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BMR MACLEAN NO. 1
STRATIGRAPHIC DRILL HOLE
CLARENCE MORETON BASIN

by

A.T. Wells & P.E. O'Brien

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ABSTRACT

B.M.R. Maclean No. 1 was a fully cored stratigraphic hole drilled on the eastern margin of the Clarence-Moreton Basin near Evans Head. It reached a total depth of 664.8 m and intersected 590.05 m of Marburg Formation overlying 74.75 m of Ripley Road Sandstone. The lower 42.60 m of the Marburg Formation correlates with the Calamia Member recognised by Etheridge & others (1985). The sequence is mostly multistorey fluvial channel sandstone with only a small proportion of fine grained facies so that potential hydrocarbon source rocks are rare. Porous sandstone is also rare, though parts of the Calamia Member and the Ripley Road Sandstone may be porous and permeable.

INTRODUCTION

B.M.R Maclean No. 1 was drilled as part of the joint B.M.R.- State Geological Surveys Clarence-Moreton Basin project. It was intended to provide stratigraphic information on part of the Clarence-Moreton Basin that lacked good outcrop and deep stratigraphic holes, provide material to aid sedimentological studies of the Bundamba Group and assess the reservoir and hydrocarbon source potential of the Bundamba Group on the eastern part of the basin. It was originally planned to site the hole on a company seismic line but because of heavy rain in the area, the line was not shot in time and the hole was located on the basis of outcrop geology. The hole was intended to intersect the entire Marburg Formation but actually spudded some distance below the top. Though the hole did not intersect the upper part of the Marburg Formation it did penetrate the Ripley Road Sandstone a potential reservoir unit within the basin.

The hole was fully cored with 63 mm (HQ) diameter core which is now lodged in the B.M.R. Core and Cuttings Laboratory in Canberra. Wireline logs were run on completion and are shown in Appendix 2. Core material was submitted for palynological examination, organic petrological and geochemical analysis and the petrology and petrophysical characteristics of some units will be investigated further.

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WELL HISTORY

GENERAL DATA

Well : BMR Maclean No. 1

Location : Lat. 29°10'20"S
: Long. 153°17'50"N

Australian Map Grid Reference : NN 289728

Locality : Maclean 1:250 000 sheet
Approximately 12 km SSW of
Woodburn and 14 km SW of
Evans Head; 0.8 km E of
the Pacific Highway.

Title holder: : Hartogen Energy Ltd -
operator

Petroleum Title : PEL 259

Area : Clarence Moreton Basin,
NSW

Total depth : Driller - 664.80 m
Geosource - inconsistent
(667.08, 673, 675.18,
676.04)

Drilling commenced : 19 April 1985
ceased : 4 May 1985

Elevation : Drilling floor: approx
0.5 m above ground level
Ground level: approx. 24 m
a.s.l.

Status : Abandoned, open hole, 18 m
HW casing in hole; casing
closed with locked cap.
Lock Keys held by Longyear
and Bureau of Mineral
Resources.

Drilling Data

Drilled by : Longyear Australia Pty Ltd

Drilling plant : Longyear Heavy Duty 44 -
rated capacity 850 m with
88.9 mm (O.D.) drilling
pipe.

Hole size : Refer to caliper log

Drill pipe : HQ, 88.9 mm (O.D.)



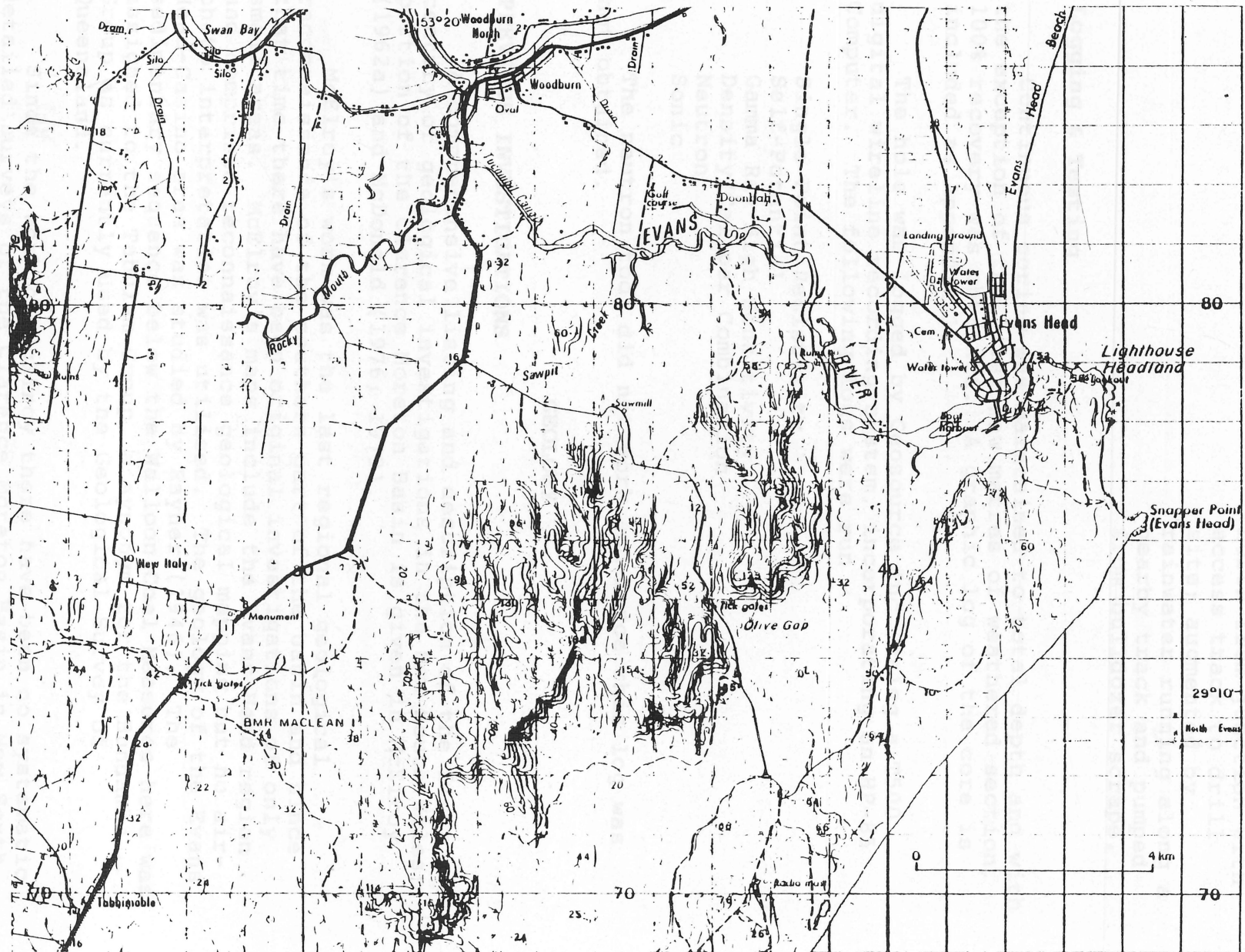


Fig. 1. Locality map

Casing : HW, 114.3 mm (O.D.)
Core size : HQ3, 63.5 mm diameter

Water Supply: : Pumped and trucked about 5 km from billabong next to Pacific Highway about 4 km north from junction with access track to drill site; augmented by rainwater running along a nearby track and pumped from bulldozer scrape.

Logging & Testing

Continuous coring was maintained to total depth and with the exception of the first few metres of weathered section, 100% recovery was obtained. A graphic log of the core is included as Appendix 1.

The hole was logged by Geosource Inc. using a T500 digital wireline recording system, incorporating an HP-85 Computer. The following logs were run -

- Single Point Resistivity
- Self-Potential
- Gamma Ray High Sensitivity
- Density/Caliper Combination
- Neutron
- Sonic

The neutron tool did not work and hence this log was not obtained.

GEOLOGY

PREVIOUS INVESTIGATIONS

A comprehensive listing and description of the first century of geological investigations in the New South Wales portion of the Clarence Moreton Basin is given in McElroy (1962a) and McDonald (1976; 1979).

McElroy's work was the last regional geological reconnaissance of the southern part of the basin and since that time there have been original investigations of only small areas. McElroy's maps include the Evans Head region and comprised reconnaissance geological mapping but no air-photo interpretation was utilised. The geology of the Evans Head-Casino area was studied by Rayner (1946). The sedimentary sequence below the Walloon Coal Measures here was assigned to the Tabulam Group, a synonym for the Bundamba Group as currently used by the Geological Survey of Queensland.

Since the work of McElroy there have been no systematic detailed surveys of the Clarence Moreton Basin in New South Wales although several reviews have been published, and

include Cranfield et al. (1975), Day et al (1974), McElroy (1962b,) and Nicholson (1975). Day et al. (1974), reviewed the geology of the Queensland portion of the basin, a regional synthesis is given in Benstead (1975), and a regional review is included in Day et al. (1983). Ties et al. (1985) discuss the petroleum prospectivity of the Clarence Moreton Basin in New South Wales based on recently acquired seismic data. Popescue (1984) carried out a review of the basin for the New South Wales Geological Survey and a review of petroleum data was completed by Willis (1985). The most recent geological field work carried out in the Evans Head/Ballina area is by Scott (1982).

Petroleum exploratory drill holes in the Maclean area include Tullymorgan No. 1 (Williams & Boisvert, 1965), Sextonville No. 1 (Perryman, 1964) and Halfway Creek Bore. Exploratory drilling for coal in the Moonem Range area is described by Lloyd (1950) and later drilling of the Walloon Coal Measures is documented by McDonald (1979). A stratigraphic test at the Pillar Valley (DM Pillar Valley DDH No. 2) was drilled by the NSW Mines Department in 1985 (Etheridge et al. 1985). The hole was fully cored and complements the earlier coal drilling at Pillar Valley DDH No. 1 and provided a complete section through the Walloon Coal Measures to the base of the Clarence Moreton Basin sequence.

REGIONAL GEOLOGY

The regional geology of the Clarence-Moreton Basin is shown on the New England and Moreton 1:500 000, and Maclean 1:250 000 geological series sheets. The drill site is located on the eastern margin of the Clarence Moreton Basin (figs 1 & 2) and the stratigraphy adopted for this area is shown below:

TABLE 1 - STRATIGRAPHY - EVANS HEAD AREA

<u>Age</u>	<u>Formation</u>	<u>Map Symbol</u>	<u>Approx Thickness (m)</u>
Cretaceous	Grafton Formation	Kg	50+
Cretaceous- Jurassic	Kangaroo Creek Sandstone	KJk	300
UNCONFORMITY			
Jurassic	Walloon Coal Measures	Kw	370
Jurassic	Marburg Formation	RJm	~750
	Upper Member		(~125)
	Middle Sandstone Member		(~550)
	Calamia Member		(75)

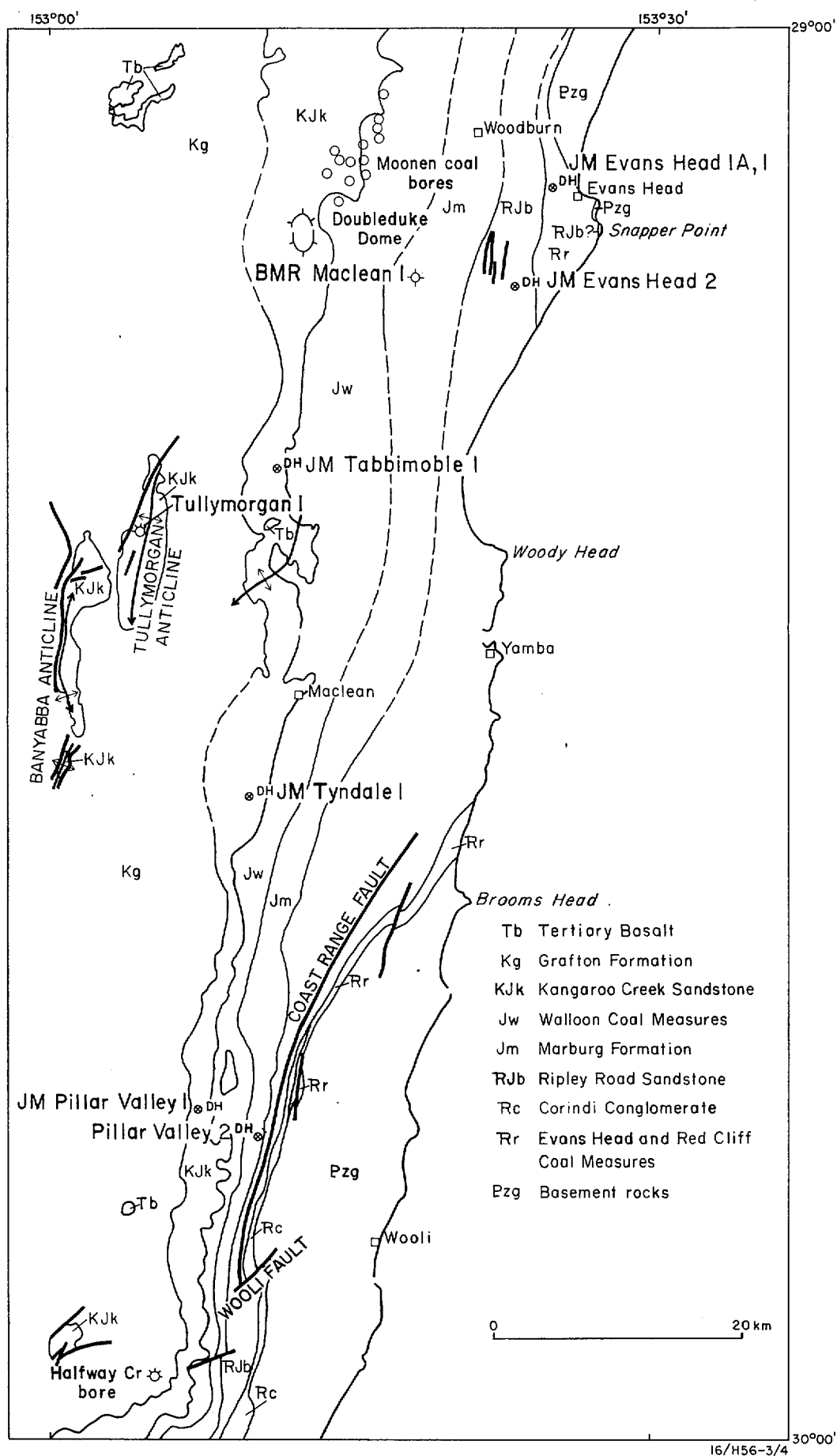


Fig.2. Geology of the Evans Head-Pillar Valley area.

Triassic- Jurassic	Ripley Road Sandstone	RJb	750
UNCONFORMITY			
Triassic	Evans Head Coal Measures	Rr	130+
UNCONFORMITY			
Palaeozoic	Greywacke, slate, sandstone quartzite, chert, volcanics, banded jasper	Pzg	-

PALAEOZOIC

Palaeozoic Basement Rocks

Palaeozoic basement rocks are exposed at Lighthouse Headland about 2 km north of Evans Head Township. The basement here is strongly deformed and comprises recrystallised volcanic rocks and folded dark lutites.

Elsewhere greywacke, slate, sandstone, quartzite, chert and jasper are described from the basement (Rose, 1970).

What is probably Ripley Road Sandstone occurs at Schnapper Point (Evans Headland) and not Palaeozoic basement as shown on the Maclean 1:250 000 geological sheet.

TRIASSIC

Evans Head Coal Measures

Evans Head Coal Measures unconformably overlies Palaeozoic basement rocks. The formation crops out on the coast at Lighthouse Headland and Goanna Point and comprises thinly bedded, quartzose, coarse grained, cross-bedded sandstone, dark grey siltstone and carbonaceous shale and some coaly interbeds. The sequence shows large planar-beds and smaller troughs. Just west at Snapper Point (Fig. 1) the Coal Measures are preserved in an overturned fold with the fold axis dipping steeply westward (site of JM Evans Head - 1 Fig. 2). The Coal Measures dip about 50° west and 20° west at the Evans Head Coal Mine.

An angular unconformity is probably present with the overlying Ripley Road Sandstone which dips westward mostly from 2° to 10°.

Scott (1982) indicates a Late Triassic age for the Evans Head Coal Measures and correlates them with both the Red Cliff and Ipswich Coal Measures. JM Evans Head DDH1 was solely in Evans Head Coal Measures to a total depth of 130 m. A megaf flora collected near this drill site indicates a mid-Late Triassic age (Pickett, 1977).

Corindi Conglomerate

There is no known representative of the Corindi Conglomerate in the Evans Head area.

Triassic-Jurassic

Ripley Road Sandstone

The Ripley Road Sandstone forms prominent hills between Tabbimoble and Evans Head and is tentatively identified at Snapper Point. The cross bedded sandstone in this area was termed Olive Gap Formation by Scott (1982) but it is lithologically similar, and has a similar stratigraphic position to the Ripley Road Sandstone described to the south in Pillar Valley DDH 2 drillhole and to outcrops and type section (NS 272; Staines, 1964) in the Ipswich area, the term Olive Gap Formation is therefore discarded.

The Ripley Road Sandstone comprises coarse to very coarse sandstone and quartzose granule conglomerate in cross-bedded sets 2-3 m thick. The sandstone weathers massively but is mostly medium bedded with bedding accentuated by thin coarse sandstone to granule conglomerate interbeds; the quartz grains commonly exhibit secondary overgrowths. Cross bedding azimuths commonly trend between 027° and 050°.

A thickness of 150 m of the Ripley Road Sandstone was intersected in JM Evans Head DDH 2 bore (Fig 2, (Scott, 1982) but he inferred a total thickness of 750 m from outcrop.

A probable JI zone microflora was recorded from the formation in JM Evans Head DDH 2 (Morgan, in McDonald, 1979).

Jurassic

Marburg Formation

The Marburg Formation is mostly poorly exposed with the exception of road cuts of short sections on the Pacific Highway and a road cutting on the Olive Gap road about 2½ km west of the Pacific Highway.

Outcrops on the Pacific Highway tentatively identified with the Marburg Formation comprise fine grained, cross-bedded, lithic and quartzose sandstones and interbedded dark grey carbonaceous siltstone and shale. An igneous dyke intrudes the shale 5 km north of Tabbimoble.

On the Olive Gap road medium and coarse grained quartzose, poorly sorted, cross bedded sandstone is interbedded with poorly sorted quartzose granule conglomerate. One large cross-bed at least 5 m thick is preserved in the outcrop on the Olive Gap Road. The cross-beds mostly trend to the north with the exception of an outcrop south of the drillsite where they dip towards 180° to 190°. //

In the Evans Head area the Marburg Formation dips from 6-10° west and is probably conformable with the Ripley Road Sandstone.

Walloon Coal Measures

There are no outcrops of the Walloon Coal Measures of any note in the Evans Head region although large areas are designated as being underlain by the Coal Measures on the Maclean geological map. The formation was penetrated in several DM coal bores (Fig. 2) and has been worked in coal mines southwest of Woodburn (Lloyd, 1950). Other sequences in the Walloon Coal Measures penetrated in coal exploration drill holes in the New South Wales part of the basin are described by McDonald (1979). Abundant microfloras in the Walloon Coal Measures indicate a mid Jurassic age (J4B, J5-J6).

A unit of feldspathic and lithic sandstone at the top of the Walloon Coal Measures has been defined as the Maclean Sandstone Member (Flint et al. 1976). The member is apparently missing along the northeastern margin of the basin (McDonald, 1979).

Kangaroo Creek Sandstone

Steep scarps of Kangaroo Creek Sandstone are present west of Woodburn and from the southward trending Moonem and Richmond Ranges. The contact with the Walloon Coal Measures is disconformable although a probable angular unconformity has been recorded by McElroy (1962a). The abundant pink garnets recorded from the Kangaroo Creek Sandstone (notably in the base of the formation), and from the Woogaroo Sub-Group have been described by Byrnes (in McDonald, 1979).

Grafton Formation

The Grafton Formation, the youngest formation in the basin, crops out poorly. Burger (1974) records microplankton from the formation west of Casino, and Morgan (1978) records possibly Cretaceous and Jurassic microfloras. It is predominantly arenaceous in composition but outcrops are mostly deeply weathered.

DRILL SITE GEOLOGY

There is no outcrop at the drill site and there is no detailed information on the geology of the area around the site. The drill hole was originally positioned on the boundary between the Walloon Coal Measures and the Marburg Formation as shown on the Maclean geological map (Rose, 1970). The source of the mapping is not known but probably dates from the original work of Rayner (1946).

A brief reconnaissance of the area prior to the commencement of drilling indicated that the Marburg Formation /Walloon Coal Measure boundary lay further west than shown on the Maclean sheet. The drill site was relocated about 1 km further west and a complete sequence of the

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Marburg Formation was expected.

STRATIGRAPHY OF MACLEAN -1

Stratigraphic Nomenclature

The formations of the Bundamba Group are best mapped using the criteria established by McTaggart (1963), Cranfield Schwartzbock and Day (1976) and Gray (1975) working in Queensland. The Queensland stratigraphy is better understood and documented than the New South Wales part of the basin. Therefore it is logical to try to extend this nomenclature and thus avoid duplication of stratigraphic names. In B.M.R. Maclean No. 1 and in other sections, this has been achieved by using names that have precedence over local nomenclature.

The term "Olive Gap Formation" used by Scott (1982) is discarded in favour of the established name Ripley Road Sandstone and the terms Tabulam Group (McElroy, 1962a), Pillar Valley Sub-Group and Timbarra Formation (Ellis-Flint, 1973; Lancaster, 1974) and the Pillar Valley Formation (Ties & others, 1985) should also be discarded. These units can be readily indentified as formations in the established Queensland nomenclature.

Boundary Criteria

The sand-sized component of the Ripley Road Sandstone consists mostly of quartz grains with subordinate feldspar and white interstitial clays. The sand-sized component of the Marburg Formation however contains more rock fragments than quartz grains. It is buff to dull red in weathered outcrop but may also be dull grey green to blue grey in some fresh exposures. Calcareous cements are common. The Marburg Formation conformably overlies the Ripley Road Sandstone with a gradational change in sand fraction composition over some tens of metres but the formation boundary can be placed with reasonable precision and can be recognised consistently throughout the Queensland part of the basin. Continuing work by the authors suggests that these criteria can be applied also to the New South Wales part of the basin. Use of this scheme eliminates many redundant stratigraphic names and much confusion caused by some other schemes.

Three distinct members can be recognised in the Marburg Formation in wells in the New South Wales part of the basin (e.g. Tullymorgan No. 1, Pillar Valley No. 2). The upper member consists of interbedded sandstone and shale with minor coal, the middle member is mostly sandstone with some pebble conglomerate and rare shale beds and the lower member consists of fine sandstone, siltstone and shale. Etheridge & others (1985) named the lower member the Calamia Member.

Ties & others (1985) restricted the term Marburg Formation to the upper part of the Marburg Formation and called the middle member Ripley Road Sandstone. This usage is inconsistent with the original definitions of the units and can only lead to errors in correlation within the basin and therefore should be discarded.

FORMATION BOUNDARIES

Using the criteria set out above, the sequence in Maclean No. 1 is as follows:-

Marburg Formation

middle member, 0-557.45 m

Calamia Member, 557.45 - 590.05 m

Ripley Road Sandstone 590.05 - 664.8 m (T.D.)

UNIT DESCRIPTIONS

Marburg Formation

Middle Member

The middle member of the Marburg Formation in Maclean No.1 consists of predominantly of medium and coarse sandstone bed sets, mostly in the order of 2 to 5 m thick with a maximum thickness of 9 m. These bed sets are typically large-scale cross-bedded though massive and parallel laminated beds are common. Beds are typically more than 20 cm thick. In parts of the sequence sandstone beds display slight normal grading with coarse to very coarse sandstone at the base of the bed grading up into medium sandstone at the top. Erosion surfaces are common at the base of the coarser sandstone beds. Granule and pebble conglomerates are also common in parts of the section interbedded with coarse and medium sandstone beds. The conglomerates are large-scale cross-bedded or massive.

Two parts of the middle Marburg Formation are predominantly siltstone and fine sandstone. Between 80 m and 94 m and 10.6 m and 14.7 m, the section contains black to dark grey fine and medium sandstone and a few beds of mud chip conglomerate consisting of mudstone clasts set in medium sandstone. Ripple cross laminated sandstone beds are more common in these intervals than in the rest of the member.

Calamia Member

The Calamia Member of the Marburg Formation is a generally fining-up sequence. Its lower part consists mostly of cross-bedded, parallel laminated and ripple cross-laminated medium to fine sandstone with one bed of coarse sandstone. This interval is overlain by an interval consisting mostly of dark grey to black siltstones that are either laminated or disturbed by roots and burrows. Laminated, large-scale cross laminated and ripple cross-laminated fine and medium sandstone beds are also present in this part of the Calamia Member. Some of the cores of the Calamia Member are badly fractured suggesting the possibility of faulting in this part of the sequence. 14

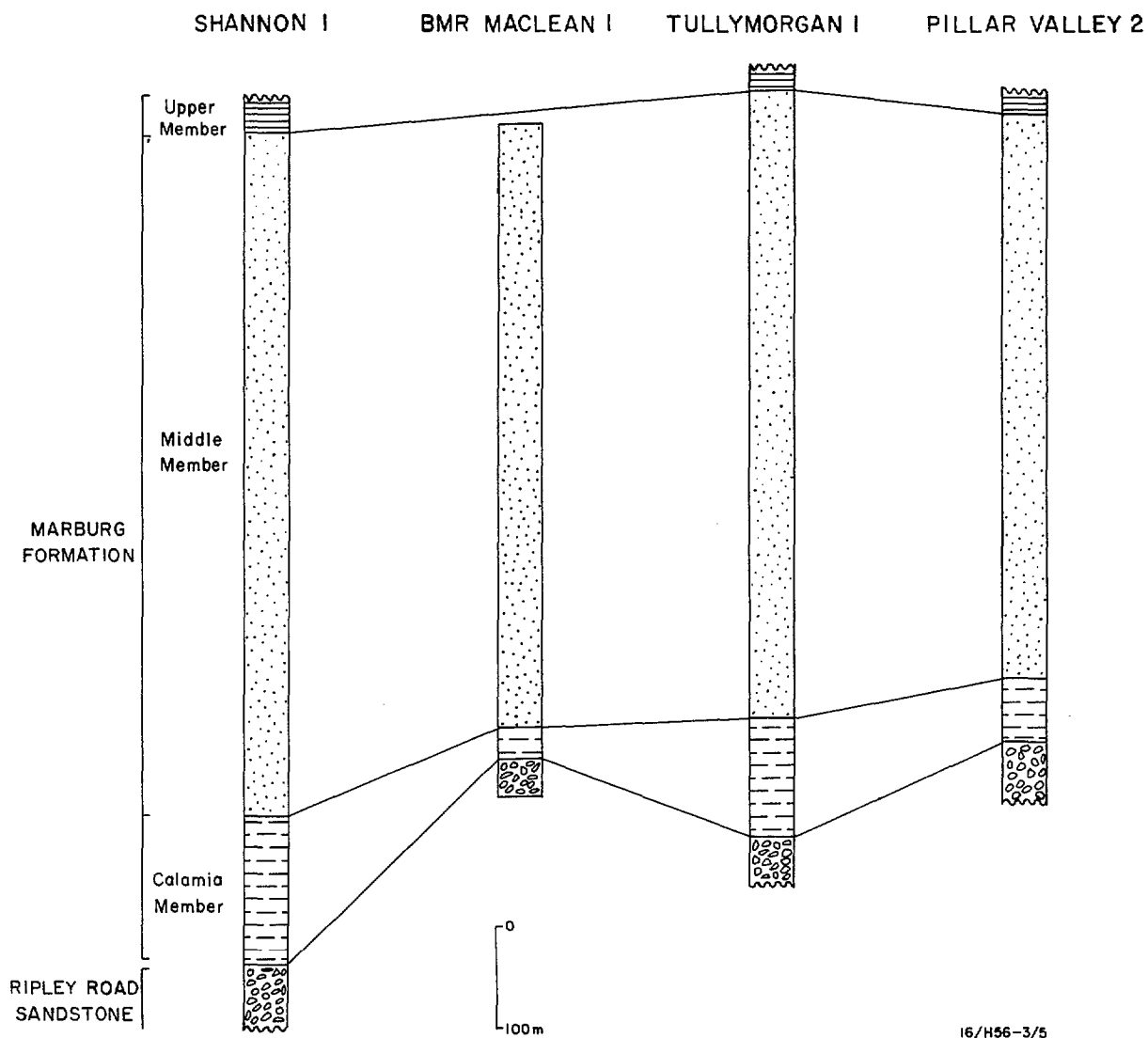


Fig.3. Correlation of BMR Maclean I and other deep wells in the region.

Ripley Road Sandstone

The Ripley Road Sandstone consists of white to light grey, coarse to very coarse, large scale cross laminated and massive sandstone with some granule conglomerates. Cross-bedded medium sandstone predominates in the upper 12 m of the Ripley Road Sandstone.

DEPOSITIONAL ENVIRONMENTS

The sediments penetrated by Maclean-1 are entirely fluvial. The middle member of the Marburg Formation and the Ripley Road Sandstone are dominated by channel facies with only a minor proportion of floodplain deposits. The Calamia Member consists of a higher proportion of floodplain sediments.

STRUCTURE

Dips evident in the core are low, not exceeding 10 degrees, except for cross bedding and a few bedding contacts that are probably erosional or draped over underlying cross beds. Some cores from the Calamia Member are extensively fractured, suggesting the possibility of faulting at this level. Other cores from the Calamia Member display steeply dipping fractures that are coated with white clay, white calcite or both coarse calcite and dull olive green kaolinite (J. Fitzsimmons, pers. comm).

CORRELATION WITH OTHER SEQUENCES

Figure 3 shows the correlation of B.M.R Maclean No.1 with the nearest two deep petroleum wells, Tullymorgan No. 1 and Shannon No. 1 (Lat 28°54'16", Long 152°52'29") and Pillar Valley No. 2, a deep stratigraphic bore (Fig. 2). The stratigraphy of Shannon No. 1 is modified from Ties & others (1985) and the stratigraphy of Pillar Valley No. 2 is from Etheridge & others (1985). Though Maclean No. 1 did not clearly intersect the top of the middle Marburg Formation, the presence of 590.05 m of the member suggests that it spudded close to the top and that the middle Marburg Formation does not thin drastically onto the present eastern basin margin. The Calamia Member, however is only one quarter the thickness in Maclean No. 1 that it is in the other two wells. This suggests either that the unit thins onto the eastern basin margin or that the fracturing seen in core from Maclean No. 1 results from a fault that removes part of the section. In Pillar Valley No. 2, the Calamia Member is also thinner than in the wells in the basin centre (Fig. 3), suggesting that there is some depositional thinning of this member onto the eastern margin. However, seismic surveys tied to Maclean No. 1 or further drilling are required to resolve this problem with certainty.

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IMPLICATIONS FOR PETROLEUM EXPLORATION

SOURCE ROCKS

The few fine grained beds in Maclean No.1 are fairly carbonaceous and representative samples have been submitted for analysis.

POROSITY AND PERMEABILITY

Most of sandstone beds in Maclean No. 1 contain abundant diagenetic clays and cements and appear to be impermeable in hand specimen with abundant diagenetic clays and cements. However, some beds of coarse sandstone near the base of the middle member of the Marburg Formation, in the Calamia Member and in the Ripley Road Sandstone may be slightly porous. These beds are marked on the lithological logs. Petrophysical tests will be necessary to confirm this.

CONCLUSIONS

BMR Maclean No. 1 was programmed to penetrate and fully core the entire section of Marburg Formation at the eastern margin of the Clarence Moreton Basin, and to obtain data on sedimentary sequences, environment of deposition and petroleum source rock potential. The Evans Head region was chosen because it is a part of the basin where no information is available on the Marburg Formation which in other drilled sections has proven source rock potential.

The sequence penetrated in BMR Maclean No. 1 was -

Marburg Formation - middle member	0-557.45 m
- Calamia Member	557.45-590.05 m
Ripley Road Sandstone	590.05-664.8 m TD

The middle member comprises medium and coarse grained sandstone beds mostly 2-5 m thick, and is dominated by channel facies with only a minor proportion of floodplain deposits.

The Calamia Member comprises mostly cross-bedded, medium and fine grained sandstone at the base overlain by mostly dark grey to black siltstone that is laminated or in places bioturbated. The member consists of a high proportion of floodplain sediments.

The Ripley Road Sandstone comprises coarse to very coarse sandstone and some granule conglomerate and is also dominated by fluvial channel facies.

The percentage of fine grained rocks of possible source potential is very low and representative samples are being analysed. Permeability and porosity appears to be low.

The drill hole has confirmed the identification of the Ripley Road Sandstone in the area and added further evidence for abandoning the term Olive Gap Formation. It has also indicated that the geological boundaries shown on the Maclean geological sheet should be revised. The Marburg Formation Walloon Coal Measures boundary should be moved approximately 2 km to the west and the Marburg/Ripley Road Sandstone boundary also needs revision and field verification.

Geological reconnaissance prior to drilling indicated the need to revise much of the geological mapping around Evans Head, for example the identification of Ripley Road Sandstone at Snapper Point not Palaeozoic basement as indicated on the Maclean 1: 250 000 geological map.

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APPENDIX 1

GRAPHIC LOGS

BMR MACLEAN NO 1

30-2/38

Age	Formation	Depth (m)	Sedimentary Structures	Description		Dip	Photograph	Colour
			Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	LEGEND				
				conglomerate				
				mud chip conglomerate				
				sandstone				
				siltstone,				
				claystone, mudstone				
				coal				
				massive				
				crossbedded				
				ripple cross-bedded				
				climbing ripples				
				parallel laminated				
				discontinuous parallel laminae				
				low angle cross bedding				
				thinly interbedded				
				rootlets				
				burrows				
				fining up sequence				
				coarsening up sequence				
				erosion surface				
				load cast				
				concretion				
				slump				
				convolute lamination				

30-2/36

CORE AGE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour	
				Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders					
		5															
*1		10%															
*2		47%															
*3		100%															
*4		40%															
*5		100%															
*6		100%															
*7		100%															
*8		100%															
*9		100%															
*10		70%															
*11		100%															
*12		100%															
*13		15															
*14		100%															
*15		100%															
*16		20															
*17		100%															
*18		25															

o-br, plastic

clay matrix, friable, deeply weathered,

subrounded to sub angular; quartz, some dk qy chert and quartzite, white clay matrix, deeply weathered. base of weathered zone

carbonaceous, coaly in part, dk qy, laminated

mid qy, minor o-br, discontinuous, poorly defined laminae, fine sandy, lt qy as above

lt qy, plastic

70% sandstone, qy, fgr

30% siltstone, qy,

bl qy, tough, m. & f. gr, fractured, calcite veins

m & c. gr interbedded, lt qy, tough, quartzose,

c gr., lt. qy, tough.

lt. qy, tough

80% sst, + gr, lt. brgy, tough

20% silt, dk qy, laminae.

40% sandstone,

19% tough,

60% siltstone, dk qy, ripple x. laminated & lt qy sst

tough, lt qy, quartzose.

sst. & lt qy, tough, quartzose

25% cgr & some v.c gr sst. as above, subangular

mod. porous sst.

75% m. gr, sst. as above.

30-2/35

Core #	Age RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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30-2/38

CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
C34		75			css + mss white to grey X bedded, coal spars. pebb at base X lam mss, grey, lam. v. thin.			
100%					fss, X laminated, carbonaceous laminae define X lam. Grey.			
C35					mss, X laminated, lt grey, X sets $\approx$ 20cm thick, defined by fss lam.			
100%					fss, 1/16 lam. grey.			
					Mss, X bedded sets 12-25cm thick. Some X sets separated by 1/16 lam fss lam. + thick. X lam defined by fss lam.			
					Interlam. fss (brn grey) and black siltstn			
C36		80			mss, single cross set, blue grey.			
100%					black to brn black fissile carb claystn. Conchoidal fracture brn streak. Sampled.			
					Interlam carb siltstn (80%) durfss brn grey to black			
					claystn to coaly claystn, Mass to fissile. black.			
					lam sy siltstn A into mss brn black siltstn with carbonate veins. laminae in lower part dip 20°			
C37					Black siltstn with lighter interbeds $\approx$ 1cm thick. (fss lam (interbeds $\approx$ 20%) Some interbeds inclined 20°			
100%								
		85			Pure mud chip conglomerate. A little matrix sand near base Mud pebbles $\approx$ 2cm.			
					mss, X bedded, Dark grey.			
					Faintly lam. fine sandstone. lam not evenly spaced or 1/16.			
					Fss interbedded with mss grey. Some mudchips. Some planar ripple Xsets $\approx$ 5cm thick			
C38					mss, X bedded grey. Fine mudchips and fss lam.			
100%					Black fss with white speckles, massive.			
					Mss low angle Xsets 30-60cm thick. Groups of carbonaceous laminae. 2-3cm thick. Dark grey.			
C39	MAPOURGE	90			Poorly lam. siltstn, Some lt fss grey fss lam and ripple Xsets. Mostly black.			
100%					Mss, massive to faintly lam, some cherty, carbonaceous lam. zones Blue grey with mottling			
					Mss, massive with mudchips, grading up into laminated fss.			
C40					8 siltstn, massive + carbonate veins. Rests on an sharp surface.			
100%								
		95			Fine peb conglomerate and css Cross bedded at base otherwise massive to po 1/16 lam. Coal spars and mud chips present. Pebbles qty > rock frags. Pinkish sandstone matrix			
C41					Mss, X lam, sets 30cm, grey			
100%					css + vcss & pebble cong. X bedded Pink shing sandstone matrix. Erosional base			
					Mss, X bedded lt grey to green grey, Pink tinge.			
					Mss, X bedded. greeny grey to brn grey. Pink mineral in upper half			
C42								
100%					mss, Mass, brn grey. Erosional base Fss. ripple X lam, greeny grey to pink.			

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CORE No.	Recovery %	Formation	Depth (m)	Sedimentary Structures	Description	Dip	Photograph	Colour
C63	100%		150		Mon. Vass, massive, white. Lam. - Mss, 116 lam. some css lam, Css with mss interbeds 1cm thick, horizontal bedding. Finning up css into mss. X beds 2.0cm thick, some separated by 116 lam. Poorly sorted Mss, some thin css beds, X bedded, brn grey.			
C64	100%		155		VCSS, some css and mss X bed packages 4-5cm thick. Mss, X lam grading up into css, X lam. Forsets are ditto packets of different grn sizes.			
C65	100%		160		Mss + css, (80% Mss) Grain size varies through the unit X laminated or X bedded (X beds 4cm thick) Colour varies from lt to drk grey with some white mottling.			
C66	100%		165		fsy mss, X sets 10-15cm thick separated by thin 116 lam beds. Chaff laminae.			
C67	100%		170		Fsy mss, X sets 25-10cm thick, grey to blue grey.			
C68	100%		175		Mss, coarser and better sorted than overlying unit. X sets, 30-40cm thick			
C69	100%		180		Css with vcss at base, mss packets 2cm thick on X sets, X laminated.			
C70	100%		185		Css ↑ mss, white to lt grey, X laminated.			
C71	100%		190		VCSS ↑ mss, X bedded with X laminae defined by mss lam near base and css lam. near top. White to lt grey.			
C72	100%		195		Css, X lam with mss lam 1-2cm thick. Mss. Faint lam inclined slightly.			
C73	100%		200		VCSS, X lam with mss packets marking X sets.			

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CORE #	RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour
					Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders				
#76	100%	MARBURG	200													regular graded thin beds in x-beds, beds 1cm thick in x-beds, lt qy and mid qy, some vgr, grading down into thin bas at conglomerate, v lower 15cm is flat bedded.	
																qy with irregular coal spar, sharp contact with dk qy siltstone	
																poorly sorted with dk qy chert & wh qtz.	
#77	100%															lt qy, quartz/lithic, beds 1.5cm in x-beds, fractured in places.	
				205												quartzose, med. well rounded, well sorted, black grns and occ. vc qtz grns, lt qy, indistinct bedding, closely fractured, coarser grained downwards	
#78	100%															quartzose, mid qy, very closely, fractured,	
																as above.	
																x-bedded, quartzitic, lt qy	
#79	100%			210												lt qy, friable, quartzose, poorly sorted, poorly x-bedded, intervals of dk qy, m qy silt 209.22 - 209.55 - 211.9.	
#80	100%															br dk qy. m & cgr with thin line of granules of qtz and rock fragments	
#81	100%														beds 1.5-2cm in x-sets, lt qy & mid qy, cgr towards base of x-bedded set		
															mid qy to dk qy, mainly x-bedded & dk qy laminae marking bedding, occ. cgr laminae, well sorted, about 25% lithics comprising dk qy intervals.		
#82	100%		215												quartzose, mid qy, subangular qtz and rock fragments.		
#83	100%		220												60% conglomerate, granite & occ. pebble, quartzose, poorly sorted, subangular to angular, occ. qy flattened siltstone plates to 2cm long.		
															40% sandstone, quartzose, mid qy, poorly sorted, some lithics; basal 3m pebble conglomerate with subangular to angular, dk siltstone and lithics incl. volcanics, lower poorly sorted? flat bedded 40cm of cgr sandstone.		
#84	100%														mid qy to dk qy, lithic includes two beds of cgr sandstone, conglomerate, pebbles, 2cm width at 219.9 & 220.47 lithic, lithic, rough, flat wavy x-lamination, dk qy, c dk qy laminae.		
															as above.		
#85	100%		225														

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CORE # RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour
				Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders				
		225														
#86		100%														
#87		100%														
#88		100%														
#89		100%														
#90		100%														
#91		100%														
#92		100%														
#93		100%														
		250														

quartzose, poorly sorted, granules of dk qy siltstone and quartz, beds 1.5cm thick in X-sets, some lithics.

quartzose/lithic, well sorted, mid qy dk qy, tough, fine mica flakes
tough, mid qy, X-laminated, lithic
quartzose, mid qy, low angle poorly defined X-beds, & bedding, 20% cgr, 80% mgr

quartzitic, mid qy, quartzitic & lithic,

quartzose/lithic, X-bedded in upper 60cm, remainder apparently flat bedded, coal spar ~5cm long in upper 20cm, occas. black siltstone clasts of irregular shape, poorly bedded, some thin beds of cgr sandstone.

quartzose, wh qtz, qy gr and dk qy rock fragments, poorly sorted, subangular

quartzose/lithic, qy to br qy, dk qy in top 10cm, qy in lower part, some flat thin bedded

as above
dk qy, carbonaceous
mid qy to br qy, quartzose/lithic, poorly sorted.
as above, 1cm mgr, mid qy near middle of interval

quartzose/lithic, in qy, mid qy, poorly sorted in part with quartz and lithic granules, mostly massive

quartzose/lithic, as above.

quartzose/lithic, br-qy, poorly sorted, mostly quartzose.
quartzose, poorly sorted, 70% cgr, 30% mgr, mottled lt qy, mid qy.

quartzose/lithic, mottled wh, gr qy & dk qy grains

quartzose/lithic, flat bedded, med qy, tough.

as above, wh qtz, gr qy & dk qy rock fragments

carbonaceous streaks, dk qy, laminated.

mostly quartzose, poorly sorted, wh qtz, dk qy lithics, occas gr qy volcanic clasts, and rare pink clasts to 1cm across, pebble conglomerate over bas at 70cm with dk qy siltstone clasts in up to 5cm across in bas at 2cm.

CORE NO. RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour
				Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders				
94		250														
C																
95																
100%																
C																
96		255														
100%																
C																
97																
100%																
C																
98		260														
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102%																
C																
101		270														
100%																
C																
102																
100%																
C																
103																
100%																

CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description	Dip	Photograph	Colour
C 103		275		Pebble cong ↑ CSS, massive, lt grey, Mud chip up to 13cm.			
100%				Mss, some c.sand grns, 116 lam & low angle X sets, Dark grey			
E				Mss (70%) + CSS(20%) X lam and 116 lam Poorly sorted greenish grey.			
104		280					
100%				Mss, X lam, csy & mud clasts at base, blue grey m some scattered c.s grns			
C							
105							
100%							
C							
106		285		Vcss ↑ mss, 116 lam, lt grey gradational base. CSS ↑ mss 116 lam and X lam. Fining up. Gradational base. csy mss, 116 lam.			
100%							
C							
107				mss Vcss ↑ css, X lam ↑ 116 lam, coarse tail grading with decreasing Vcsand up.			
100%				vcss ↑ css ↑ mss, X lam ↑ 116 lam mudclasts at base. mss, low angle X sets, brn grey, csy at base.			
C		290					
108				Vcsy Cms, X lam, ↑ csy mss, X lam defined by gm size packets 0.5 to 3cm thick Mss, X lam, csy base that is massive. X sets defined by csy packets ≤ 7cm thick that have sharp bases and gradational tops. Vcss ↑ mss olive green with green diagenetic min. X bedded. vcss ↑ mss ↑ fss.			
100%				Vcss ↑ mss, gm size in packets 6-14cm thick. Packets graded Csy mss, 116 lam. mss CSS ↑ mss, X bedded			
C		295					
109				Csy mss, mass., mid grey.			
100%							
C							
110				vcss to pebble cong, massive, mud clasts + 9cm.			
100%				Fss, 116 lam some ripples, one large X set mid grey			
C							
111							

Core #	App Recovery	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
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cgr & lt qy at top, vcgr & bl qy at base, beds 1 1/2 cm in X-sets.

quartzose/lithic beds 3-5 cm in X-sets, pebble conglomerate at base with blk qtz clasts to 5 cm across, gr volcanics, dk qy lithics
br qy, granule conglomerate over basal zone.

80% sandstone, laminated, lt br qy
20% siltstone dk qy to bk, laminated, irregularly dispersed laminae and beds to 3 cm
lithic, tough, mid blk qy, laminated, cgr in basal 4 cm

90% siltstone, bk, laminated, flat bedded
10% sandstone, laminated, vtgr, qy, tough, flat bedded.
laminated, lt qy, tough, flat bedded
laminated, tough, dk qy, -bk.

quartzitic well sorted, lt bl qy, flat bedded, X-bedded over last 60 cm

quartzose, poorly sorted, cgr and m gr, flat bedded, some low angle X-beds

quartzose, 70% cgr, poorly sorted, X-bedded in upper part, occas coal spears, pebbles and subrounded discs of bk siltstone and irregular laminae, 15% mgr, 15% vcgr.
br qy, well sorted, thin dk qy carbonaceous laminae.

quartzose, as for 310.04 - 310.26, lt qy - qy.
as for 312.26 - 312.54, lt bl qy to br qy some carbonaceous laminae towards top of interval
60% sandstone, quartzose, tough, bl qy, well sorted, laminated
40% siltstone, bk.
quartzose/lithic, irregular discontinuous laminae, carbonaceous patches, lt qy

quartzose, well sorted, gr qy

Multistony sst body with vcgr ss marking base of sets, quartzose, lt gr qy, gr lithic fragments in coarser bed, poorly sorted, mostly X-bedded, beds 1 1/2 cm in X-sets, lt qy intervals are quartzose, 40%; gr qy intervals are lithic, 60%. Base of each story marked by lithic conglomerate ~ 8 cm thick, stories ~ 60 cm thick, Sandstone, mgr, lt gr qy, lithic, cgr sst, X-bedded, with 2 cm beds in X-sets. Basal lg conglomerate and succeeding conglomerate contain volcanic clasts to 4 cm +, siltstone 7 cm +, irregular coal spears. Sandstone mgr 60%, cgr 25%, vcgr (15%)

dk qy, bk siltstone laminae in upper half, shows irregular disturbed bedding

Core App RECOVER	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
#120		325			laminated throughout, lt bk qy, fine mica flakes on bedding planes, poorly x-laminated in upper 25 cm			
100%					laminated, dk qy to bk, vf gr sandstone laminae in upper part, massive bk siltstone in lower 6 cm.			
#121		330			qy, mostly fgr, 15% mqr, rare cqr interbeds, calcite veins			
100%					quartzose, lt qy			
#122					qy, mostly fgr, 15% mqr, rare cqr interbeds, laminated, thin beds of bk carbonaceous siltstone common towards base			
100%					multistorey sandstone, conglomerate			
#123		335			quartzose, lt qy, some br qy lithic mqr sst intervals at base of conglomerate,			
100%					basal two conglomerate sections contain pebbles of gtz rock fragments & irregular coal spars, very poorly sorted			
#124		340			lithic, br qy, poorly sorted, vc grains of quartz			
100%					sandstone, multistorey with interspersed granule conglomerate; quartzose lt qy in upper half, lithic quartzose mottled lt qy, dk qy in lower half			
#125		345			40% sandstone, vc gr, quartzose			
100%					60% conglomerate, granule, no sharp contact or pebble base grad at into sandstone below			
#126					lt gr qy, mod poorly sorted, scattered vc gtz grains, poorly defined flat x-bedding			
100%					Multistorey sandstone/conglomerate unit			
#127		350			sst, cqr, quartzose, qy to lt qy			
100%					quartzose, lt qy, granule & pebble, poorly sorted			
#128					sst, mqr, qy, quartzose, ~20% cqr, occas pebbles			
100%					~20 cm of cobble conglomerate at top and base of interval separated by fining upward sequence comprising granule conglomerate at base to cqr quartzose sst at top. Basal conglomerate has abundant irregular coal spars and cobbles of rock fragments incl volcanic fragments and quartz.			
#128		350			qy, poorly defined low angle x-beds, abundant mica on bedding surfaces			

CORE NO.	FORMATION	DEPTH (m)	SEDIMENTARY STRUCTURES	CLAY SILT Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	DESCRIPTION	DIP	PHOTOGRAPH	COLOR
128	E	350			Mss, X lam, sets ~10cm separated by 116 lam, lt grey cgy and pebbly at base.			
100%	E				Vcsy css, X lam, sets 10cm thick, X lam defined by sorting variations cgy pebble cong overlain by cgy mss.			
	E				cymss ↑ base pebbly css, faintly 116 lam.			
C					Csy mss, X lam & 116 lam, no pebs at base, mid to dark grey			
129					Csy fgs, X lam, carb lam.			
100%					vcss ↑ mss, X lam., lt to mid grey.			
		355						
C					Csy mss, cherty lam, X lam, lt to dark grey			
130								
100%					Gran. cong. ↑ Csy mss ↑ fss, X lam.			
					Poorly sorted, cgy mss, massive, coal spars.			
C					Mcy css, X lam, lt grey, X lam defined by diffuse gm size changes.			
131		360			fss, X lam, mid grey			
100%	E				vcss, pebbly, X bedded, X sets ~10cm thick			
					Css, pebbly, coal spars, X bedded.			
C					mss, 116, dark grey.			
132					Mcy css, lower 4cm is poorly sorted mss pebbly mss, overlain by 7cm fine pebble cong.			
100%					Csy mss, fines up slightly, X lam defined by grain size packets 2cm thick separated by finer lam.			
C		365			vcsy css ↑ fsy mss, X bedded, X sets defined by gm size packets 2-3cm thick separated by finer lam.			
133					Fsy mss, some scattered cs grns, X lam with undulating laminae on foresets, some thin massive and 116 lam zones separating cross sets. Lower part contains less fgsand. Gha Carbonaceous laminae common			
100%								
C								
134								
100%								
C								
135		370			vcss ↑ css, X lam.			
100%	E				116 lam, fsy mss.			
					Pebbly cgy mss ↑ vcss ↑ X lam css ↑ massive mss. Inverse normal grading.			
					Poorly sorted cgy mss, green grey X lam.			
					Cgy mss, pebbly at base, 116 lam & low angle X sets.			
C					Pebbly mss & vcss & fss, massive.			
136					fsy vcss, 116 lam.			
100%								
C								
137					Fsy mss, X lam, X sets ~9cm			
100%								
C								
137		375			Mcy css, Sorting improves up, X bedded, X bed packets becoming less well defined towards top. Dk to lt grey			

Age	Formation	Depth (m)	Sedimentary Structures	Clay Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders	Description	Dip	Photograph	Colour
137		375										Lower 10cm grades from csg mss into msy vcss.			
100%															
C															
138															
100%												csg mss, 116 lam ↑ X lam mss, X sets 5-10cm separated by 116 lam ↑ fsy mss, 116 lam & low angle X sets.			
		380													
C															
139															
100%												vcss ↑ csg, gradational base, wht to lt grey.			
												Csg mss, 116 lam & low angle X sets, vcss at base, lt grey.			
C															
140												vcss, fines up over top part, 116 lam & low angle X sets.			
100%		385													
C															
141												fsy, 116 lam.			
100%												Pebble cong ↑ vcss, massive to X lam.			
												vcss, faintly lam, some X sets 20cm thick, lt grey scattered mud clasts			
C															
142															
100%		390										csg ↑ ^{csg} mss, X lam, X lam, thin lam separated by gm size packets 2-4cm thick			
												msy csg, pebbly at base, X bedded, X beds diffuse gm size packets ≤ 5cm thick			
												msy mss, massive.			
												csg, pebbly at base, X bedded			
C												csg mss, X bedded, X beds defined by csg packets 3cm thick separated by 5-10cm faintly lam mss.			
143															
100%															
												vcss ↑ msy csg, X bedded, X beds defined by gm size packets 1-3cm thick			
		395													
C												116 lam mss			
144												vcss to mss, X bedded, gm size varies with different proportions of gm size packets. 0.5 to 5cm thick			
100%												vcss to csg graded, X bedded, poorly sorted, lt to mid grey			
C															
145												vcss ↑ mss, X lam, g X beds diffuse gm size packets 1-3cm, lt grey			
												msy csg ↑ mss, low angle X sets, coal spots.			
												msy csg ↑ X lam ↑ mss 116 lam.			

Age	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
		400			quartzose, occ. pebbles, poorly sorted lt qy			
#146		100%			quartzose, lithic fragments, poorly sorted, subangular ^{dark} clast 6cm + across and irregular siltstone at base			
#147		100%			lithic, occ. cgr thin beds which appear to mark base of X-bedded sets, gr qy, beds to 2cm thick in X-sets, regular beds 1cm thick in X-sets in basal part			
#148		100%			quartzose, lt qy; grading to granule conglomerate over lower 10 cm. lithic, poorly sorted, gr qy, matrix of poorly sorted dk br qy, m gr sst. sandstone, vgr, lt gr qy with dk qy and bk lithic grains conglomerate, lt gr qy			
#149		100%			poorly sorted gr qy, some cgr; ~ 3cm of m gr carbonaceous sst beneath conglomerate, contains carbonaceous streaks, dk qy. interbedded lt qy quartzose 50% & gr qy lithic, m cgr poorly sorted regularly interbedded in upper part 2-18 cm intervals in lower part			
#150	MARGUR	100%			quartzose, subrounded, quartz, vol. and lithic clasts, well sorted, lt qy to gr qy, gradational lower contact poorly sorted, br qy, m gr with thin beds of c to vgr, lithic, gr qy, thin beds, occ vgr qtz towards top, dk qy carbonaceous laminae in upper interval sandstone, lithic & quartzose, gr qy - br, thin bedded, thin flat beds conglomerate, quartzose/lithic, wh qtz, dk qy lithic s & gr volcs.			
#151		100%			lithic, lt qy, massive, split in part, as above, quartzose, lt qy, gr qy lithic, X-sets ~ 25 cm thick			
#152		100%			lithic, poorly sorted, thin cgr interbeds, dk br qy & dk gr qy, ? flat bedded. 50% sandstone, cgr, poorly sorted, lithic, lt gr qy 50% conglomerate, granule, quartzose, poorly sorted, lt qy, quartz, rock fragments. gr qy, well sorted, thin bedded, flat bedded, carbonaceous plant debris on bedding planes. multistage sandstone/conglomerate sequence.			
#153		100%			sandstone, cgr vgr, poorly sorted, lithic scattered granules & pebbles, 2-3cm beds in X-sets br qy to gr qy conglomerate, granule, some pebbles, quartzose, wh qtz, gr qy? volcs, dk qy lithics, 3-4 cm beds in X-sets,			
#154		100%						

Age	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
#154		425						
100%								
#155					gr-qy & br-qy, & lt qy inter bedded, occas thin granule beds more common in upper part, rare pebbles and coal spars			
100%								
#156		430			quartzose, bl qy, mqr & some cqr & vcqr, with occas. interbeds of granule conglomerate, some carbonaceous laminae and large dk qy siltstone clasts, to 4cm+ in cqr sandstone interval.			
100%								
#157		435			quartzose, poorly sorted, occas subangular pebbles and coal spars lower 10cm pebble conglomerate, with large dk qy siltstone clasts 10cm+ across			
100%					thin carbonaceous laminae & cqr thin beds in places			
#158	MARGUR				cqr vcqr at base & interbedded mqr x bedded and pebble layer. lt gr qy, beds to 2cm in X-sets, poorly sorted, X-beds with alternating mqr thick and cqr thin beds, quartzose & lithic.			
100%					as above, basal 11cm of x bedded granule quartzose conglomerate			
#159		440			lt gr qy thin bedded, quartzose, some lithic			
100%					Predominantly sandstone, cqr with vcqr interbeds, and thin beds of granule conglomerate			
#160					sandstone cqr gr qy, quartzose, lithic grains, beds 2-3cm thick in X-sets			
100%					conglomerate, quartzose, granule, mottled wh & gr qy, qtz & lithic grains, in thin beds through sst.			
#161		445			lithic, thin bedded, gr qy to bl qy, some fine mica on bedding plane			
100%					quartzose, lt qy, irregular carbonaceous laminae in places			
#162		450			mottled wh & gr qy, wh qtz, lt gr qy & qy lithics, poorly sorted, abundant lt gr? chlorite beds 2cm in X-sets. 10cm of cqr sst, br qy, poorly sorted 7cm from base.			
100%					sandstone, cqr, x bedded, gr qy & lt qy, quartzose & lithics, occas granules			
#162					conglomerate, granule, clast to 7cm, mod well sorted, quartzose, gr qy lithics (? volcs), and dk qy lithic grains.			
100%					sandstone, quartzose & lithics, mqr, bl qy, occ. cqr beds and grains, rough			
#162					conglomerate, granule, quartzose, occas qtz and siltstone pebbles, & gr qy & dk qy lithics.			

CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
162		450			Csy mss, X lam., lt grey.			
100%					Fine wss, 11e lam., lt grey			
					Mss, X lam, grey.			
C					Csy mss, X lam, lt to mid grey.			
163					Massive pebbly wcss ↑ 11e lam mss, coal spars			
100%					Csy mss, 11e lam, gray green			
					Fss, 11e lam, Dark grey.			
					Csy mss, massive, Mid grey.			
C		455						
164					Mssy css, mss in packets & (foresets) up to 5cm thick. One			
100%					X bed 90cm thick.			
C								
165								
100%		460			Mssy Ccs ↑ mss, massive, mid grey, poor/moderately poorly sorted.			
C								
166					Pebbly wcss, pebbles up to 5cm.			
100%					Pebbly, csy mss. Pebbles & granules float in csy mss. Mud clasts up to 7cm. Fines up with reduction in proportion of pebbled ccs. Top part 20cm lt grey, possible porous.			
C		465			Mss, massive to faint lam., blue grey, One dark brown zone (concretion)			
167					1cm w fss overlying pebbly ccs, 4cm thick			
100%					Mssy ccs, X lam, X sets ~ 18cm, dark grey to greenish grey			
					wss, 11e lam, ripple X lam, micaceous			
					Vcsy ccs, some mss packets on foresets, drk grey to lgrey, Porous?			
C		470			wcss ↑ ccs, mssy foreset packets, lt grey to white			
169					mss, carbonaceous			
100%					Css, X bedded, lt grey, Porous?			
C					Css, X bedded (X beds packets of white ccs < 4cm d mss < 2cm).			
170					Coal spars			
100%					Css, X lam, mss top, coal spars,			
					c + wss, X bedded, white to mid grey, Yellow diagenetic mineral. Porous?			

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CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
		475			As Above			
C		171						
100%								
					Mssy css, pebbly at base, Low angle X lam., dark grey, Porous?			
C		172						
100%					Css, X lam, lt grey, pebbles & mudclasts at base			
		480			Mssy css, with scattered coarse sand grains, X laminated.			
					Mssy pebble conglomerate ↑ css, fss, X lam, chert laminae.			
C		173			Css, vcss at base, X lam, dark grey			
100%					Mss, X laminated with some massive beds. Some css packages on X sets			
					Fsy mss, Faint lllc lam, grey. Lower part has abundant mudchips & is polished with greenish tinge, concretion.			
					Fsy mss, Very lower 18cm, Faint lllc lam top, X lam lower part.			
C		174			Css, Xbeds defined by mss packets 0.25cm to 1cm separating css packets < 5cm thick. Lowest 10cm is poorly sorted,			
100%					mssy css.			
					Vcss, mssy at base ↑ css ↑ fsy mss, X lam.			
					Fsy css, massive, poorly sorted, dark grey.			
C		175			Δ fsy mss, X lam ↑ mssy fss, ripple X lam Dark grey with pinky laminae.			
100%								
		490			Css, Xlam with normally graded or to mss packets 5cm thick			
					Δ mssy css, X lam, fines up, lt grey ↑ dark grey			
					Mss ↑ csy mss, X lam, Dark greeny grey.			
C		176			Css, X lam, no Xsets diffuse gon size ssd packets < 5cm. lt to drk grey.			
100%								
					Mssy css, poorly sorted, X lam.			
C		177			Fsy mss, lllc lam & low profile ripples, csy in places, gon drk greeny grey.			
100%					Css, X bedded, Xbeds diffuse gon size packets ≤ 3cm thick			
					Fsy mss, lllc lam, drk grey, carbonaceous.			
					Mssy css, Xbedded, X set beds diffuse gon size packets some graded with sharp bases, Packets 3-5cm, lt grey.			
C		178						
100%								
		500			csy mss, X lam, drk grey			

Core Recovery	Formation	Depth (m)	Sedimentary Structures	Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders	Description	Dip	Photograph	Colour
179		500			sandstone, cgr, lt qz & gr qz, lithic mod well sorted, occas. quartz and siltstone granules graded beds in X-beds, mica flakes on bedding surfaces, beds 2-4 cm in X-sets conglomerate, granule			
#180		100%			conglomerate, granule, X-bedded, lithic; interbeds of dk qz cgr sst, a thin bk carbonaceous layers.			
		505			conglomerate, graded & coarse granule conglomerate at base.			
#181		100%			sandstone, quartzose, cgr, br qz, to gr qz, conglomerate, quartzose, granule lt qz			
#182		100%			sandstone, quartzose, dk gr qz, poorly sorted with abundant qtz granules esp. towards top conglomerate, wh qtz, gr v. lcs, gr ? chlorite, lt qz			
#183		100%			sandstone, upper 10 cm cgr, & abundant carbonaceous laminae; over v-cgr sst, lt qz, quartzose, poorly sorted conglomerate, quartzose, poorly sorted, 2 cm bed. in X-sets, upper med gr granule, lower 35 cm cgr granule			
#184	MARBURG	51			lithic in upper 18 cm where sst has been reworked poorly sorted over sst dk qz, quartzose, mod. well sorted, dk laminae mark X-beds, micaceous, occas blue qtz grains. quartzose, m gr granule at top, cgr granule at base, large siltstone clasts to 8 cm + across over lower 40 cm, wh qtz, gr qz v. lcs, dk qz siltstone, qz lithics and blue quartz lithic, qz & dk gr qz, micaceous, thin carbonaceous laminae quartzose upper 4 cm pebbly with blue quartz, gr qz, volcanic & dk qz lithics, over granule X-bedded conglom. sandstone, v-cgr, lt qz, quartzose, tough, some purple qz, micaceous siltstone laminae & thin beds. conglomerate, lower 40 cm, quartzose, wh & blue qtz, & irregular dk qz siltstone clasts, poorly sorted, carbonaceous laminae. m & cgr, lithic, poorly sorted, occas. blue & wh qtz granules, v-cgr thin beds, micaceous, ? flat X-beds 80% conglomerate, quartzose, lower 6 cm poorly sorted, medium granule with abundant irregular coal spars, wh qtz, and dk qz lithic, dk br qz, med gr sst. 20% sandstone, cgr, quartzose, qz,			
#185		100%						
#186		100%						
#187		525			quartzose, poorly sorted non bedded, lt qz, occas wh & blue qtz granules, & cgr qtz grains, ~10% dk qz lithics			

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CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description					Dip	Photograph	Colour
				Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand			
		550									
C		197									
100%											
C		198									
100%											
C		199									
100%											
C		200									
100%											
C		201									
100%											
C		202									
100%											
C		203									
100%											
C		204									
100%											
C		205									
100%											
C		206									
100%											

CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description										Dip	Photograph	Colour		
				Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders						
C	MARBURG (CALAMIA MFB)	575																
206		100%																
C		207	100%															
C	MARBURG (CALAMIA MFB)	580																
208		100%																
C		209	100%															
C	MARBURG (CALAMIA MFB)	585																
210		100%																
C		211	100%															
C	RIPLEY ROAD SANDSTONE	590																
212		100%																
C		213	100%															
C	RIPLEY ROAD SANDSTONE	595																
214		100%																

Core #	Depth (m)	Sedimentary Structures	Description						Dip	Photograph	Colour
			Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand			
	600										
# 215	100%										
quartzose, oolitic, clean sst, some dk carbonaceous laminar & veins filled with aragonite & unidentified green mineral. It gr qz to br qz, st porous in part. mostly lithic, v. poorly sorted coarser grained at base and v. poorly sorted with qtz granules, occas carbonaceous laminar											
# 216	100%										
quartzose, poorly sorted, lithic in part with dk qz & gr volcanic fragments, including 2 1/2 cm of mgr lithic sandstone; coarse to v. coarse granules, pebbly in part, pink weathered feldspar in coarser grained pebbly intervals, coarser grained towards base with large coal spars											
# 217	100%										
quartzose, gr qz, mostly well sorted, some lithic grains thin interval of dk qz fine gr, silty sandstone. abundant carbonaceous bk irregular shaped siltstone clasts, v. poorly sorted, occas lithic fragments.											
# 218	100%										
upper part - quartzose, cgr, wh, bk irregular siltstone fragments, very poorly sorted towards base with granules of qtz and some lithic grains, ? feldspathic in weathered pink gran non bedded. sandstone, br qz, med gr, lithic, occas thin carbonaceous laminar. poorly sorted, abundant lithic grs & pink feldspar, subangular dk qz chert grains											
# 219	100%										
75% sandstone, quartzose, qz to lt qz, x-bedded 25% conglomerate, quartzose, granule, rare pebbles, x-bedded, wh, abundant feldspar, pebbly in places. upper half - sandstone, v. cgr, x-bedded, beds in x-sets 3-4 cm thick, x-beds marked by dk qz thin beds in lt qz cgr sandstone, feldspathic conglomerate, granule, pink feldspar, dk gr lithic fragments, wh qtz lithic, br qz to dk br qz, thin bedded, friable, poorly sorted multi-story x-bedded sst, steep x-beds, & conglomerate. quartzose, poorly sorted, cgr, v. cgr, feldspathic, quartzose feldspathic granular conglomerate in the bed											
# 220	100%										
dk br qz, v. poorly sorted, abundant granule size qtz, lithic D type quartzose, similar to 614.13-617.07 A type quartzose, occas. pebbles, & lithic fragments, qz, poorly sorted, thin intervals of granule conglomerate, B type sst, A type											
# 221	100%										
poorly sorted, lt qz, mottled dk qz lithic, v. cgr sandstone matrix, irregular coal spars, gr volcs, pink feldspar - conglomerate C type. sst, A type Conglomerate C type.											
# 222	100%										
v. poorly sorted, mostly quartzose, dispersed quartz granules, some thin beds of mgr lithic sandstone, ? flat bedded. Similar to D-type											

					Description										Dip	Photograph	Colour
Core #	Core Recovery	Formation	Depth (m)	Sedimentary Structures	Clay	Silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse Sand	Granules	Pebbles	Boulders				
#			62.5											quartzose, occas. pebbles, occas lithic fragments, qz, poorly sorted, thin interbeds of granule conglomerate			
223														mqr & cqr, flat bedded, well sorted, bk laminae, lithic with some thin interbeds of dk br qz sst, lithic smth fining up cqr to fqr intervals in lower part of interval or ~ 12cm thick. E type sst.			
#			63.0											quartzose, cqr, poorly sorted, feldspathic, granule conglomerate intervals A type grading down into B type - occas. pebbles, vqr, quartzose, occas lithic fragments, qz, poorly sorted, thin interbeds of granule conglomerate.			
224														vqr, occas. pebbles, thin interbeds 2-3 cm of granule conglomerate, quartzose, B type sst except bedding is flat and contains interbeds of dk br qz medium grained lithic sst.			
#			63.5											quartzose, wh, fqr granule, pink feldspar, bk rock fragments, quartzose, mod. well sorted. vqr to cqr, quartzose, poorly sorted, feldspathic, granule conglomerate intervals & bedding not pronounced, becoming finer grained towards base.			
225														poorly sorted, dk qz, some interbedded granule conglomerate, one large angular chert fragment 8cm across at base of interval, pink feldspar grains, quartzose with blueish qtz grains, chert fragment mottled dk qz & fawn.			
#			63.5											v. poorly sorted non bedded, quartzose, clean with angular chert fragments, subangular wh quartz grains, pink feldspar & dk qz unidentified lithic grains, bedding well defined below 63.6-70. includes 3cm of mqr dk qz lithic sandstone, similar to sandstone above but has higher lithic content, dk qr qz colour, blue quartz & dk qz lithics.			
226														quartzose, occas. pebbles and lithic fragments, qz, poorly sorted, thin interbeds of granule conglomerate. B type.			
#			64.0											- dk br qz, mqr, lithic, poorly sorted, occas. granules.			
227														quartzose, v. large X-bedded sets, vqr, occas. pebbles and lithic fragments, qz, poorly sorted, thin interbeds of granule conglomerate, largest X-bed 1.2m others 25cm, 15cm; 3cm beds in X-sets, some angular chert pebbles, poorly sorted sequence; similar to B type sandstone			
#			64.5											lithic friable, dk br, qz, mqr friable, boundary layer between v. bedded quartzose lower part contains two 5cm beds of granule, lithic X-bedded conglomerate			
228														cqr & vqr, large X-beds, quartzose, poorly sorted, irregular X-beds, feldspathic, granule conglomerate intervals, quartzose, feldspathic, A type.			
#			65.0											dk qz, fqr, lithic, poorly sorted with occas. granules.			
229														m & cqr, poorly sorted, tough, occas qtz granules, quartzose, occas. irregular coal spars, fractures show green amorphous mineral.			
#			65.0											60% sandstone, cqr, X-bedded, poorly sorted, occurs mostly in upper part of interval.			
230														40% conglomerate, granule, X-bedded, poorly sorted, thin pebble bed at base of interval, generally 150cm interval in lower 50 cm. of section.			

CORE RECOVERY	Formation	Depth (m)	Sedimentary Structures	Description		Dip	Photograph	Colour
				Clay Silt Very Fine Sand Fine Sand Medium Sand Coarse Sand Granules Pebbles Boulders				
C		65			Vcss, abundant black mud clasts, 11e lam, white, Porous? Interbedded vcss, css & ms. coalspars css, faint 11e lam. sltsta 3cm thick. css, x lam, Porous, white Cong & msy css, x bedded, x bed packets ≤ 4 cm. Porous? css ms, x lam, poorly sorted in places, dark grey. 11e lam, dark grey.			
231		100%						
C					Css, lower part part grades from vcss $\uparrow$ css, wht to lt grey, Porous?			
232		655						
100%					Drk grey sltsta 2cm.			
C					Peb cong $\uparrow$ css, massive, wht to grey, Porous?			
233		100%						
C					Clayey sltsta. Massive, Drk grey			
234		660			Peb cong, massive, wht.			
100%					vcss, x lam, pebbly in places, lt grey to wht, coal spars, Porous? and more friable than older sandstones in the sequence.			
C								
235		100%			Fine Cong, x lam, wht, Porous? Vcss, x lam, wht, Porous?			
		665			T.D 664-80m.			

APPENDIX 2
WIRELINE LOGS



HOLE NO.: BMR MACLEAN 1
LOGGED: 06/05/85 at 15:09

COMPANY BMR
AREA HELLHOLE
PROSPECT
OPERATOR DICK

DRILLING DATA

PERM DAT HERE
ELEV ???
HOLE POS None
HOLE DIA None
DEPTH N/A
CASE TYP N/A
CASE BTH N/A
CASE DIA N/A
CASE THK N/A

FLUID DATA

FLD TYPE WET
FLUIDLEV High
LOGTYPE TD-5
APROX SP 6

TOOL: T059--DENSITY/CALIPER
Serial Number: 1717
Spacer (cm's): 0

CHANNEL DATA

CHANNEL	AMPLITUDE	RANGE	CHART	AREA	SENSOR	FILTER
CALIPER--1 ARM	2	4	0.00	6.00	74	2.0 TRCN
DENSITY	0	4000	5.00	25.00	134	2.0 TRCN

Calibration Data

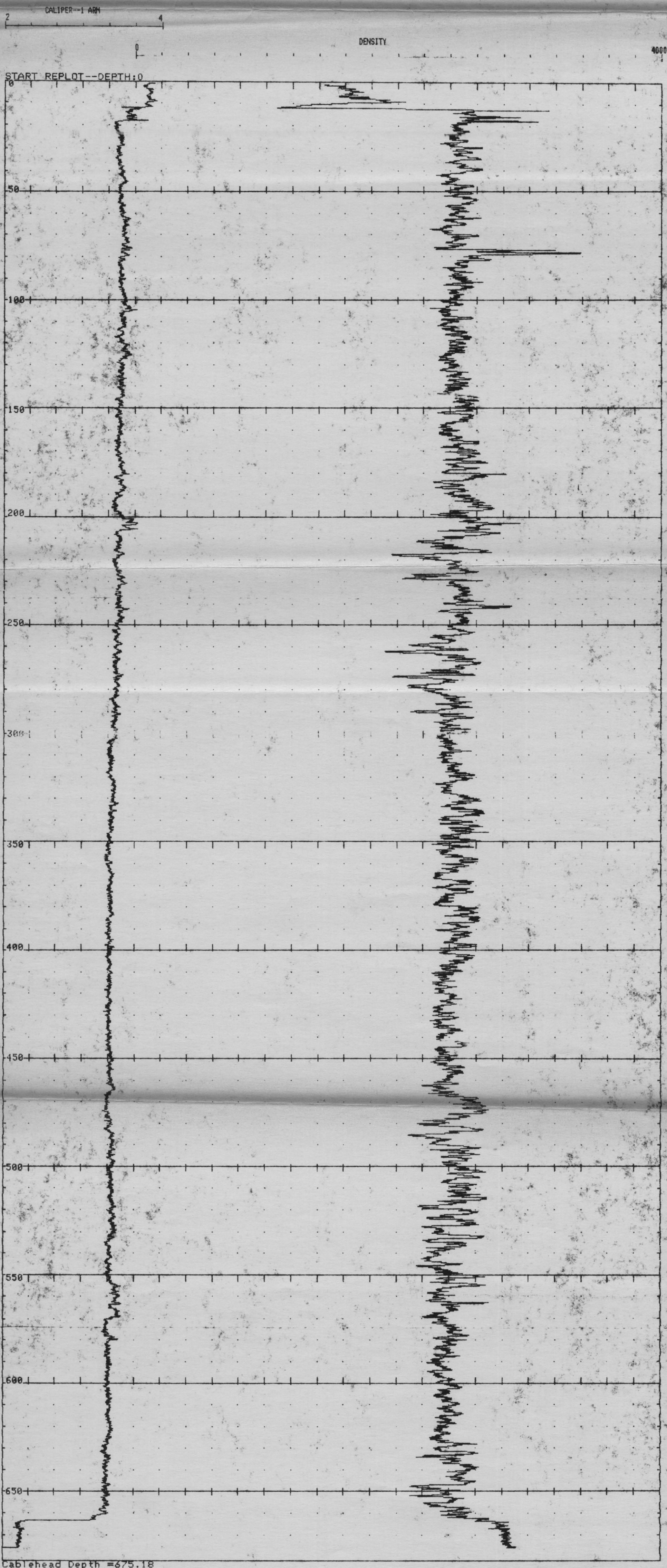
CHANNEL	mx	b	C1	C2	C3	C4
CALIPER--1 ARM	Ins=.003668	-6.2945	10	4448.6		3356.
DENSITY	cps=1	0	64.2	0	0	0

LOG CASSETTE FILE: DEN CAL 1

Logged: UP by DEPTH Interval = 5 cm's

Replay of File: DEN CAL 1

SCALE: 1 TO 1200
using
DEPTH CORRECTION





HOLE NO.: BMR MACLEAN 1
LOGGED: 01/01/80 at 00:54

COMPANY: BMR
AREA: HELLHOLE
PROSPECT:
OPERATOR: DICK

DRILLING DATA ##
PERM DAT: HERE
ELEV: ???
HOLE POS: None
HOLE DIA: None
DEPTH: N/A
CASE-TYP: N/A
CASE-DTH: N/A
CASE-DIA: N/A
CASE-THK: N/A

FLUID DATA ####
FLD TYPE: WET
FLUIDLEV: High
LOGTYPE: TD-5
APPROX SP: 6

TOOL: T013--ELOG
Serial Number:
Spacer (cm's): 0

CHANNEL DATA

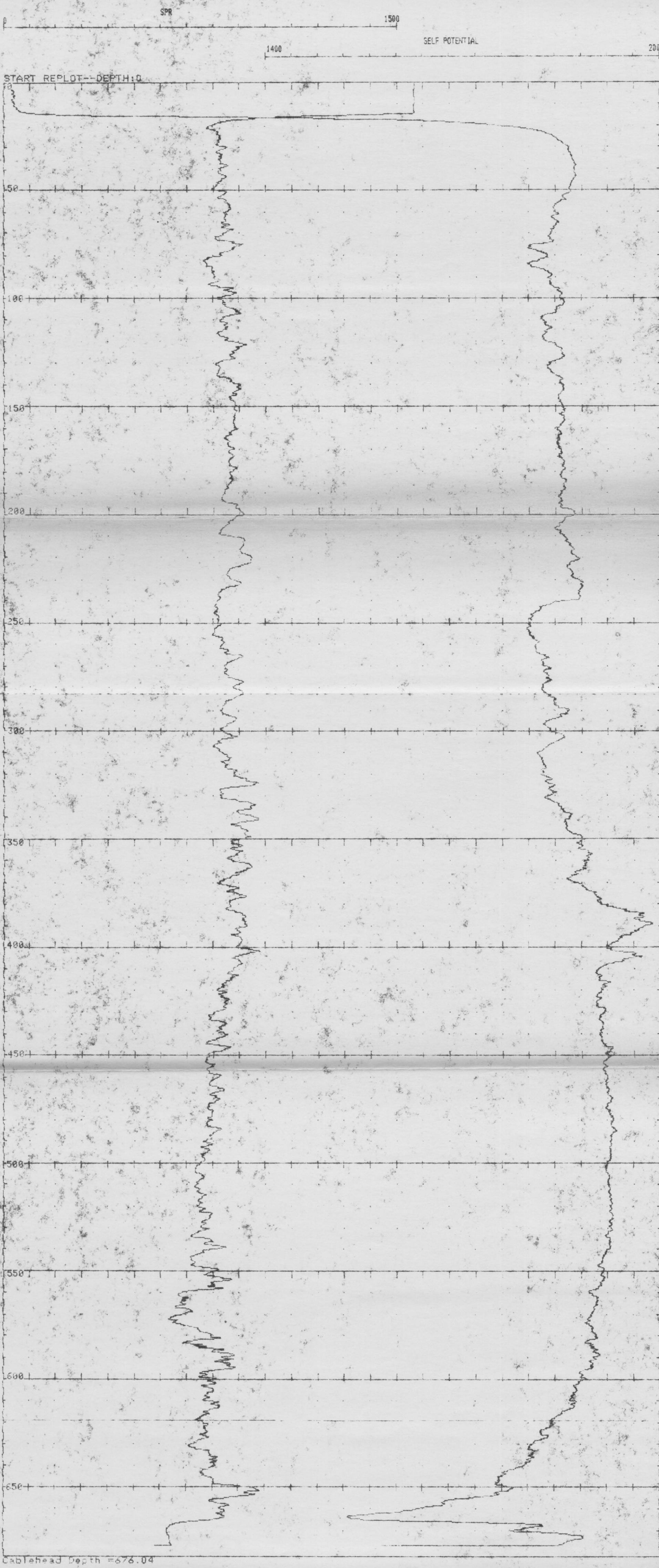
CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	
SPR	0 - 1500	0.00 - 15.00	59	5.0	TRCN
SELF POTENTIAL	1400 - 2000	10.00 - 25.00	59	5.0	TRCN

Calibration Data

CHANNEL	mx	b	C1	C2	C3	C4
SPR	ohm=76913	-876.53	1148.	2454.	1144.	1783.
SELF POTENTIAL	mV =4.5029	-4338.6	0	630.4	932.8	1185.

LOG CASSETTE FILE: BMR E 2

Logged: UP by DEPTH Interval = 5 cm's





GEOSOURCE

HOLE NO.: BMR MACLEAN 1
LOGGED: 01/01/80 at 00:08

COMPANY
AREA
PROJECT
DEPTH

DRILLING DATA ##
PERM.DAT Bench
ELEV 2.5m
HOLE POS None
HOLE DIA None
DEPTH N/A
CASE-TYP N/A
CASE-DTH N/A
CASE-DIA N/A
CASE-THK N/A

LOGGING DATA ##
FLD TYPE Dry
FLUIDLEV High
LOGTYPE TD-5
APPROX SP 6

TOOL: 1995
Serial Number: 358
Spacer (cm's): 0

CHANNEL DATA

CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	TRCN
GAMMA	0 - 250	0.00 - 25.00	100	5.0	TRCN

Calibration Data

.....EQUATION.....
CHANNEL mx b C1 C2 C3 C4
GAMMA cps=1 0 1836 0 0 0

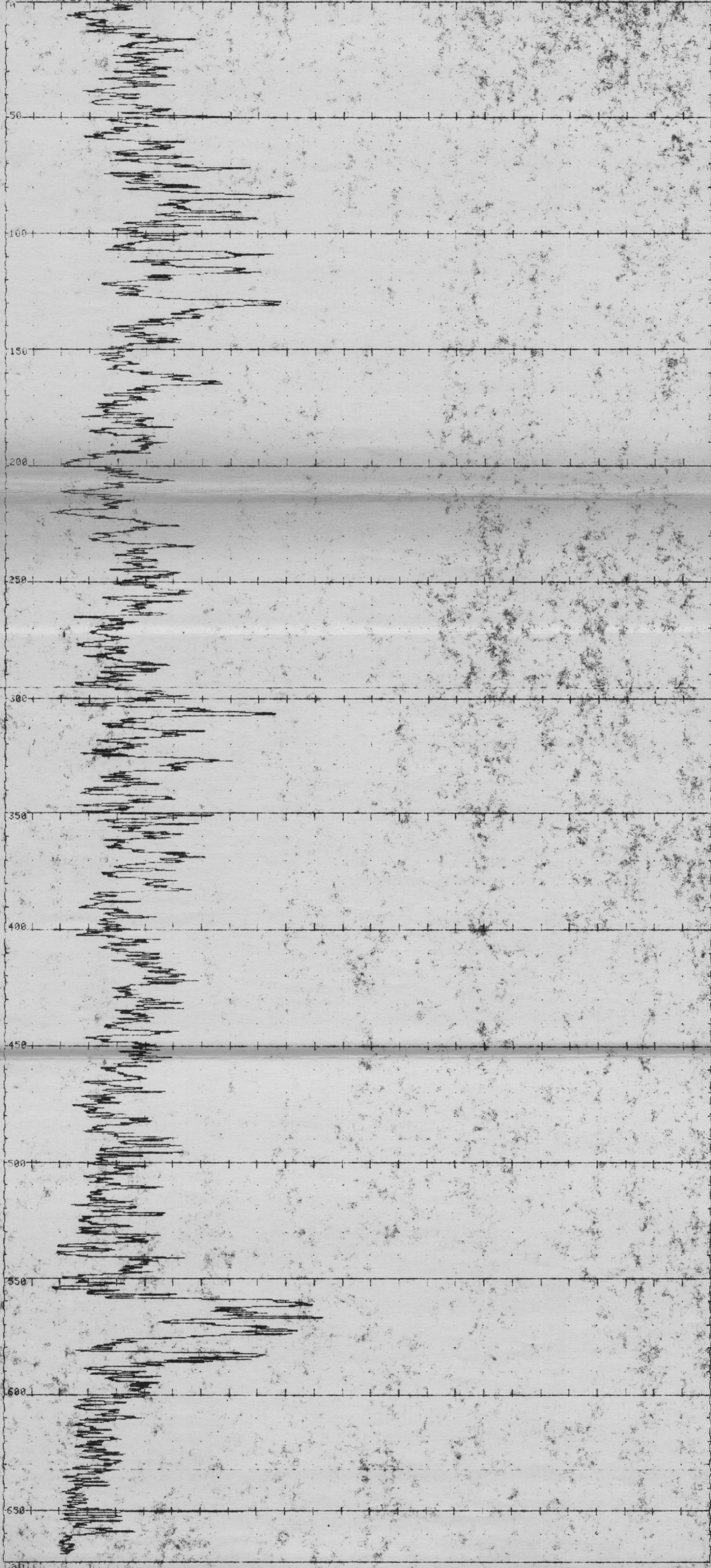
LOG CASSETTE FILE: BMR 1

logged: UP by DEPTH Interval = 5 cm's

GAMMA

250

START REPLOTT--DEPTH:0





HOLE NO.: BMR MACLEAN 1
LOGGED: 06/05/45 at 12:41

COMP: BMR
APR: BMR
PKUS: BMR
OPTN: BMR

DRILLING DATA ##
PERM DAT: HERE
ELEV: 222
HOLE POS: None
HOLE DIA: None
DEPTH: N/A
CASE-TYP: N/A
CASE-DIA: N/A
CASE-THK: N/A

FLU: BMR
FLU-MOD: BMR
LOG-TYPE: TD-5
APPROX SP: 3

TOOL: CRYSTAL
Set: 1
Space: 1

CHANNEL DATA

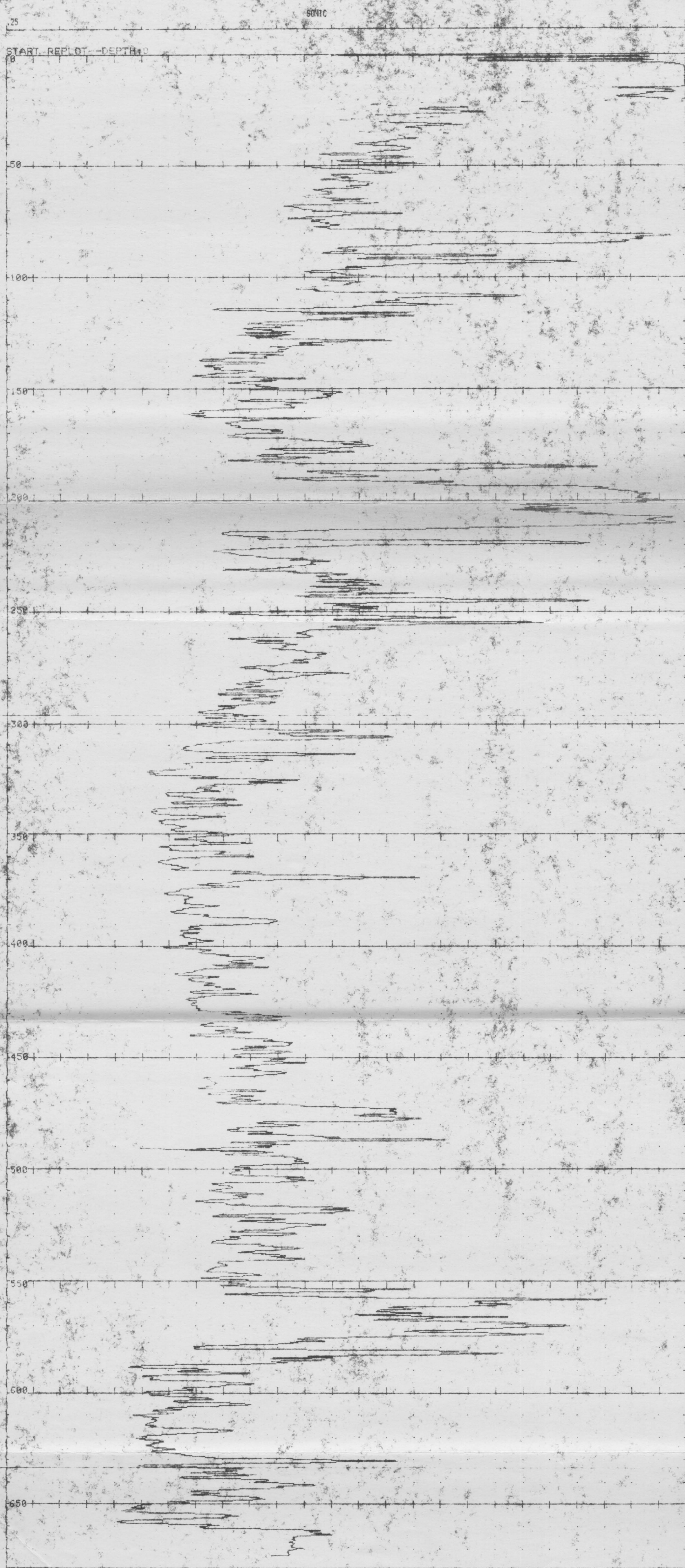
CHANNEL	AMPLITUDE RANGE	CHART AREA	SENSOR OFFSET	FILTER CNST	TRCN
SONIC	1	0.00 - 25.00	0	1.0	TRCN

Amplitude Unit: Volts

CHANNEL	UNITS	Signal Range
SONIC	MICROW	0 - 10000

NOTE: All values are plotted in VOLTS (X0-1)

LOG CASSETTE FILE: BMR-S
Logged: UP BY DEPTH Interval = 5 cm/s



APPENDIX 3.

Palynology

Samples were submitted for palynological examination
(Table 2).

<u>Sample No.</u>	<u>Depth (m)</u>
1	12.69
2	20.02
3	82.00
4	92.50
5	93.95
6	107.65
7	127.75
8	128.02
9	247.17
10	303.00
11	305.78
12	313.75
13	468.43
14	557.43
15	565.02
16	569.46
17	570.26
18	572.04
19	580.30

At the time of writing samples 1-4, 12, 13 and 19 had
been examined by D. Burger, BMR, and proved to be barren.