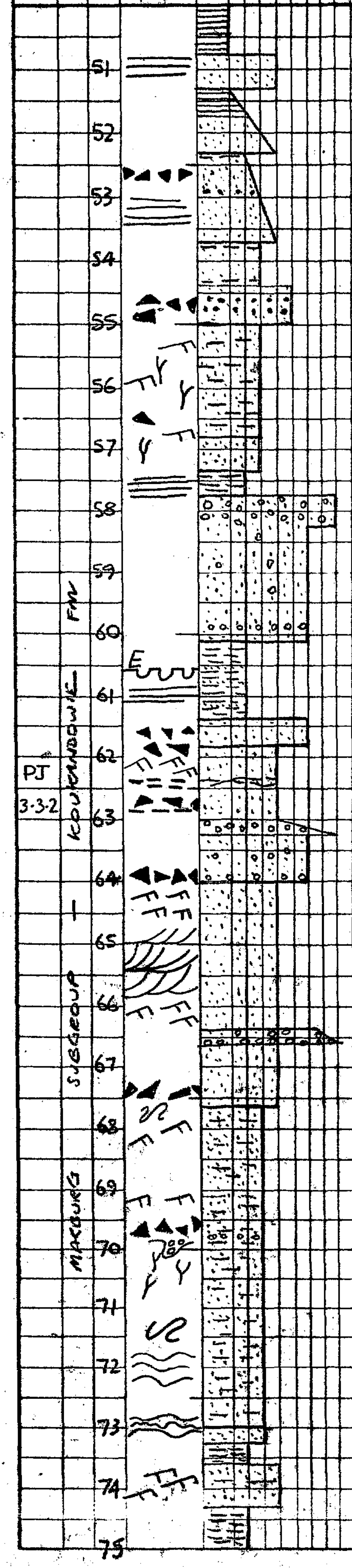
Record 1990/8

DRILLHOLE: BMR WARWICK No 6

Sheet 3 of 8

50-75m

Age	Formation	Depth (m)	Sedimentary Structures	Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders	Description	Dip	Photograph	Colour



Gy. claystone to ~~cl~~ clayey siltstone. Br., high-angle x-laminated siltstone (4 cms) at top.
Base is irregular, poss. gradational thru siltstone.

50.72

Gy. fsst to vfsst, parallel laminated with gy. siltst. & carb. laminae. Base sharp, irregular, load cast.

51.29

Dk gy to gy-br. claystone, abundant subvertical to subhor. carb. wisps (= ? rootlets), single coaly horizon. Grades downwards to vf sst., qtz-lithic, clay matrix, carb. wisps, grades down to fine sst. All parallel laminated. Base is sharp, regular

52.29

Lt. gy-br. siltst. (1-2cms) at top, grad. down to lt. gy. vf sst (~40%) with parallel laminations, some carb. laminae, carb. wisps, grad. down to parallel laminated f gr. (some med. gr.) qtz-lithic sst. with mudchip congl. horizon, coaly fragments and some carb. laminae.
Base is sharp & regular.

53.67

Gy. vf to f sst., qtz-lithic, parallel laminated. Interbedded & interlaminated with gy-br. siltstone (40%), finely laminated (parallel to lesser low-angle x-laminations). Sst intervals have sharp, regular bases, load casts & sharp tops with siltst.

54.43

Mgr. qtz-lithic sst, abundant mudchip congl. (15%), minor laminated gy. siltst. with carb. laminae (~10%). Base sharp, regular.

55.03

Gy-gr. vf sst (~80%), parallel to ripple x-laminated, with carb. & siltst. laminae. Gy to gy-br. siltst. (20%), parallel & ripple x-laminated, interbedded & interlaminated c̄ sst. Irregularly contorted laminae at base. Base sharp, irregular.

56.83

vf sst. as above, diffuse parallel & low-angle x-laminae, some carb. Base sharp to irregular marked by disrupted bedding contact with siltst.

57.36

Dk gy siltst. as above (55%) interbedded & interlaminated with vf sst. as above. Base sharp, regular.

57.73

Fine to coarse pebble congl., polymictic, poorly-sorted m sst to vc sst matrix, carb. cement, + pebbly v.c. sst. Clasts of qtz., chert, (? meta) siltst., felsic volcanics. Grades downwards to ↓

Lt. gy. csst - msst, in part is very coarse to pebbly sst., calcareous cement in 2 intervals. Poorly parallel bedded to mod. well x-bedded (high-angle x-beds).

60.09

Gy to gy-br. finely laminated siltstone (70%), with interlaminations & interbeds of f sst. (30%) (lt. gy, parallel laminated, sharp bases on interbeds). Some carb. laminae in siltst., parallel & low-angle x-lamination.

61.43

c sst. to m sst., qtz-lithic mod. poorly sorted, subangular grains. Base irregular, sharp, disrupted contact c̄ siltst. Poss. upward fining to thin siltstone at top.

61.78

Lt. gy f sst, x-laminated an parallel laminated, some intervals (~8%) of carb. parallel laminations. With gy-br siltstone (as above) (10%) as interbeds or mudchip fragments. Base grad. to ↓

F-m pebble congl., polymictic, f sst. matrix, clasts subrounded-subangular, comprise white qtz., jasper, chert, volcanics, ?meta siltstone. Base sharp, coal lamination

63.26

C-vc sst, lithic-qtz, friable, clay matrix, mod. poorly sorted, poorly laminated, pebbly to granule horizons, Base abrupt.

64.05

Lt. gy fss, high-angle to low-angle x-lamination, parallel x-lamination, small-scale x-lamination, some carb. lamination. Sst is qtz-lithic, mod. sorted to mod poorly sorted. Pebbly horizon at 66.48 - 66.58.

Base is sharp, irregular, load cast, disrupted.

67.61

Gy. vf sst, (~65%) interlaminated & interbedded with dk. gy. & gy-br siltstone, minor claystone. Parallel & low-angle x-laminae, some ripple x-laminae. Irregularly disrupted & contorted bedding common. Some vf sst interbeds, 10-30cms thick with carb. & siltst. laminae, sharp to diffuse bases. F pebble congl. at 69.83 m prominent load casts at base. Minor intervals of m sst, & claystone. Base sharp.

72.99

Gy. vf sst, parallel laminated, carb. laminae. Base sharp, irregular

73.25

Gy. clayey siltstone, base diffuse, irregular

73.60

Gy. fsst to vfsst, parallel laminated, carb. laminae. Base sharp, regular.

74.28

74.83

~~30-2/75~~ 16/H56/9 (3/8)

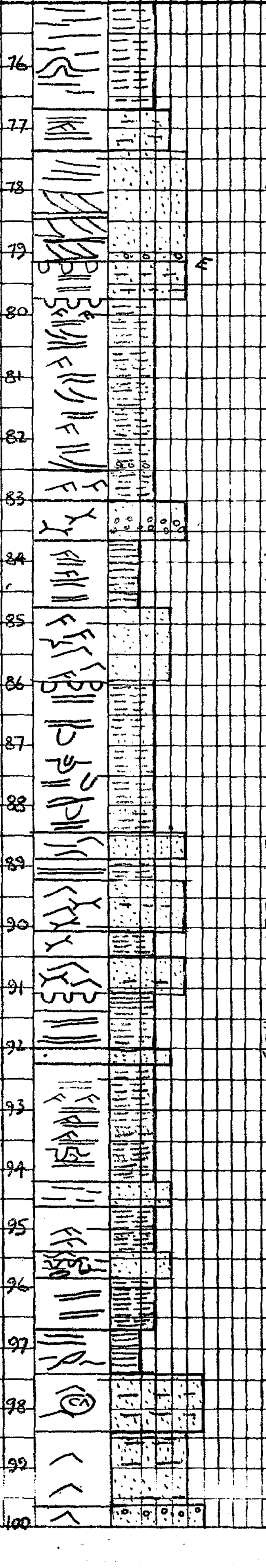
Record 1990/8

DRILLHOLE: BMR WARWICK No. 6 Sheet 4 of 8

75 - 100m

Age: PJ 3.3.2 — MARBURG SUBGROUP

Formation: KOUKANDOWIE FM



Description	Dip	Photograph	Colour	
Dk. gy clayey siltst., minor gy claystone, interlaminated & interbedded with gy vf sst, (30%) Irregularly contorted laminae + parallel laminae. Base transitional.				76.66
Vf sst as above, interlaminated & interbedded with dk gy clayey siltst as above, (~30%) Base diffuse, irregular.				77.37
Lt gy fsst, parallel & low-angle x-laminated, carb. laminae towards top. F pebble congl. layer at base. Base sharp, regular.				79.16
Lt gy fsst to msst (55%) ~~[illegible]~~ interbedded ~~[illegible]~~ = dk gy siltst. Sst beds have sharp ~~[illegible]~~ irregular bases				79.72
Interlaminated dk gy siltstone and gy vf sst. Parallel & low-angle x-laminations, ripple x-laminations, occ. pebbly horizons. Base is sharp, slightly irregular.				83.01
Gy to Gy-gr fine sst. to f-m pebble conglomerate. Congl. clasts are subangular-subrounded, comprise ? felsic volcanics, gy chert, coal spars, jasper. Abundant coaly wisps & laminae. Base is sharp & regular				83.66
Interlaminated gy to gy-br claystone - fine siltstone, with gy-br siltstone, & gy-gr f sst. Laminations irregular. Thin interbeds (2-3 cm) of gy-gr f sst + pebbles. Base sharp, slightly irregular.				84.74
Vfgr to fgr gy to gy-gr sst. low-angle x-lamination, small-scale x-lamination. Contains thin interbeds (several mm - several cm) of siltstone / claystone, with sharp, regular to irregular contacts with sand. Base sharp, slightly irregular (? some erosive)				85.94
Interlaminated gy siltstone, gy-br claystone & vf gy sst, with thin (1-3cm) interbeds of gy-gr m sst & gy vf sst. Parallel to low-angle x-laminae in siltstone-claystones. Sst beds have sharp, regular to slightly irregular bases & sharp to diffuse tops. Load casts on some sst. bases, erosional contacts present.				88.45
F-m sst, lt gy-gy-gr, some fine pebbles, interbeds of gy siltstone (5-10%). Parallel to low-angle x-lamination in sst., coal spars towards base. Base is sharp, sl. irregular, erosive.				88.88
Interlaminated siltstone, claystone, vf sst., as above				89.20
F ~~[illegible]~~ - vf sst lt gy-gy.gr, qtz-lithic, parallel to x-laminated. Interlaminated to thinly interbedded with gy siltstone. Abundant coal partings. Some wavy ~~[illegible]~~ bedding. Base is sharp, sl. irregular ~~[illegible]~~				90.10
Interlaminated to interbedded gy siltstone, dk gy claystone & vf sst. Laminations diffuse, irregular. Minor coal partings. Base sharp, regular.				90.47
Lt gy to gy-gr qtz-lithic vf-c sst, with minor (5%) very thin interbeds of gy siltstone. Sst parallel to x-laminated, in some cases non-laminated. Thin bed sets of about 20cms, erosive bases, upward fining. Base sharp, slightly irregular		△		91.15
Interlaminated gy-br siltstone, claystone, ~~[illegible]~~ with v. minor vf sst. Laminae parallel to low-angle x-laminations, some irregular laminae. Base sharp, regular				92.02
Vf gy-gr sst, parallel laminated to low-angle x-~~beds~~, some med-c sst. Base sharp, regular.				92.29
Interlaminated gy to gy-br siltstone, gy claystone & vf gy sst. Parallel to x-laminated, some irregularly contorted laminae. Thin (1-15cms) interbeds of gy vf-m qtz-lithic sst, with sharp, regular to slightly irregular tops & bases. Base sharp, regular.				94.18
Gy-gr vf sst interlaminated with gy siltstone (10%). Base laminated, & diffuse.				94.60
~~Interlaminated~~ As above.				95.40
Vf gy-gr sst. Irregular parallel laminations. Base sharp, regular.				95.81
As above, with m sst, lithic-qtz towards base. ~~[illegible]~~ Base sharp, regular.				96.73
Dk gy-gy.br laminated claystone-siltstone. Contact abrupt, not preserved in core				97.44
Gy-gr vf to coarse sst, with interbeds of gy siltstone (15%). Sst is poorly ~~bedded~~ qtz-lithic, some pebbly horizons, coal partings. Silty sst towards top. Base is sharp, slightly irregular.				98.46
Gy f-vf qtz-lithic sst (70%) with units of laminated gy siltstone - claystone. Sst is parallel to low-angle x laminated.				99.61

~~30 2/35~~ 16/H56/9 (4/8)

Record 1990/8

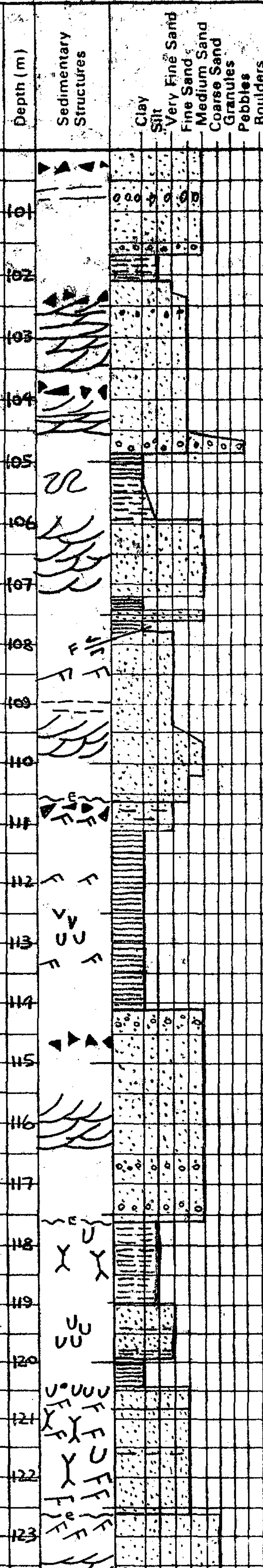
DRILLHOLE BMR WARWICK NO 6

Sheet 5 of 8

100 - 125m

Age: PJ 3.3.2

Formation: MARBURG SUBGROUP, KOUKANDOWIE FM



Description

Gy to gy-gr m-f sst. Qtz-lithic sst, pebbly at base & top. Low-angle x-beds, bed sets of the order of 450mm thick, ~~[illegible]~~ or less, upward-fining in one set. Base is sharp, slightly irregular.

101.70

Interlaminated & ~~interbedded~~ gy-br siltstone lesser claystone + vf gy sst. Some ~~pebbly horizons~~. Some carb. Base sharp, slightly irregular.

102.12

Lt gy friable qtz-lithic f sst., some carb, parallel laminae, some pebble horizons. Grades to vf gy sst at top. Minor mudchip congl. Sst is parallel laminated, ~~[illegible]~~ with lesser low-angle x-lamination.

F-vc pebble congl., subrounded-subangular clasts, poorly sorted. Base sharp, erosive.

104.91

~~Gy claystone – siltstone. Base gradational~~

Dk gy siltstone and interlaminated gy-gr vf sst + minor claystone. Base gradational. Laminae parallel to low-angle x-lamination, + irregularly contorted laminae.

105.96

Gy silty qtz-lithic m-f sst. Low-angle ~~[illegible]~~ x-lamination. Base sharp, regular on claystone. Base of sst v silty.

107.20

Br claystone. Base not preserved.

107.39

~~Pebbly lithic m sst~~

Gy claystone: Base faulted. Fault normal, displacement about 1cm.

107.65

107.90

Vf sst, parallel to low-angle x-laminations. Sst is gy to gy-gr, qtz-lithic, with carb. laminae and scattered fine pebbles. Base is gradational to:

C to m qtz-lithic sst., low to high-angle x-laminae & x-beds, scattered lithic fine pebbles, base abrupt (? erosive).

F sst., gy with scattered vc sand & vf pebbles. Base sharp, erosive.

110.64

Interlaminated vf sst, gy siltstone. Parallel to low-angle x-laminae. Coarse sand to vf ~~pebbles in some horizons. Gradational downwards to:~~

111.11

Laminated gy to dk gy claystone & siltstone, with minor v. thin interbeds of vf gy sst. Laminae are parallel to slightly low-angle x-laminae, some irregular laminae. Scattered coal partings. Base abrupt, slightly irregular.

114.11

Gy m & m-c qtz-lithic sst, with c-vc sst & pebbly horizons, minor mudchip congl., minor siltstone laminae. Sst is parallel to low-angle x-laminated, in places high-angle x-laminated. Internal bed sets not distinguished, but upper gravelly horizon is about 150mm thick. Base is sharp, erosive

~~[illegible]~~ Basal congl. is matrix-supported, poorly sorted, f-m pebble to granules, clasts subangular-subrounded, comprise chert, jasper, felsic ? volcanics, ? metasiltstone. Carbonate cement.

117.60

~~[illegible]~~laminated gy siltstone & gy-br siltstone, with minor claystone laminae. Parallel laminae, some disturbed bedding. Base sharp, slightly irregular.

118.97

~~[illegible]~~laminated gy qtz-lithic vf sst (~65%), interlaminated with gy siltstone & dk gy claystone. Laminae mainly parallel, some low-angle small-scale x-laminae. Base sharp, ? slightly irregular.

119.935

Dk gy claystone with irregular interlaminae of gy siltstone. Laminae parallel to low-angle x-laminae. Base sharp, slightly irregular.

120.45

Gy-gr to purplish qtz-lithic f to m sst, mottled, irregular structure to massive, to laminated, scattered coarse sand & f pebble grains. Base gradational.

120.78

Lt gy laminated & ripple x-laminated f to vf sst., quartz to quartz-lithic, gen. mod. well sorted, clayey matrix in part. Minor carb. siltstone bands, carb. laminae. Base sharp, scalloped, regular, erosive

122.65

Lt gy c to m ~~[illegible]~~ qtz sst. High-angle x-beds, tabular. Scattered mudclasts. Grains subangular, some subrounded, mod. sorted. Base sharp, scalloped, erosive

123.89

Lt gy f to vf sst. Parallel & ripple x-laminated. Base sharp, regular.

124.30

Lt gy coarse to vc qtz-lithic sst, some with f pebbles. Sst is ~~[illegible]~~ mod poorly sorted, subangular grains. Also contains intervals of x-laminated m to f sst.

~~30-2/35~~

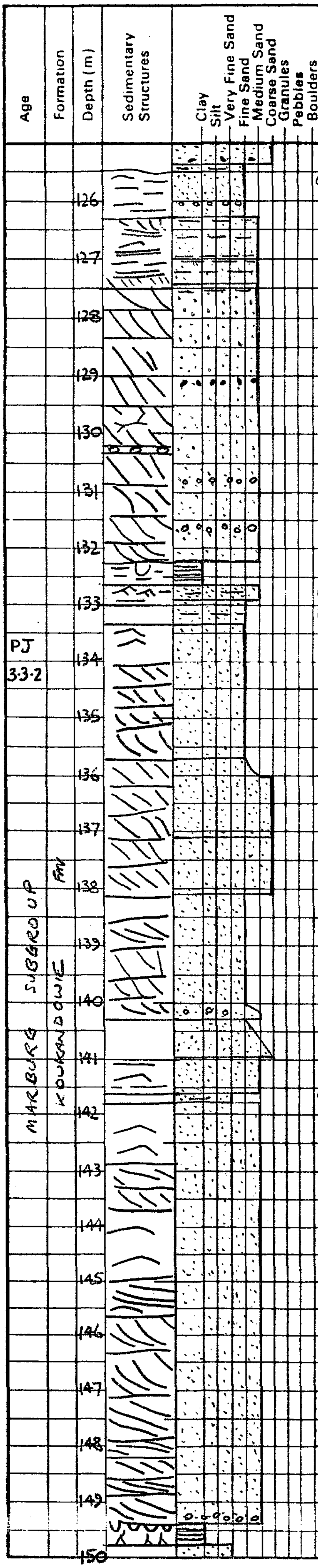
Photograph: 16/456/9 (5/8)

Record [illegible]

DRILLHOLE: BMR WARWICK 6

Sheet 6 of 8

125 – 150m



Description

mudchips at base. Base is sharp, scalloped, ? erosive.

-125.38

Gy f to vf sst, mainly laminated, some unlaminated. Laminae parallel to x-laminae & ripple x-lamination, minor clayey laminae. Siltstone (~3cm) at top, thin (~10cm) pebble congl. horizon. Base is sharp.

-126.27

Medium to thin beds (10-40cm) of of m, m-c and m-f grained gy qtz-lithic sst, parallel & x-laminated, interbedded with units (5-40cm thick) of laminated dk gy claystone - f siltstone & lt gy siltstone-vf sst. (40%). Upper & lower sst. contacts sharp & regular

-127.96

M, m-f, m-c gy & gy-gr sst, with minor pebble horizons, scattered mudchip fragments, minor dk gy claystone - siltstone interbeds & interlaminae, minor ~~[illegible]~~ coal partings. Sst variably bedded, from parallel laminated to x-laminated & x-bedded. Sst units 20-50cm thick. X-beds & laminae tabular, low-, mod- and high angle. Pebbly sst at bases of some sst units.

Base sharp, regular.

-132.25

Dk gy laminated claystone, interlaminated ~~lt~~ gy f siltstone - claystone. Base transitional.

-132.63

M-c sst. in thin upward-fining units (1-20cms thick). Sst qtz-lithic, poorly sorted, parallel to x-laminated. Grades up to gy & dk gy claystone - siltstone, laminated to x-laminated

ΔΔ

-132.90

F to vf to m gy laminated sst., minor claystone interlaminae. Base sharp, scalloped.

Gy f and f-m qtz-lithic sst, very minor gy claystone beds. Low-angle x-laminae & lesser parallel laminae, some carb. Mod. angle cross laminae at base. Poss. some upward-fining cycles. Base marked by thin m-c sst., base is sharp, sl. irregular.

-135.72

Lt gy lithic-qtz c-m and c-vc, friable sst., some granules and fine pebbles. X-laminated & x-bedded. Sst mod. poorly sorted, grains subangular. Grains include qtz, chert, jasper, ? felsic volcanics. Upward-fining cycles of 5-10 (or more cms). Base is sharp.

-137.11

C-m sst, as above, mod-angle x-bedding. Base abrupt.

-138.06

M & m-f gy to lt.gy sst, low to mod-angle x-laminated, in places parallel laminated. Some coarse sand intervals. Some carb. laminae (parallel) & parallel laminated dk gy f sst. Sst ~~[illegible]~~ mod. poorly sorted, subangular grains, micaceous in part. Scattered f pebbles. Base is sharp, regular.

Δ

-140.33

Coarse qtz-lithic sst at base, grading upwards to m & m-c sst, to f sst at top. Base is sharp

Δ

-140.94

C-vc & vc-granule sst & granule congl., with some (~15%) m sst. Sst & congl. are lithic-qtz, poorly sorted, angular-subangular grains, clayey-silty matrix. Flat to low-angle x-beds.

-141.65

F lithic sst, irregularly interlam. c̄ gy claystone. Base sharp, scalloped.

Sst, m, m-f & m-c grained. Thin inter units of dk gy claystone (½-2cm) & carb. dk gr sst-siltstone, & pebbly horizons. Parallel to x-laminated, including high- and low-angle x-lamination. Thin (3cm) unit of lithic pebble congl. at base. Sst units are of the order of 20-80cm thick. Base sharp, regular.

Δ

Δ

-149.44

Dk gy laminated claystone, minor coal spars. Base sharp, scalloped.

~~30 2/35~~ 16/H56/9 (6/8)

-149.70

Record 1990/8

DRILLHOLE: BMR WARWICK 6

Sheet 7 of 8

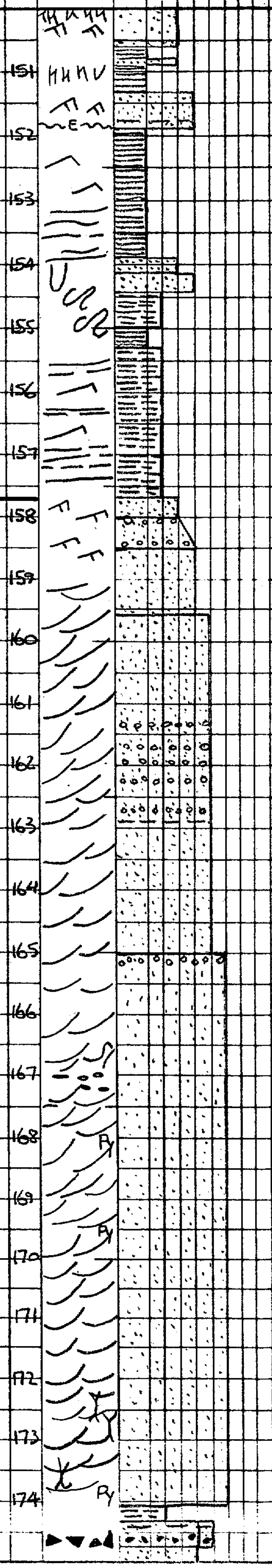
150-175m

Age | Formation | Depth (m) | Sedimentary Structures | Clay | Silt | Very Fine Sand | Fine Sand | Medium Sand | Coarse Sand | Granules | Pebbles | Boulders | Description | Dip | Photograph | Colour

Age: PJ 3.3.2

Formation: MARBURG SUBGROUP – KOUKANDOWIE FM.

HEIFER CK SST MB.



Description	Colour	
Gy vf sst, laminated, with parallel & some x-laminations. Interlaminated c̄ gy siltstone – claystone, which is parallel to low-angle x-laminated. Base sharp.		-150.57
~~[illegible]~~ Laminated dk gy claystone & lt gy siltstone, with lesser vf sst. Laminations parallel at top. Laminations irregular & parallel to low-angle x-laminations at base. Base is transitional		-151.32
F–m silty dk gy-gr qtz-lithic sst, irregularly parallel to low-angle x-laminated. Minor granule congl. horizons (1-3cm thick). Gy claystone interlaminae at base. Base sharp, ?erosive.		-151.86
Interlaminated dk gy claystone & dk gy f siltstone, lesser laminae (<10%) of gy vf sst. Laminae are parallel to low-angle x-laminae, some irregular. Base transitional		
vf gy sst interlaminated c̄ dk gy claystone & siltstone. Base transitional.		-153.92
Dk gy-gr qtz-lithic m sst. Irregular semi-parallel laminae, coal partings. Base sharp, irregular.		-154.15
Dk gy siltst. to f sst, laminated to massive. Irregular, parallel laminae, some carb, minor coal partings. Base ?transitional		-154.41
Gy claystone to f siltstone, parallel laminated. Base transitional.		-154.99
Laminated v dk gy f siltstone. Interlaminated with gy f siltstone – vf sst. Unit mainly parallel laminated. F sst ~~and~~ interlaminations with low-angle x laminations increase towards base. Base abrupt, regular		-155.29
Gy vf sst., ripple x-laminated, with siltstone (~10%) interunits. Base abrupt, draped over lithic pebble fragment in unit below.		-157.73
Gy qtz to qtz-lithic sst., pebbly at base to vf ripple x-laminated at top. Pebbly sst at very top. Base is sharp.	Δ	-158.01
Gy f qtz sst, parallel to low-angle x-laminated. Some intervals dark gy with very carb. laminae. Base is abrupt, but diffuse.		-158.52
Lt gy qtz & qtz-lithic m & m-c sst. Pebble congl. horizons, v. minor thin (2-6cm) siltstone bands. Sst mainly x-laminated, at high to low angles, some parallel laminated. Upward-fining cycles present from pebbly sst base to f x-laminated sst tops, on scales of ~~[illegible]~~ 2m or so. Base abrupt	Δ Δ Δ	-159.62
Friable c to vc ~~[illegible]~~ quartzose sst & qtz-lithic sst, and quartzose granule congl. Sst dominated by qtz but abundant lithic grains visible, sst porous, with little (clayey) matrix. High-angle x-beds present, tabular. ~~[illegible]~~ Sst grains subangular, mod. poorly sorted. Scattered pebbles, minor coal ~~[illegible]~~ partings towards base. Base marked by 3cm f gy-gr qtz-lithic sst. Base sharp flat, regular.		-165.01
Gy-br siltstone. Base irregular		-174.06
Dk gy siltstone & gy m sst (50%). Disrupted bedding c̄ mudchip fragments. Base sharp, irregular		-174.30

~~30-2/35~~ 16/H56/9 (7/8)

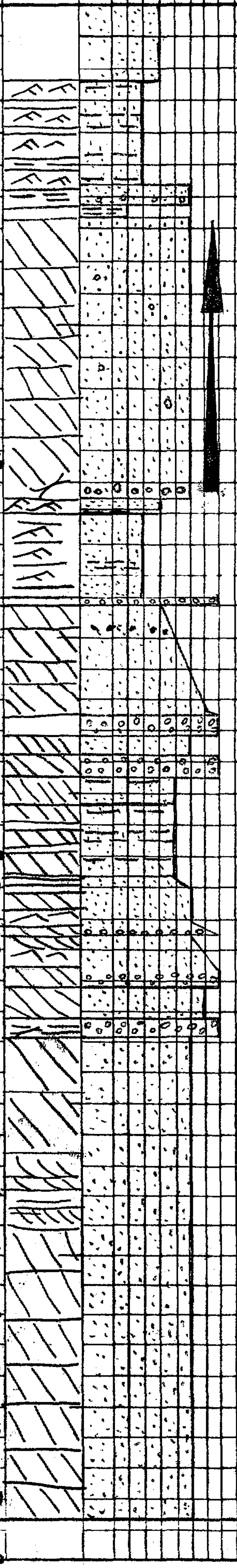
Record 1990/8

DRILLHOLE: BMR [redacted] WARWICK 6

Sheet 8 of 8

175-199.37m T.D.

Age	Formation	Depth (m)	Sedimentary Structures	Clay · Silt · Very Fine Sand · Fine Sand · Medium Sand · Coarse Sand · Granules · Pebbles · Boulders	Description	Dip	Photograph	Colour



Age: PJ 3.3.2 — MARBURG SUBGROUP — KOUKANDOWIE FM — PJ 3.3.1

Formation: Heifer Creek Sandstone Mb

Depth (m): 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200

F grained lt gy, structureless sst. with scattered coarse grains & mudchips, v minor carb. flecks. Base is v. sharp, scalloped, part load cast.

176.22 — Interlaminated gy vf-f sst & dkgy laminated siltstone. Sst is parallel to x-laminated, ripple x-laminated in part. Thin sst laminae in siltstone are lenticular. Some carb. laminae in sst. Sst ~~coarser grained towards base~~, Siltstone is parallel laminated. Base of unit is 20cm of laminated dk gy siltstone. Base is sharp, angled, regular.

177.84 — C-vc qtz-lithic sst lesser granule congl. Grains subangular - subrounded, poorly sorted, silty matrix, coal partings, mudchip fragments. Flat-laminated to x-~~lam~~bedded. Base sharp, slightly scalloped.

Dkgy laminated siltstone. Base sharp.

C & c-m quartz sst & qtz-lithic sst, friable in part, grains subangular poorly sorted clayey matrix, scattered pebbles & pebble horizons. X-bedded & x-laminated, some parallel bedding & lamination, rare coal laminae, except at base where coal spars abundant. F to c pebbly congl. at base, base of unit, sharp, irregular

182.75 — Gy f sst, carb. laminae. Base not preserved in core.

Dk gy parallel laminated siltstone

Gy to lt.gy vf qtz sst. with ripple x-laminae & parallel laminae, & interbeds & laminae of dk gy siltstone. Base sharp, scalloped, regular.

184.36 — Pebble congl. Subangular-subrounded clasts of felsic volcs., gy ?meta siltstone, sst., chert. Underlain by 70mm siltstone

184.50 — Lt.gy x-laminated f-m qtz & qtz-lithic sst, mudchips acc., grades down to c qtz & qtz-lithic sst, friable, mod. poorly sorted, grains angular to lesser subrounded, scattered vc sand to f pebble lithic grains, mod-angle x-laminations.

186.27 — Lithic vf to m pebble congl. (some c pebbles), matrix supported. Clasts subrounded to angular & comprise felsic volcs, metaseds, siltstone, chert, coal spars. Base abrupt, but poss. transitional.

186.56 — C sst as below.

186.85 — Congl. as above.

187.24 — M-c sst., qtz-lithic, friable, x-laminated. Base sharp, regular.

187.71 — M-f & m-c gy sst in units 3-25cms thick (85%), some pebbly horizons, x-laminated with thin interunits of black to dk gy siltstone-claystone, mainly parallel laminated. Base abrupt.

188.82 — F dk gy parallel laminated sst. (5cm) at top, grades down to c friable qtz-lithic sst., some vc grains & pebbles, parallel to high-angle x-bedded.

189.74 — Thin pebble congl. Base abrupt.

C-m sst, as above. Pebble congl. as above at base. Base abrupt

190.63 — C-vc & vc-granule-size qtzose sst., friable, mod, poorly sorted, subangular subrounded grains, some lithic grains, coal spars. Poorly developed mod-angle x bedding

191.14 — Lithic congl. as above, some small cobbles

191.40 — C-vc, some m sst. Beds of order of ½-1m thick. Sst is lt gy to white, friable, qtz and qtz-lithic, mod. poorly sorted, grains subrounded-subangular. Some f pebble horizons, minor coal laminae. Sst is x-bedded to parallel bedded, x-beds mod to high angle, mainly tabular.

Base of unit not exposed.

TD 199.37m from rig floor at 0.9m

~~30-2/35~~ 16/H56/9 (8/8)

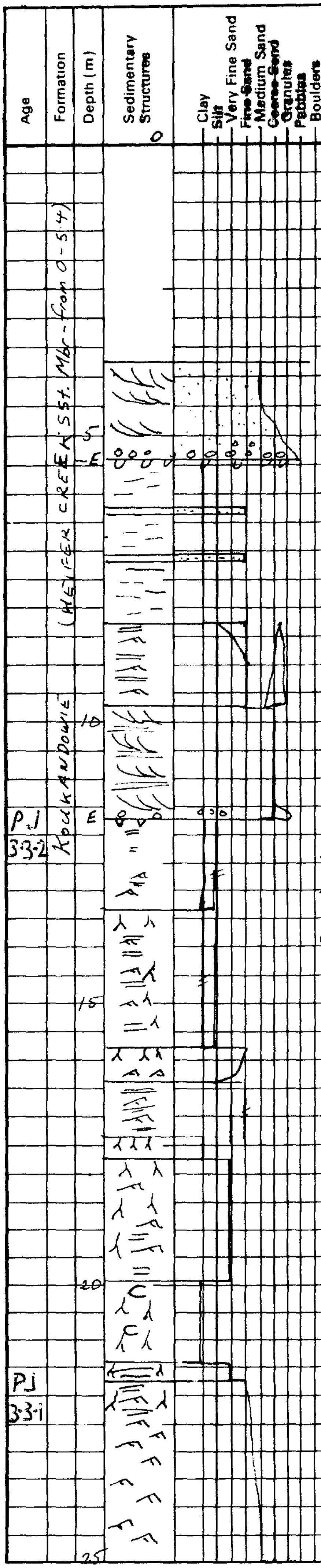
Record 1990/8

Graphic log

DRILLHOLE: BMR WARWICK - 7

Sheet 1 of 6 Fig 5

0-25m



Description

Dip | Photograph | Colour

Soil & weathered rock

Mod qtzose pebble cong with visible porosity ↑ n ss X lam.

Faint laminated grey clystn with thin (<5cm) fss interbeds

Fining up sequence of lam & ripple X lam fss ↑ interlam vfss & sltstn. Grey

X bedded lithic grey ss. Css with fss chaffy interbeds ≃ 10cm thick

Grey clayey mudstn. Some rippled fss & fss lam. Mudstn poorly lam.

Grey poorly lam clayey sltstn, thin ripple X lam fss & fss lam. Roots.

Interlam fss & mudstn with rippled fss ↑ green-grey fss Roots. Top bioturbated.

Clayey sltstn with ripple X lam fss interbeds ≃ 5cm

Mass clstn + roots.

Grey fss, some sltstn interbeds. Abundant roots Some ripple X lam.

Mass? grey mudstn. Roots, some overturned laminae

Interbedded lam mudstn & fss, roots

Mss ↑ fss. Ripples X lam in sets 1-2cm thick.

~~30-2/35~~ 16/H56/13 (1-6)

Record 1990/8

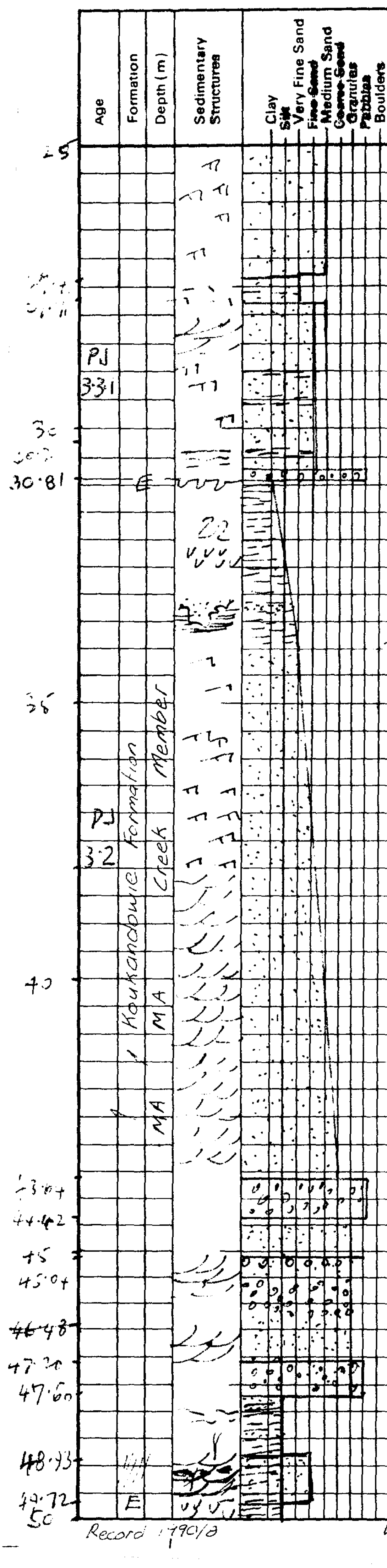
DRILLHOLE: EN.R WARWICK #1

Sheet 2 of 6

25 - 50m

Description

REG. No 4385



lt. gy, well sorted, micaceous, sk carbonaceous grains.

~~mid gy, bk carbonaceous laminae, micaceous,~~

lt gy, sparsely micaceous, carbon. grns,

clasts to 1cm across,

v. fine gy sst above erosion surface in siltstone. occas. carb. grns. v. finely micaceous

lt. gy, micac fine, qtzose. dk. gy carb. laminae abundant in places, abundant x laminae, carbonaceous slip. clayey matrix,

X-bedded, qtzose, yl-brown mottly, some lt. gy, occas. carb. laminae, pebbles, and clay pellets, lower part of section deeply weathered, kaolinitic matrix weathered to yl brn clay.

V. poorly sorted, x-bedded v. c. gr. qtz feldspathic sandstone; large rock frags to 5cm across in c-gr large irregular carbonaceous ~~wood~~ frags. Fragments of volcanics, wh. qtz, fine gr. metasediments.

dk gy, bioturbated, slt. rootlets bioturbated

x-laminated basal interval ~ 10 cm thick with rounded clay grains and pellets in C.gr Sst, and erosional base on claystn

Record 1990/8

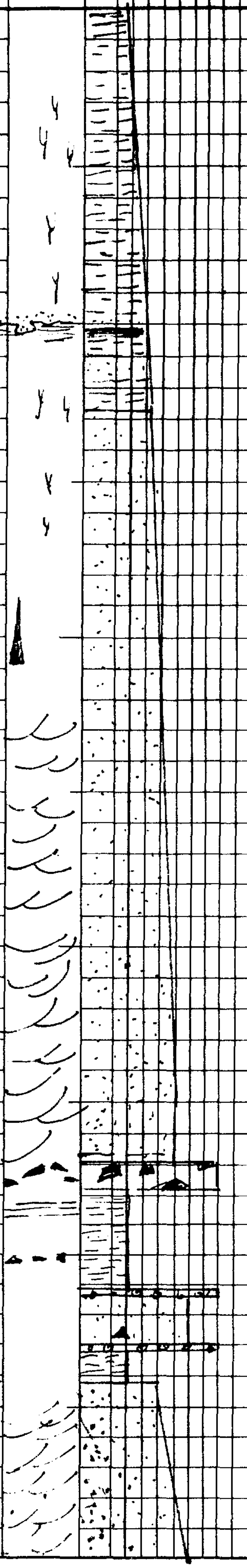
DRILLHOLE: BMR WARWICK ~~8~~ 7

Sheet 3 of 6

50-75 m

Age	Formation	Depth (m)	Sedimentary Structures	Clay / Silt / Very Fine Sand / Fine Sand / Medium Sand / Coarse Sand / Granules / Pebbles / Boulders	Description	Dip	Photograph	Colour

REG NO 4388



50

dk gy, bioturbated, rooted, carbonaceous laminae very common at base of interval. micaceous.

55.48

thin highly carbonaceous shale at 55.48 ~ 9 cm thick. Compaction feature at top of shale. very long rootlets ~ 10 cm in places.

56.36

PJ 3.2

KOUKANDOWIE FM

MA MA CREEK MEMBER

qtz-lithic, occas. mica, fine carbonaceous laminae, x-bedded. micaceous, well sorted. thin carbonaceous laminae very common at top of interval.

60

65

68.47

68.9

Large angular clasts of gy siltstone in r.c. gr. qtz-lithic sandstone.

predom dk gy shale with interbeds of lt gr sandstone laminae, some occas. breccia

70

70.59

2 cm bed of lithic conglomerate, clasts ~ 2 cm.

gy qtz lithic sandstone

2 cm bed of lithic conglom. clasts to 2 cm.

71.68

dk gy

72.16

GATTON SANDSTONE

md. gy. qtz lithic, x-bedded.

75

~~30-2/35~~ 16/HS6/10 (3/6)

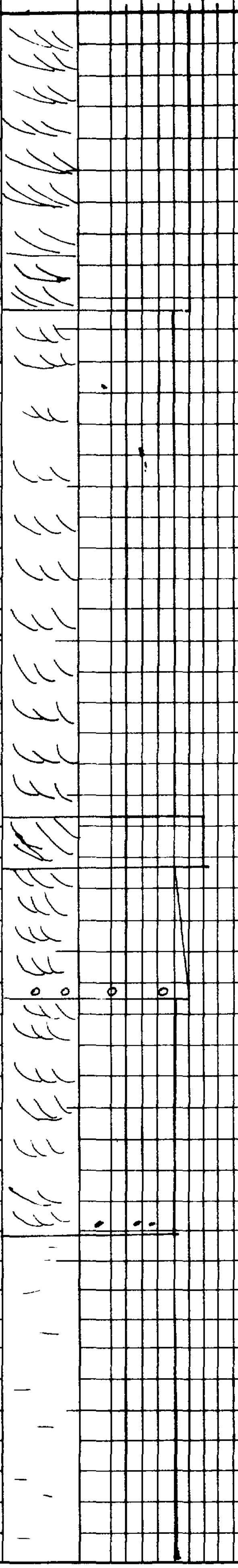
Record 1992/8

DRILLHOLE: BMR WARWICK-7

Sheet 4 of 6

75 - 100m

Age	Formation	Depth (m)	Sedimentary Structures	Clay / Silt / Very Fine Sand / Fine Sand / Medium Sand / Coarse Sand / Granules / Pebbles / Boulders	Description	Dip	Photograph	Colour
	GATTON SANDSTONE	75			X lam Css, X lam diffuse ½ cm laminae of slightly different grain size. Possibly some porosity.			
		80			X lam m ss, Grey lithic. X lam fine ~~light~~ dark grey, sometimes chatty lam ≃ 1-2mm & lighter lam ≃ ½ cm max sets ≃ 50cm.			
		85						
					X lam gran cong & vcss.			
					X lam css ↑ x lam mss. thin pebble layer at base			
		90						
					X lam ~~co~~ mss. X lam poorly defined, 1-2mm. SS grey Labile.			
		95			Mass to faint laminated mss. Grey sublabile.			



~~30-2/35~~ 16/456/10 (4/6)

Record 1990/8

DRILLHOLE: BMR WARWICK 7

Sheet 5 of 6

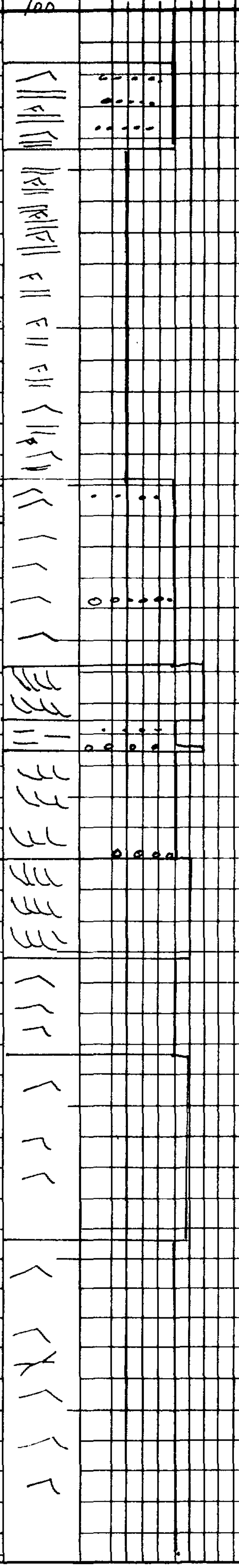
100 - 125m

Age	Formation	Depth (m)	Sedimentary Structures	Clay / Silt / Very Fine Sand / Fine Sand / Medium Sand / Coarse Sand / Granules / Pebbles / Boulders	Description	Dip	Photograph	Colour

Age: PJ 1

Formation: GATTON SANDSTONE

Depth (m): 100, 105, 110, 115, 120, 125



Mass Mss

Mss - Low angle x lam with ripple x lam mudstn interbeds, chaffy lam mud chip horizons

Mudstn with thin fss lam & fss interbeds. Fss interbeds ripple x lam, low angle lam & chaff lam. Ss interbeds have erosional bases.

Some thin (5cm) css beds with erosional bases, mud chips

Low angle x lam mss, mud chips. (fine).

Several pebble layers.

X lam vcss. to gran cong

Faint lam mss with mud chips & thin (6cm) peb cong.

X lam grey sublabile mss. Pebble layer (2cm) base

X lam css, mod qtzose, slightly porous.

Csg mss. Low angle x lam grey sublabile.

Low angle X lam css with a few mss interbeds 20cm thick. ||| x bedding.

Possibly Porous. (Sampled).

Low angle x lam ms with a few css beds < 5cm that have grad boundaries with mss.

A few coal spars & chaff lam.

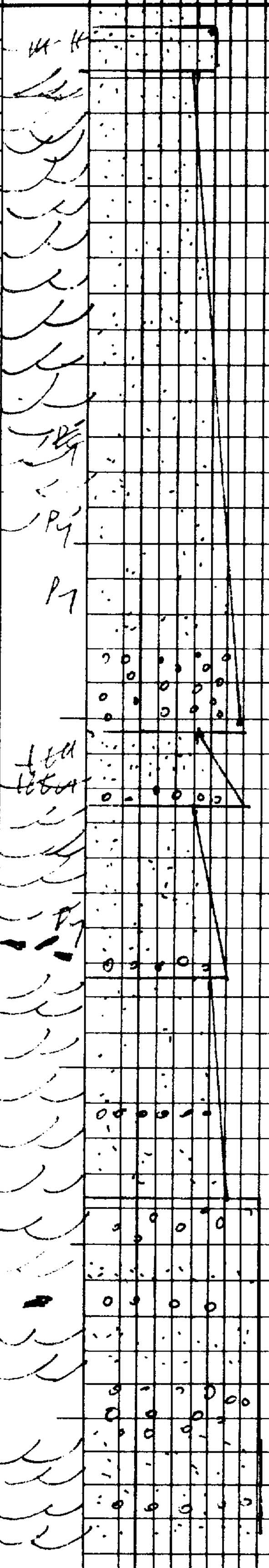
~~30-2/35~~ 16/456/0 (5/6)

Record 1990/8

DRILLHOLE: BMR WARWICK #7 Sheet 6 of 6

125-146.55m T.D.

REG Nº 4388.



Age	Formation	Depth (m)	Description
		125	
		125.34	lt gy, qtz, feldspathic, lithic
		125.92	md gy, very coarse to m-gr., qtz, feldspathic, lithic sandstone, abundant lithic frags. at base, large vugs with weathered out pyrite and ? other sulfides, porous over about 2m., calcareous in part.
		130	
		135	
		135.1	gn gs, poorly sorted, qtz, lithic, feldspathic.
GATTON SANDSTONE		136.12	cgr, x-bedded, qtz, lithic, feldspathic, poorly sorted, calcareous in part, pyritic, porous in part over interval of ~1.5m.
		138.76	pebbly and granule conglomeratic sandstone, poorly sorted, X-bedded, qtz, lithic, feldspathic, calcareous in part
		140	
		141.73	Conglomeratic sandstone and conglomerate v. poorly sorted calcareous in part clasts to 5 cm. across subrounded, coal spars, and large clay clasts. thin porous intervals, qtz, lithic, feldspathic.
		145	
		146.55	

~~30-2/35~~ 16/H56/10 (6/6)

Record 1990/8

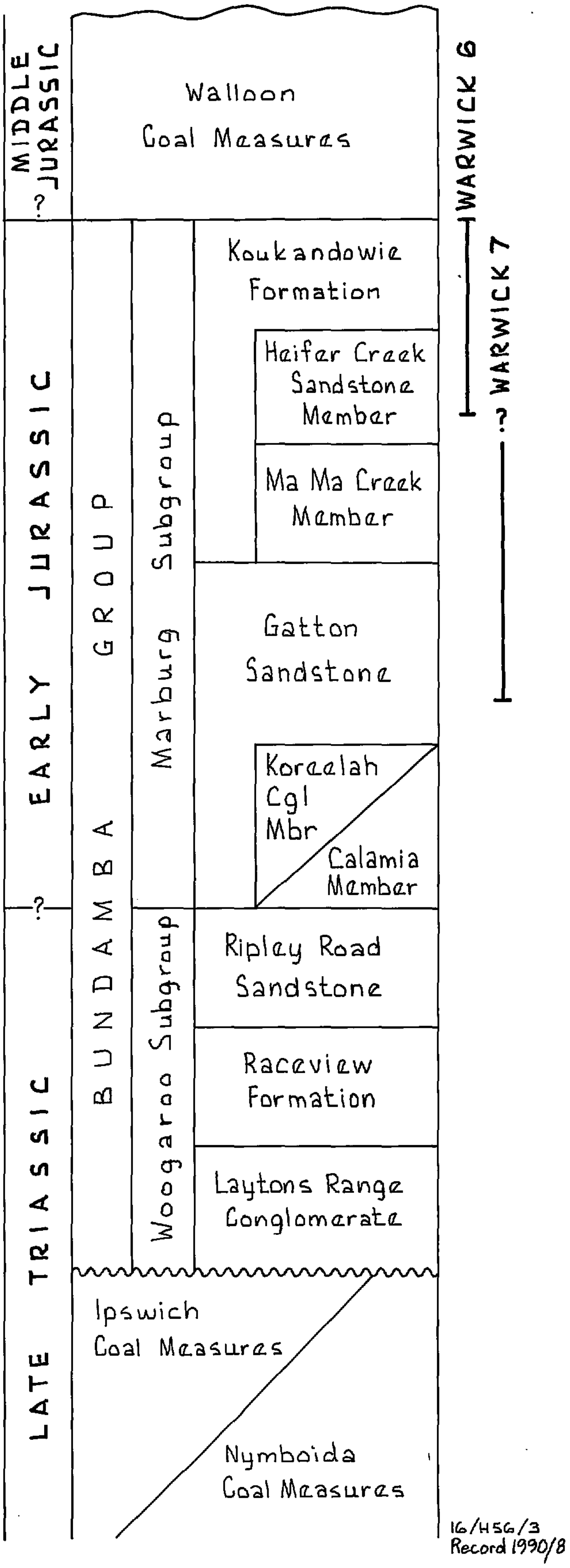
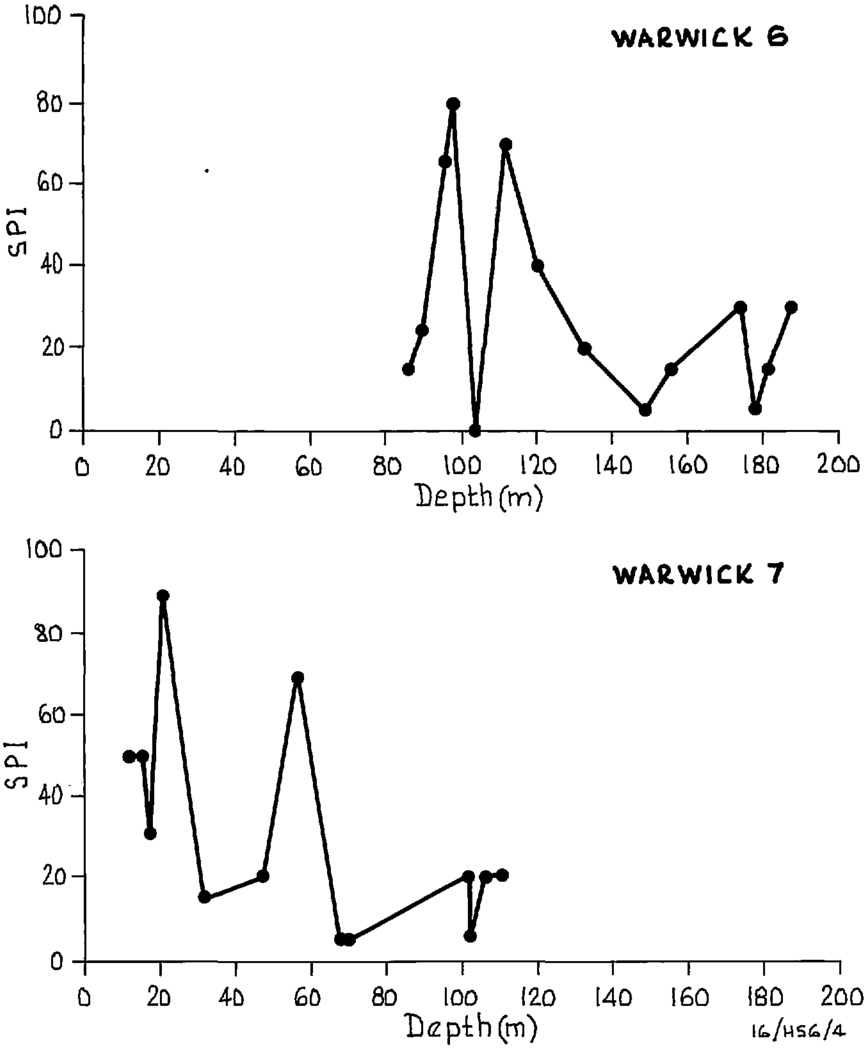
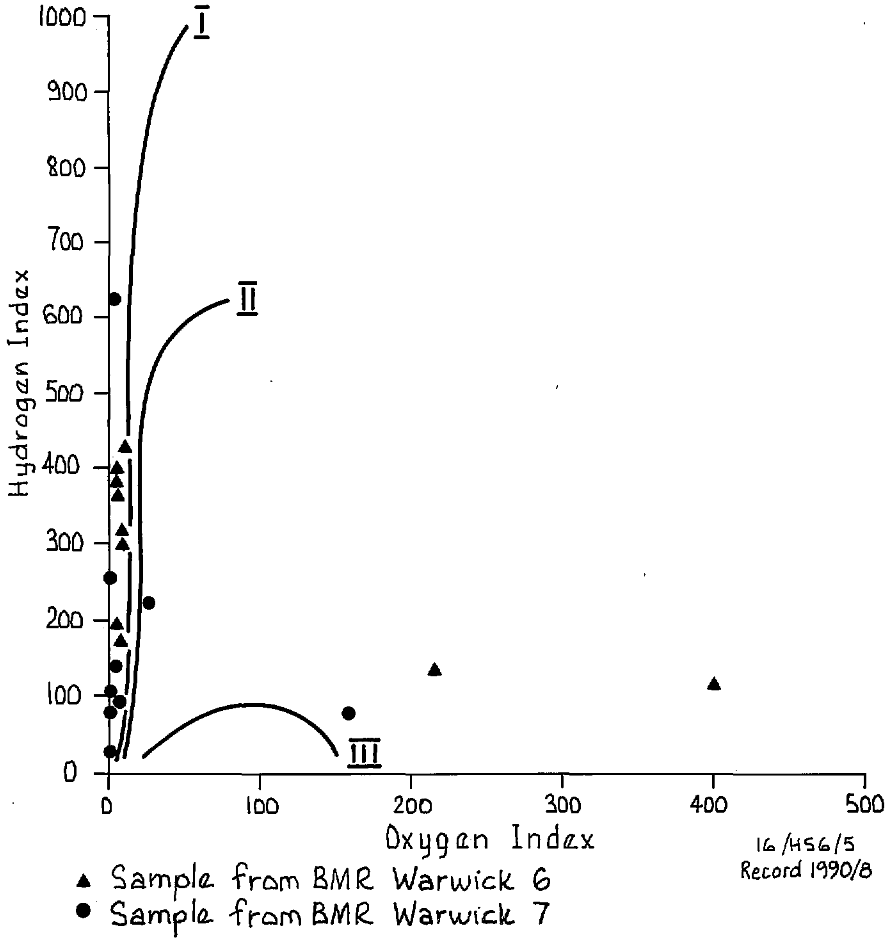


Fig.6. Stratigraphy of Clarence-Moreton Basin and correlation of BMR Warwick 6 and 7 sequences



16/H56/4
Record 1990/8

Fig. 7. Kerogen analysis
(SPI = Source Potential Index)



16/HS6/5
Record 1990/8

Fig.8. Hydrogan index/oxygan index plot

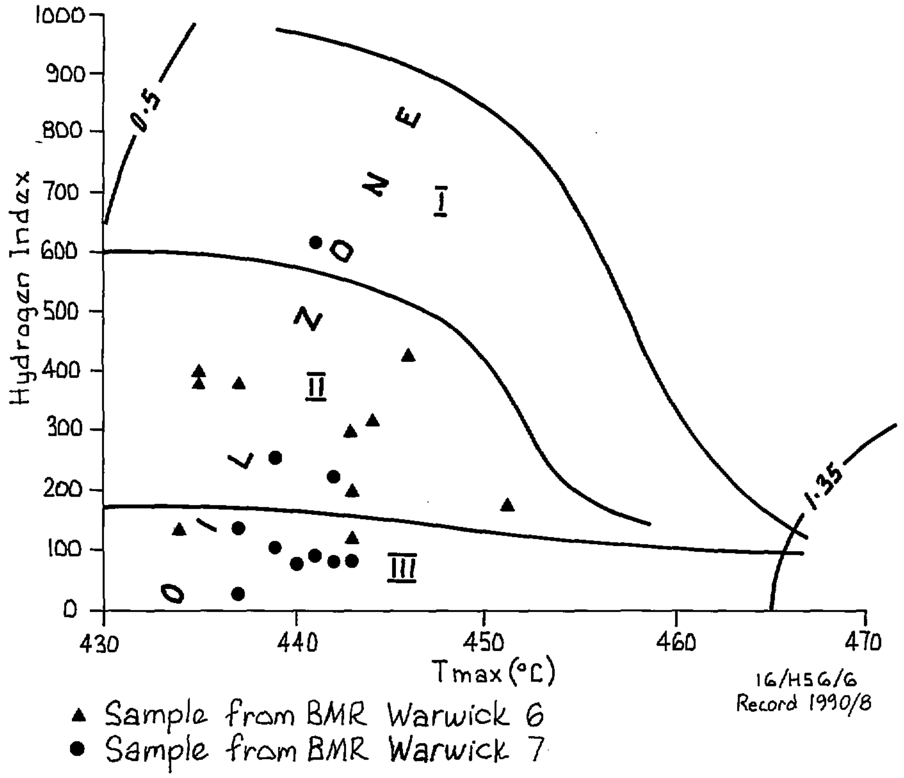
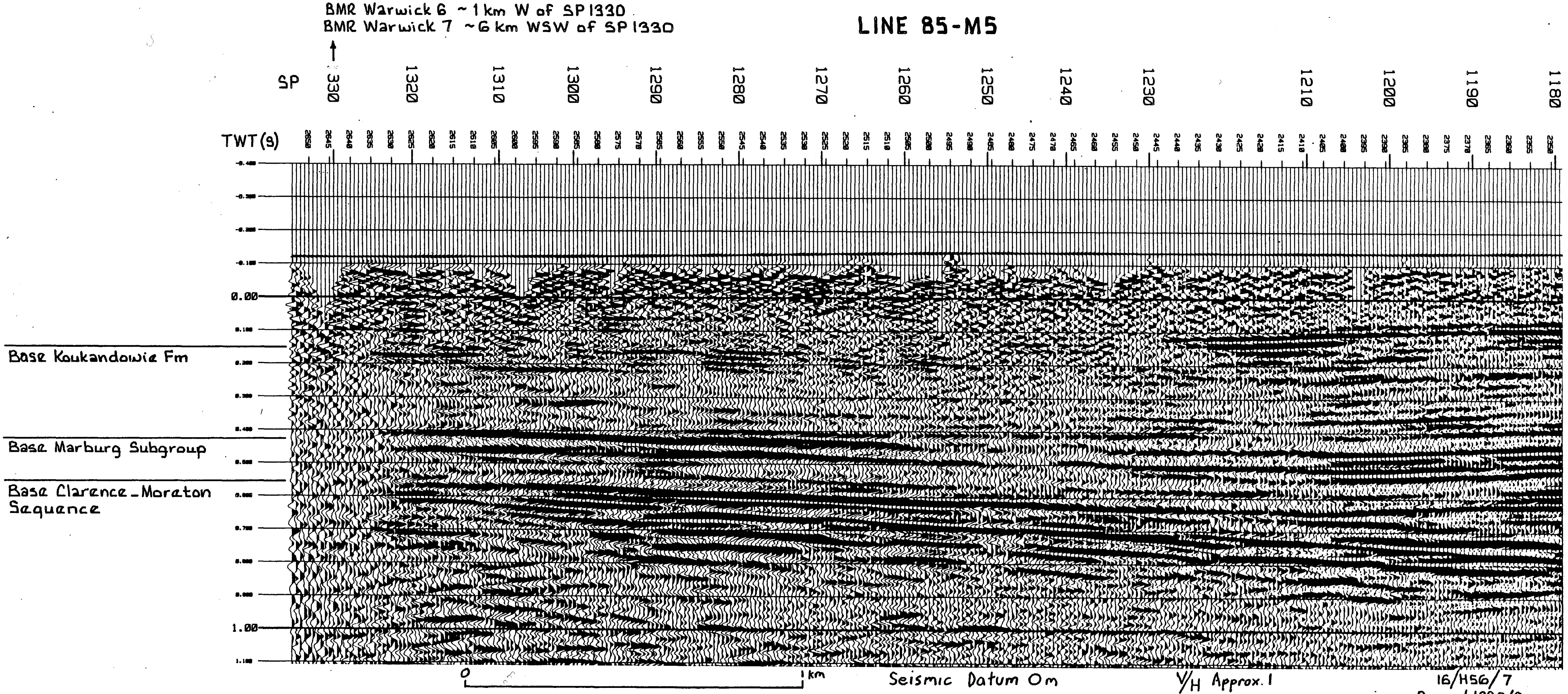


Fig.9. Hydrogen index/Tmax plot



16/H56/7
Record 1990/8

Fig. 10 Position of BMR Warwick 6 and 7 in relation to seismic section 85-M5

ZONES Price and others, 1985	McTaggart, 1963			Wells and others, 1988		
PJ4.2	MARBURG FORMATION	Heifer Creek Sandstone Member		MARBURG SUBGROUP	KOUKANDOWIE FORMATION	Heifer Creek Sandstone Member
PJ4.1						
PJ3.3.2						
PJ3.3.1		Ma Ma Creek Sandstone Member				Ma Ma Creek Member
PJ3.2						
PJ3.1		Tenthill (≡Winwill) Conglomerate Member			GATTON SANDSTONE	
PJ2.2.2		Gatton Sandstone Member				Koreelah Conglomerate Member
PJ2.2.1						
PJ2.1						Calamia Member
PJ1	RIPLEY ROAD SANDSTONE			RIPLEY ROAD SANDSTONE		

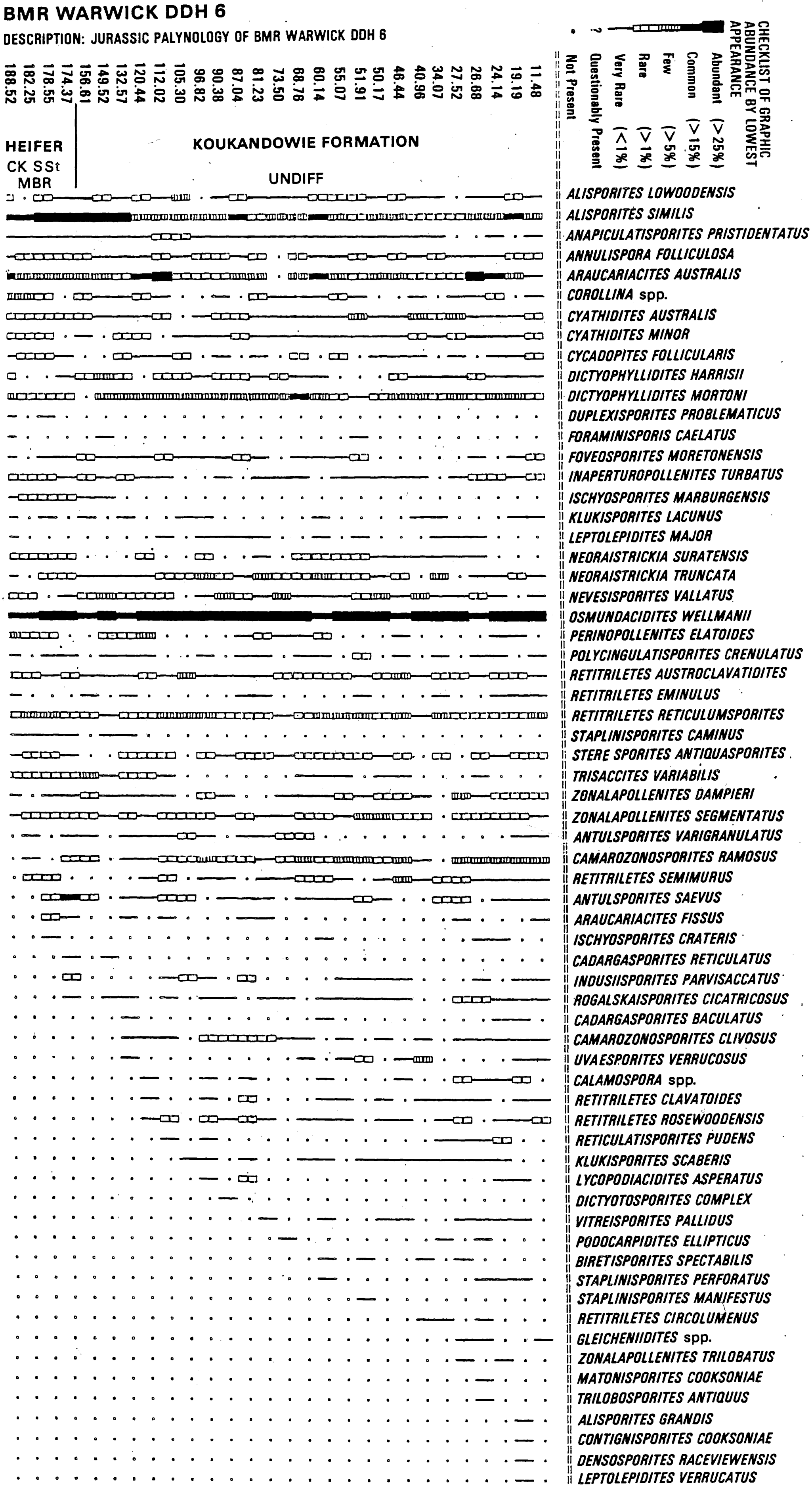
16/H56/8
Record 1990/8

Fig. 11 Palynostratigraphy

TABLE 4

BMR WARWICK DDH 6

DESCRIPTION: JURASSIC PALYNOLOGY OF BMR WARWICK DDH 6

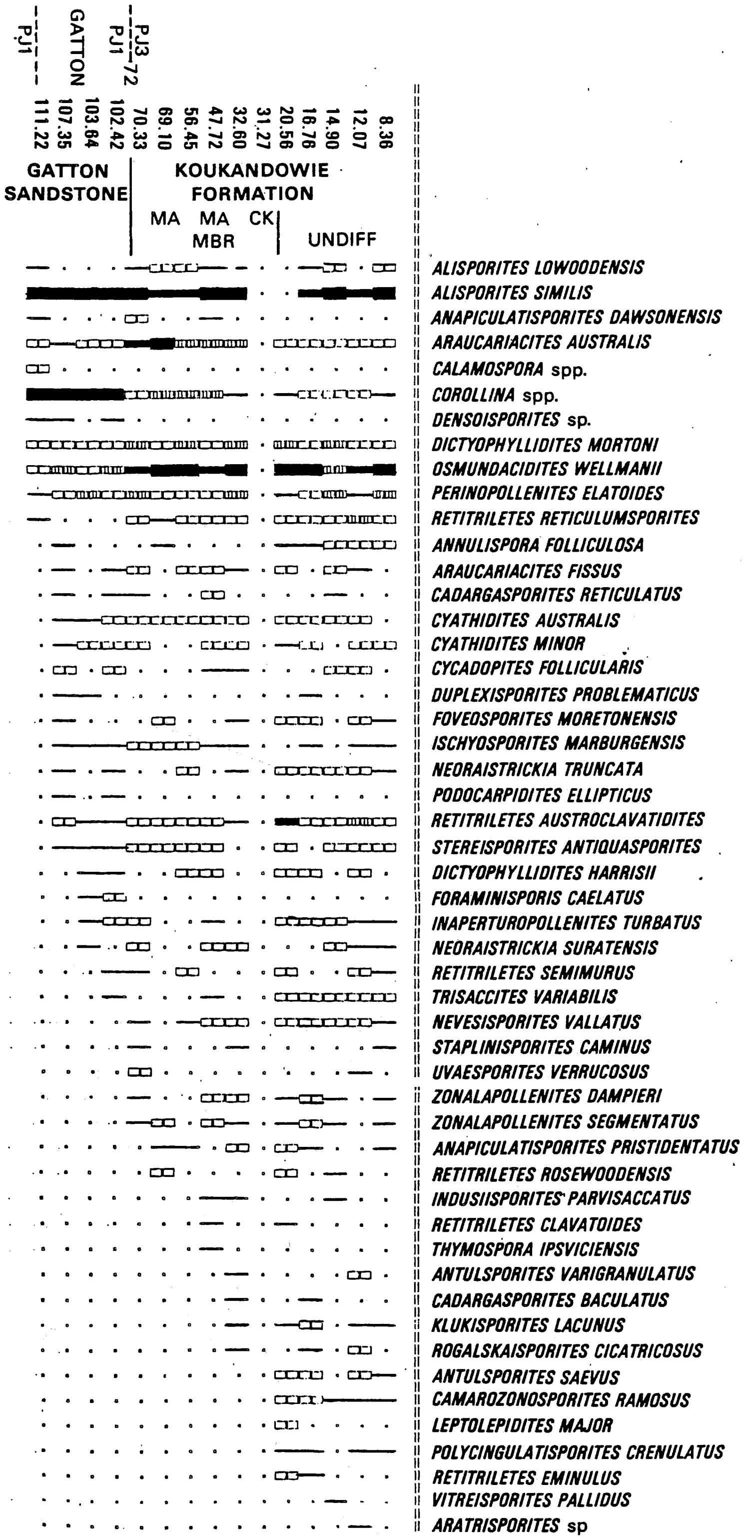


16/H56-2/2
Record 1990/8

TABLE 5

BMR WARWICK DDH 7

DESCRIPTION: JURASSIC PALYNOLOGY OF BMR WARWICK DDH 7



CHECKLIST OF GRAPHIC ABUNDANCE BY LOWEST APPEARANCE

- Abundant (>25%)
- Common (>15%)
- Few (>5%)
- Rare (>1%)
- Very Rare (<1%)
- ? Questionably Present
- • Not Present

16/H56-2/3
Record 1990/8