

# Data Repository



## Well Completion Report Scanned Image File

Well Name	Bass 3
UNO	W7670001
PLSA File Reference	67/4241
Operator	Esso
Contractor	Global Marine
Date of Report	April 1967
Confidentiality	

This file contains scanned images of a Well Completion Report submitted under the Petroleum (Submerged Lands) Act of the Australian Government. The data in this file are made available to assist future explorers for petroleum and may be distributed freely.

Please refer any queries to

AGSO – Geoscience Australia  
Data Repository  
Cnr Jerrabomberra Avenue & Hindmarsh Drive,  
Symonston ACT 2609  
GPO Box 378, Canberra,  
ACT, 2601, Australia

Phone: +61 2 6249 9222  
Fax: +61 2 6249 9903  
Email: [ausgeodata@agso.gov.au](mailto:ausgeodata@agso.gov.au)  
Web Page: [www.agso.gov.au](http://www.agso.gov.au)

Punch CARD BY SM.  
PREPARED 9/8/67.

Copy 2

67/14241

CONTENTS

	<u>Page</u>
I SUMMARY	1
II INTRODUCTION	2
III WELL HISTORY	3
(1) General Data	3
(2) Drilling Data	3
(3) Logging & Testing	5
IV GEOLOGY	8
(1) Summary of Previous Work	8
(2) Regional & Historical Geology	8
(3) Generalized Stratigraphy of the Bass Basin	9
V STRUCTURE	14
VI RELEVANCE TO OCCURRENCE OF PETROLEUM	15
VII POROSITY & PERMEABILITY OF SECTION PENETRATED	15
VIII CONTRIBUTIONS TO GEOLOGICAL CONCEPTS AS RESULTING FROM DRILLING	16
IX SELECTED REFERENCES	17
X ENCLOSURES	

## ENCLOSURES

- Fig. 1    Locality Map.
- Fig. 2    Section before and after drilling.
- Fig. 3    Composite Well Log. ✓
- Fig. 4    Well History chart.
- Fig. 5    Time-Depth Curve.

## APPENDICES

- 1.    Paleontological Report.  
      by D.J. Taylor, Victoria Dept. of Mines.
- 2.    List and Interpretations of Electrical Logs  
      by Esso Exploration Australia Inc.
- 3.    Core and Sample Descriptions and Core Analysis  
      Report.
- 4.    Velocity Survey  
      by Esso Exploration Australia Inc.
- 5.    Petrological Report  
      by Department of Mines, Tasmania.

## I

SUMMARYA. Drilling

Esso Bass-3 was spudded on February 11, 1967 in Tasmanian waters of the offshore Bass Basin, and after drilling to a total depth of 7978 feet was plugged and abandoned on April 2, 1967.

B. Geological

The well was drilled on the crest of a well-defined northwest-southeast closed anticlinal feature as mapped by seismic. Vertical closure on the mid-Eocene unconformity is 300+ feet and covers an area of 22 square miles.

The sedimentary section penetrated by Bass-3 was essentially as predicted. The section from 721 feet (-690) to 5304 feet (-5273) consisted of marine Tertiary sediments - principally limestone, calcareous mudstones and shales and minor sandstone. The Delta Complex from 5304 feet (-5273) to 7830 feet (-7799) consisted essentially of sandstone with interbedded shale and siltstone with rare coal seams. The top 300 feet of the Delta Complex, lying above the mid-Eocene unconformity, is partly marine sequence forming a transitional zone between the fine marine clastics of the Demons Bluff Formation and the underlying continental beds of the Delta Complex. Basement, extending from 7830 feet (-7799) to 7978 feet (-7947) total depth, consisted of metamorphics.

With the exception of basement, the various formations ran consistently low to those predicted by seismic. This was due entirely to the fact that the velocities of the various rock units were slightly greater than originally predicted.

Basement was actually some 270 feet higher than the seismic prediction of 8200 feet. This was due to the original basement top being picked one cycle too low on the seismic section.

Despite slight errors in the assumed rock velocities, the original structural picture of a closed anticline, having 300 feet of vertical closure on the mid-Eocene unconformity, remains valid.



## II

INTRODUCTION

The Bass Basin is a separate and distinct geological province covering some 25,000 square miles and lying offshore between the Gippsland Basin on the east and the Otway Basin on the west.

The Tertiary stratigraphy of the Bass Basin, as seen in the wells Bass-1 and Bass-2, is similar to that of the Gippsland Basin in that the Lower Tertiary section is a delta complex which comprises the principal reservoir objective of the basin. In both basins the reservoir rocks are overlain by a marine sequence which provides both cap and potential hydrocarbon source rock.

After the drilling of Bass-1 and Bass-2, considerable information was available regarding the stratigraphy of the northeastern portion of the Bass Basin. However, little was known of the geology of the southwestern portion of the basin. Bass-3, located some 29 miles southwest of Bass-1, was partly designed to provide this much-needed information. The well was drilled on the crest of a seismic anticlinal closure, located on the southwestern side of the basin axis.

The well was in the optimum position to evaluate -

- (1) Lithology of the entire sedimentary section to basement on the southwestern flank of the basin.
- (2) Regional stratigraphy and structure of the southwestern flank of the basin.
- (3) Presence or absence of hydrocarbons in several closed prospective horizons, namely sand developments within the Lower Tertiary deltaic complex.
- (4) Partial hydrocarbon potential of the basin.

## III

WELL HISTORY(1) GENERAL DATA

- a) Well Name & Number: Esso Bass-3
- b) Name and Address of Operator:  
Esso Exploration & Production  
(Australia) Inc.  
G.P.O. Box 4249  
SYDNEY, N.S.W.
- c) Name & Address of Tenement Holder:  
Hematite Explorations Pty. Ltd.  
440 Collins Street  
MELBOURNE, Victoria.
- d) Details of Petroleum Tenement  
EL 1/60 issued by the State of  
Tasmania covering an area of  
25,134 square miles. Farmed-in  
by Esso Exploration Australia Inc.  
from Hematite Explorations.
- e) District: Bass Strait.
- f) Location: Latitude 39° 59' 51" S  
Longitude 145° 16' 57" E
- g) Elevation Permanent Datum:  
Mean Sea Level  
Rotary Table: 31 feet above mean  
sea level.
- h) Total Depth: 7978 feet.
- i) Date Drilling Commenced:  
February 11, 1967.
- j) Date Drilling Completed:  
March 29, 1967.
- k) Date Well Abandoned: April 2, 1967.
- l) Date Rig Released: April 2, 1967.
- m) Drilling Time to Total Depth:  
46 days.
- n) Status: Plugged and abandoned.
- o) Total Cost: To be furnished later.

(2) DRILLING DATA

- a) Drilling Contractor: Global Marine Australasia, Pty. Ltd.  
380 Lonsdale Street  
MELBOURNE, Victoria.
- b) Drilling Plant:  
Make National  
Type 1625 DE  
Rated Capacity 20,000 feet with 5" D.P.  
Motors Cummins VT-12-GA-30 for electric  
power.

- c) Derrick: 136' x 58' x 34' special design, galvanised, 1,000,000 lb. Hookload capacity.
- d) Pumps: (2)  
     Make National  
     Type G-1000-C Duplex  
     Size 7-3/4" x 16"  
     Motors Dual electric independent drives from above motors.
- e) BOP Equipment:  
     Make Hydril Hydril Cameron Triple U  
     Size 20" (MSP) 13-5/8" (GK) 13-5/8"  
     Working Pressure (PSI) 2,000 5,000 5,000
- f) Hole Sizes & Depths: (Rotary Table Measurements).  
     36" to 359' (third hole, first hole abandoned at 365', second hole abandoned at 365').  
     26" to 759'  
     17 1/2" to 2801'  
     12 1/4" to 7974'  
     7-3/4" to 7978'
- g) Casing & Cementing Details:  
     Size 30" 20" 13-3/8"  
     Weight, lb/ft. 196 & 310 129 & 167 54.5  
     Grade B B J-55  
     Range 2 & 3 2 & 3 3  
     Setting Depth 336' 721' 2750'  
     Location of shoe Shoe @ 336' Shoe & Collar @ 721' Shoe @ 2750'  
     Collar & Centralizers @ 721' Collar @ 2670' Centralizers @ 2730, 2710, 2630 & 2550.  
     Cement (sacks) 350 1221 1550  
     Cemented to Ocean floor Ocean floor Ocean Floor  
     Method used Displacement thru drill pipe. Displacement thru drill pipe. Two plug Displacement pipe.
- h) Drilling Mud: Sea water and fresh water gel mud were used to drill to 759 feet. The remainder of the hole was drilled with a fresh water Spersene XP-20 mud system.

Weekly mud properties while drilling are summarized below:

	Feb.20/ Feb.27	Feb.27/ Mar. 6	Mar.6/ Mar.13	Mar.13 Mar.20	Mar.20/ Mar.27
Wt. - lb/gal	10.0	10.0	10.7	10.8	10.8
Viscosity-secs.	35	39	55	45	45
Filter loss -cc	8.5	8.5	8.0	8.3	7.5
Filter cake -1/32"	3	3	2	2	2
% sand	1	1	2	1	0.5
% solids	-	-	15	15	17
pH	9.7	9.7	10.0	9.5	9.3
NaCl	7750	2542	2500	2800	2500
Alkalinity	0.05	0.15	0.3	0.2	0.2

<u>Mud &amp; Chemicals Used:</u>	<u>Item</u>	<u>Pounds</u>
	Barite	381,700
	Bentonite	132,500
	Megcophos	1,300
	Spersene	30,300
	XP-20	14,400
	CMC	1,150
	Caustic	7,100

- i) Water Supply: Fresh drill water was transported from Port Welshpool to the location by the MV "Pointe Coupee".
- j) Perforation Record: No perforations.
- k) Plugs:
- |                |           |           |                        |         |
|----------------|-----------|-----------|------------------------|---------|
| Depth          | 6850-6650 | 5400-5200 | 2900-2600              | 450-250 |
| Cement (sacks) | 140       | 140       | 250                    | 150     |
|                | 0.3% HR-4 |           | 1.0% CaCl <sub>2</sub> |         |
| Checked        | No        | No        | Yes @ 2645'            | No      |
- l) Fishing Operations: None
- m) Side-tracked Hole: None

(3) LOGGING & TESTING

- a) Ditch Cuttings: Cuttings were taken over a normal shale shaker at thirty foot intervals while drilling from under the 20" casing shoe at 721' to 2801', and at ten foot intervals from 2801' to 7978', total depth. While coring cuttings samples were taken at five foot intervals. All samples were lagged and caught by the mud logging personnel under the supervision of Esso geologists and are representative of the labelled depth. Representative suites of samples are stored with the Bureau of Mineral Resources, the Tasmanian Mines Department and with Esso in Melbourne.

- b) Coring The original coring programme called for the taking of 16 cores - every 500 feet from 3000 to 4500 feet; every 300 feet from 4500 to 6000 feet, and every 500 feet from 6000 to the originally predicted total depth of 9500 feet.

14 cores were cut in Esso Bass-3. Considering that the total depth of the well was over 1500 feet shallower than predicted, these cores satisfied the demands of the original coring programme.

Core	Interval Cored	Feet Cut	Rec. (feet)	Rec. (%)
1	3000-3030	30	30	100
2	3500-3530	30	30	100
3	3997-4022	25	18	72
4	4516-4539	23	23	100
5	5009-5039	30	26	87
6	5315-5336	21	21	100
7	5620-5650	30	23	77
8	5905-5920	15	14	93
9 Run 1	6420-6429	9	2.5	27
Wireline Run 2	6429-6442	13	11	84
10	6903-6933	30	30	100
11	7433-7453	20	20	100
12	7877-7892	15	0	0
13	7903-7914	11	5	45
14	7974-7978	4	4	100

The thirteen conventional cores cut a total of 274 feet and recovered 244 feet. The one wireline core (2 runs) cut a total of 22 feet and recovered 13.5 feet.

Representative slabs of these cores are stored with the Bureau of Mineral Resources, the Tasmanian Mines Department and with Esso in Melbourne.

- c) Sidewall Sampling. One run for sidewall cores was made over the interval 3356 feet to 7914 feet using Schlumberger CST equipment. A total of 30 cores was attempted and 26 were recovered.

- d) Electrical and Other Logging  
Wireline logging was carried out by Schlumberger Seaco.  
The following types of logs were run -

<u>IES</u>	<u>Interval</u>
Run 1	721-2801
Run 2	2753-6235
Run 3	6235-7911
Run 4	7911-7985

<u>SGRC</u>	
Run 1	721-2792
Run 2	2753-6226
Run 3	6226-7976

<u>MLL</u>	
Run 1	2753-6235
Run 2	6235-7979

<u>FDC</u>	
Run 1	2753-7984

<u>CDM</u>	
Run 1	721-2801
Run 2	2801-7978

A specially designed device was used in all log runs to compensate for the movement of the vessel while logging.

- e) Penetration Rate Log.  
A drilling time log is included as part of the composite well log and also as part of Enclosure

- f) Gas Log.  
In addition to the continuous hot wire mud gas recorder, a chromatograph was used to detail mud gas shows. Cuttings gas was measured in a Waring blender and recorded.

The cuttings were examined for stain and fluorescence.  
The gas log is included as part of the Composite Well Log.

- g) Formation Testing.  
To obtain information concerning hydrocarbons, formation fluid and pressure characteristics, four wireline formation tests were run by Schlumberger at 5409 feet, 5736 feet, 5737 feet and 6740 feet.

Test No. 1 at 6740 feet

During drilling of the well a small but significant gas show was recorded at the top of a thick sandstone bed over the interval 6745 to 6760 feet.

Electrical log analysis indicated the gas sand to extend from 6739 to 6744 feet. The sand was tested at 6740 feet with the wireline formation tester.

29 feet of gas were recovered, together with 800 cc of condensate and 12,250 cc of discoloured water. The gas has the following composition -

Methane	77.8%
Ethane	8.35%
Propane	5.45%
L.-Butane	1.80%
n.-Butane	1.52%
i.-Pentane	0.56%
n.-Pentane	0.38%
Carbon dioxide	<u>3.71%</u>
TOTAL	99.57%

The recovered water was mud filtrate, having an equivalent NaCl content of 3300 ppm.

Sampling pressure during the test was 3025 psi and the final shut-in pressure was 3125 psi.

Test No.2 at 5737 feet

To obtain formation pressures within the Latrobe Delta Complex immediately below the mid Eocene unconformity, a test of a sandstone was made at 5737 feet. The initial test of this zone was unsatisfactory. While testing, erratic sampling pressures indicated plugging of the tool. This was confirmed when attempts were made to drain the tool at the surface. In all, 20,000 cc of mud and mud filtrate were recovered. No reliable pressure data were recorded during this test.

Test No.3 at 5409 feet

A sandstone above the unconformity was tested at 5409 feet. 20,000 cc of formation water were recovered, having an equivalent NaCl content of 17,500 ppm. While sampling, sampling pressure was 2300 psi and the final shut-in pressure 2400 psi.

Test No.4 at 5736 feet

Due to the inconclusive results of Test No.3, the same sand was tested again at 5736 feet. Again, due to a bad seal between the pad and the formation, the test was unsatisfactory. No reliable pressure data were recorded, and only mud was recovered in the sample chamber.

h) Derivation Surveys

The surveys were carried out with a Totco instrument and results are plotted on the composite log. The well had very little deviation to 7200 feet, being within the limits of 0 - 1°. At 7796 feet the deviation was 2°. Schlumberger deviation recordings taken in conjunction with the Dipmeter Survey indicated that no dog legs were present.

j) Temperature Surveys

None.

k) Velocity Surveys

A velocity survey was shot at a depth of 7914 feet on March 27, 1967 by Western Geophysical Company. Results are included as an Appendix.

l) Other Well Surveys

None.

m) Production Testing

None.

## IV

GEOLOGY(1) Summary of Previous WorkPetroleum Indications

No oil or gas had been recovered from the Bass Basin. Prior to drilling Bass-3 Esso had drilled two dry stratigraphic tests in the Bass Basin; one to 7717 feet near the basin centre, and one to 5910 feet near the northeastern flank of the basin. Minor background gas readings were recorded by the mud logging unit during the drilling of both Esso Bass-1 and Bass-2 wells. No seeps or other occurrences of hydrocarbons are known from the few Tertiary outcrops around the periphery of the Bass Basin. There have however been consistent reports of specimens of coastal bitumen stranding along the South Australian and Victorian coasts since white man's early occupation. It is believed by some geologists that these may represent bonafide oil seeps from submarine Tertiary rocks. The hydrocarbon show logged from 6739 to 6744 feet in the Bass-3 is the first valid show in the basin.

Existing Geophysical Data

The following is a summary of geophysical surveys completed by both Esso and Hematite -

Hematite Petroleum

- a) Aeromagnetic Survey, completed in 1961.
- b) 1765 miles of single fold coverage completed in 1963.

Esso

- a) Esso Bass Survey  
182 miles of 6 fold C.D.P.  
37 miles of single fold.  
3 velocity and refraction profiles completed 10-5-65.
- b) Esso King Island East Survey  
252 miles 6 fold C.D.P. completed 25-10-65.
- c) Esso Bass Strait Survey  
395 miles 6 fold C.D.P.  
1115 single fold coverage completed 13-10-65.

Existing Geological Work

As the Bass Basin lies almost entirely under the continental shelf, direct geological work has been limited to studies of cores, samples and electric logs of the Bass-1 and Bass-2 wells. The major geological interpretations, therefore, have been based on seismic control in conjunction with geological information from the adjacent Gippsland and Otway Basins.

Regional & Historical Geology

The Bass Basin lies at the southern end of the Paleozoic Tasman Geosyncline. The Paleozoic sequence probably exceeds 25,000 feet in thickness on the Mornington Peninsula on the northern side of the basin (Kemble, 1950). The strata range in age from Cambrian through Carboniferous and are made up of a complexity of folded, faulted and intruded marine to non-marine sedimentary, metamorphic, extrusive and intrusive igneous rocks. In Tasmania similar complex rocks, tens of thousands of feet thick, occur along with more than 25,000 feet of pre-Cambrian sedimentary and metamorphic rocks. It is logical to expect the Bass Basin to be underlain by any of these rocks. They would extend from shallow depths at the basin edge, and downwards from 12,000 feet in its deepest part.

Bass is essentially a Cenozoic basin, although it may contain Permian, Triassic, Jurassic and Lower - mid Cretaceous rocks between the relatively undisturbed Tertiary above, and complexly folded and intruded pre-Permian rocks below. Permian "tillites" are known from small outcrops along the northern Tasmanian coastline. These may extend northward for some distance into the Bass Basin. The Triassic is represented by sandstone and shale with minor conglomerate and coal in Tasmania, and by minor glacial beds in Victoria. The Jurassic - Lower Cretaceous, generally non-marine, Otway Group occurs in the Gippsland and Otway Basins and may be present in the Bass Basin.

During the Paleocene and Eocene time, gentle regional downwarping occurred in the Gippsland and Otway Basins and similar downwarp occurred in the Bass Basin. Tasmania remained a positive area. Volcanism and lava flows were abundant from the western part of the Gippsland Basin to the eastern part of the Otway. Similarly, a few small flows occurred in Tasmania. No volcanic rocks of this age are known in the axial portion of the Bass Basin. During this time in Bass there were widespread swamp conditions under which peat, clay, sand, silt and gravel were deposited. During Lower and Middle Eocene occasional thin marine sediments may have intercalated with these non-marine rocks. Upper Eocene time saw a change in sedimentary conditions from non-marine to restricted marine.

Uplift and slight deformation took place in Gippsland after deposition of the Eocene coal measures. Deposition apparently was continuous during this time in the Otway basin. In the Bass Basin there is seismic evidence of an unconformity near the top of the Eocene.

During the Oligocene and Miocene time marine conditions prevailed in the Bass Basin with deposition of fossiliferous limestone, calcareous mudstone, marl, and minor siltstone beds. Local angularity beneath the Oligocene-Miocene contact on seismic sections indicates a regressive pulse at the beginning of Miocene time. At and near the present edges of the Bass Basin in Tasmania and Victoria are outcrops of mainly Miocene skeletal limestones and some marine, fossiliferous siltstone.

In the southwest part of the Bass Basin in the vicinity of Three Hummock Island, and in the northern half of the basin, tuffite cones of Upper Oligocene and Lower Miocene age indicate tectonic activity during this period.

During Pliocene time the marine transgression reached the end of its full cycle in Gippsland and Otway. During Middle Pliocene time these areas, and also the entire Bass Straits region, were subjected to uplift, probably accompanied by some gentle deformation and faulting. Volcanism and outpouring of lava was widespread in Tasmania and west - central Victoria.

The sea in general regressed to its present limits during late Pliocene and Pleistocene time.

#### Generalized Stratigraphy of the Bass Basin

##### Paleozoic Rocks

Paleozoic sediments (marine to non-marine) metasediments, metamorphics, and igneous intrusive and extrusive rocks are believed to comprise "economic" basement in the greater Bass Straits region.

In the Mesozoic - Tertiary Otway Basin, two wells reached the Paleozoics (Fergusons Hill-1 and Pretty Hill-1), as did the Arco S.W. Bairnsdale-1, Duck Bay-1 and others in the Gippsland Basin. Hence, it is reasonable to expect that the Paleozoics



will similarly be an unprospective complexity of sedimentary, metamorphic and igneous rocks in the Bass Basin.

### Mesozoic Rocks

Mesozoic rocks are present in the surface in both Victoria and Tasmania. They have been penetrated or encountered in many wells in the Otway Basin and Gippsland Basin. In onshore Gippsland more than 8600 feet of the Jurassic and Lower Cretaceous Otway Group have been drilled. This group consists of non-marine feldspathic sandstone, chloritic greywacke, siltstone, mudstone and carbonaceous shale, with fossil plants and thin black coal seams. In the Otway Basin the Cretaceous and Jurassic rocks have a maximum composite thickness of 15,000 feet. They consist of several marine and non-marine formations comprised of siltstones, sandstone and greywacke with lesser amounts of conglomerate, mudstone and coal. Plant fragments, spores and foraminifera are present. In the Bass Basin there are no Mesozoic sediments known at present.

Some thin non-marine Triassic rocks are present in west-central Victoria. In Tasmania the only known Mesozoic sedimentary rocks are of Triassic age. They consist of 1500 to 2000 feet of lacustrine and fluviatile protoquartzites, lithic arenites, lutites, minor fine grained conglomerates and coal beds (Hale, Spry and Banks, 1962).

The volcanic association occurring at the base of Esso Bass-2 (from 5511 to 5910 feet) is possibly of Mesozoic age. It may be correlative with the widespread Jurassic dolerite of Tasmania.

### Tertiary Rocks

#### Paleocene-Eocene

The Basal Tertiary section in the Bass Basin encountered by drilling is a thick deltaic complex. This unit is the principal reservoir objective in the basin.

The distribution of this sequence in the basin is largely controlled by the flanking down to basin fault systems, with the bulk of the sediment confined to central downdropped portions of the basin. The sequence may overlap the Mornington-King Island basement ridge to the northwest and be in part continuous with the Easternview Coal Measures.

This deltaic complex is made up of interbedded sandstone, siltstone, shale and coal, all of dominantly continental origin. Sparse microplankton were noted in cores from the Esso Bass-1 well, suggesting the paralic and/or marine conditions prevailed in the central part of the basin during the deposition of this interval. This sequence lies unconformably on economic basement and is transitional into the overlying marine Eocene sequence.

#### Upper Eocene

The Upper Eocene siltstones and mudstones overlie the deltaic complex over most of the Bass Basin. The contact between the two sequences is transitional. The fauna and lithology of this interval indicate that it is of restricted marine origin and is correlative with the Demon's Bluff Formation of the Anglesea area, Victoria.

#### Oligocene

The Oligocene series in the Bass Basin ranges in thickness to 2000<sup>+</sup> feet in the axial part of the basin. The interval is distributed throughout the basin proper and overlaps the basin margin in the northwest over the Mornington-King Island high, and possibly to the east over the basement ridge which extends from Wilson's Promontory to northeastern Tasmania.

- 7840-7850 Heavily contaminated with cavings - shale, but noticeable trace of argillaceous splinters, strands and fragments and dark grey-light grey and black quartzite.
- 7850-7860 40% Quartzite; dark grey and light grey, mottled, sometimes banded, dense, very fine grained, very hard.  
60% Cavings; buff and light grey, calcareous shale.  
Trace of sandstone, grey white to light grey, fine to medium grained, angular to sub rounded, poor sorting with scattered grains quartz sand, lithic (argillaceous dark grey quartzite granules), dense, white, siliceous cement, very hard, no porosity or permeability.
- 7860-7870 90% Quartzite; as above.  
10% cavings; shale, as above.
- 7870-7880 100% Quartzite; dark grey to light grey, mottled, very fine grained, dense, hard.
- 7880-7890 30% Quartzite;  
70% Shale; dark grey to black, dense.
- 7890-7900 Cavings; dark brown, silty, shale; light grey, calcareous.  
50% Quartzite; as above.  
50% Shale; as above.  
Cavings.
- 7910-7920 20% Quartzite; black to dark grey to light grey, mottled, dense, sparsely pyritic, very hard, very fine grained as above.  
60% Shale; black, contact met., (carbonaceous ?), as above.  
20% Sandstone; dark grey to black, silty, very fine grained, consisting of quartz grains set in a secondary silica cement, as above.

The base of the marine Oligocene sequence in the Esso Bass-1 is marked by a thin tuffaceous, poorly sorted, tight sandstone. The remainder of the section is made up of argillaceous siltstone, silty mudstone and minor sandstone. 235 feet of tuffite was encountered in the upper part of the section in the Esso Bass-1.

In Esso Bass-2 the Oligocene period is represented by 632 feet of marine sandstone, siltstone and shale and the basal sand at this locality is 328 feet thick.

#### Miocene

At least 3000 feet of Miocene rocks were drilled in the Esso Bass-1 well from the 20 inch casing shoe to a depth of 3775 feet. The Lower Miocene is fossiliferous calcareous shale overlain by a thick (500 feet) tuffite interval; the mid Miocene is marl, calcareous mudstone and skeletal calcarenite and the Upper Miocene is skeletal calcarenite.

#### Pliocene-Pleistocene

Strata of Pliocene-Pleistocene age were not observed during the drilling of the Esso Bass wells. Doubtless strata of this age lie within the interval drilled prior to setting 20 inch casing.

### Geology

#### Stratigraphy

#### Stratigraphic Table.

	Depth	Thickness	Age	Lithology
	721-3770	3000 +	Miocene	Skeletal calcarenite, micritic limestone & mudstone.
- 3739'	3770-4705 (1140 m)	935	Oligocene	Shale & mudstone.
- 4674'	4705-5305 (1415 m)	600	Eocene	Shale & siltstone, with minor sandstone.
- 5274'	5305-5590 (1601 m)	285	Eocene	Sandstone, siltstone & shale.
- 5559'	5590 1791 (1891 m)	-----U n c o n f o r m i t y -----		
	5590-7830	2240	Eocene, Paleocene older ?	Sandstone, siltstone & shale.
- 7797'	7830-7978 (1277 m)	148 +	Basement	Quartzite and metamorphosed shale.

These depths are relative to R.T. (subtract 31 feet for M.S.L. depth.

#### Miocene

721-1040  
220 317  
Coarse calcarenite to fine calcirudite, light grey, composed of loose, calcareous skeletal debris (principally bryozoa with pelycopods, echinoids, foraminifera and gastropods). Trace of rounded to sub rounded, medium to very coarse grained quartz sand: glauconite and carbonaceous flecks and grains.

1040-1400  
427  
Coarse calcarenite to fine calcirudite as above, but light brown to buff in colour.

- 1400-2120 Limestone; light grey, argillaceous, skeletal, micritic, sparsely carbonaceous and glauconitic.
- 2120-2274 Interbedded limestone and marl.  
Limestone; as above.  
Marl; light grey to grey-green, in part silty, sparsely pyritic, richly fossiliferous. Very soft and plastic.
- 2274-2450 Marl; as above.
- 2450-3770 Mudstone; dark grey-green, calcareous, in part silty, sparsely micaceous and pyritic, very fossiliferous.
- Oligocene  
3770-4280 Mudstone; as above, but becoming more compact and less calcareous.
- 4280-4705 Shale; dark grey to dark grey-brown, silty, sparsely pyritic, sparsely carbonaceous with sparsely disseminated calcareous skeletal debris.
- Eocene  
4705-4733 Sandstone; light brown, slightly calcareous, argillaceous, silty, very fine grained, sub angular to sub rounded, sparsely glauconitic and fossiliferous. Porosity fair, permeability very poor.
- 4733-5304 Shale; with minor siltstone  
Shale; dark brown, silty, sparsely micaceous and pyritic with sparsely disseminated calcareous skeletal debris.  
Siltstone; light grey-brown, argillaceous, sparsely micaceous and pyritic.
- Latrobe Delta Complex (undifferentiated)  
5304-5599 Interbedded sandstone, siltstone and shale.  
Sandstone; light brown, argillaceous, slightly dolomitic in part, very fine to fine grained, sub-angular to sub-rounded, generally fairly well sorted, but with scattered rounded medium to very coarse grained quartz sand. Moderately hard. Porosity good, permeability fair to poor.  
Sandstone; light green, argillaceous, silty, very fine grained, sub-angular to sub-rounded, fairly well sorted, variably glauconitic, sparsely micaceous, friable, porosity fair, permeability poor.  
Siltstone; light brown to white, argillaceous, very finely sandy in part, sparsely micaceous.  
Shale; light to dark brown, silty, sparsely micaceous.
- 5599-7057 Interbedded sandstone, siltstone and shale, with rare coal seams.  
Sandstone; light grey, finely pebbly to granular, fine to coarse grained, sub-angular to rounded, poorly sorted, generally abundant white clay matrix, sparsely micaceous, carbonaceous and feldspathic in part. Moderately hard. Porosity good, permeability (dependant on clay matrix content), generally poor.  
Sandstone; grey white, silty, fine to very fine grained, sub angular to sub rounded, generally fairly well sorted, moderately abundant white clay matrix, sparsely micaceous and carbonaceous. Moderately hard. Porosity fair, permeability poor.  
Siltstone; light grey, argillaceous, in part very finely sandy, sparsely micaceous, pyritic and carbonaceous.  
Shale; light grey to grey-brown, silty, sparsely micaceous, pyritic and carbonaceous.  
Coal; black, brittle, brilliant lustre, irregular to sub-conchoidal fracture.

- 7057-7215      Shale with minor sandstone.  
Shale; dark grey to dark grey-brown, in part silty, sparsely micaceous.  
Shale; light grey as above.  
Sandstone; light grey, silty, fine to very fine grained, as for interval 5589-7057.
- 7057-7830      Interbedded sandstone, siltstone and shale.  
The sandstones are the same as for interval 5589-7057, except for a greater abundance of felspar, occurring as sub-rounded to <sup>u</sup>anhedral grains, completely replaced by clay, and lithic grains and pebbles, principally dark grey shale, light grey quartzite and buff to green volcanics.  
Siltstone; light brown to light grey, argillaceous in part, very finely sandy, sparsely micaceous, pyritic and carbonaceous.  
Shale; light to mid-grey, in part silty, sparsely micaceous.
- 7830-7978      Interbedded quartzite and recrystallized siltstone and fine grained sandstone and black metamorphosed shale.

## V

STRUCTURE

Esso Bass-3 was located on the crest of a well-defined northwest-southeast trending closed anticlinal feature as mapped by seismic. A structure map on the mid Eocene unconformity within the "Delta Complex" was the primary basis for selecting the well location. The structure is developed from basement through strata of lower to mid Miocene age and all of these sedimentary intervals thin over the crest of the feature.

The closure is in part dependant upon the normal fault which occurs along the southern flank of the feature. The fault intersects the late Eocene and older beds.

Vertical closure on the mid Eocene unconformity is 300+ feet and covers an area of 22 square miles. Vertical closure has decreased to 200+ feet at the top of the Eocene (top of Demons Bluff Formation) with an areal closure of 25 square miles. Vertical closure at the top of the Oligocene is less than 100 feet.

Continuous dipmeter results confirm that the Tertiary section was encountered on or near the crest of the structure.

With the exception of basement, the various formation tops ran consistently low to those predicted by seismic. This was due entirely to the fact that the velocities of the various rock units were slightly higher than originally predicted.

Basement was actually some 270 feet higher than the original seismic prediction of 8200 feet. This was due to the original basement top being picked one cycle too low on the seismic section.

Despite slight errors in the assumed velocities, the original structural picture of a closed anticlinal feature having 300 feet of vertical closure on the mid Eocene unconformity remains valid.

## VI

RELEVANCE TO OCCURRENCE OF PETROLEUM

The primary objective of Bass-3 was to evaluate the hydrocarbon potential of a closed anticlinal feature. The potentially most prospective reservoir horizon, sandstone development at the top of the "Delta Complex" between the base of the Demons Bluff Formation and the mid Eocene intra-deltaic unconformity, was found to be water wet. However, one small non-commercial gas show from 6739 to 6744 feet was logged and wireline tested. This gas show is significant in that it represents the first legitimate show of hydrocarbons recorded in the Bass Basin. Seismic evidence indicates that the gas sand was penetrated at its structurally highest point. Pressures within the sand are only slightly above normal and it is probable that gas occurs as a small reservoir trapped under an impervious shale bed at the apex of the structure.

## VII

POROSITY AND PERMEABILITY OF SECTION PENETRATED

Porosity and permeability measurements made on core samples by Corelab are included as an appendix.

The sandstones of the "Delta Complex" are generally coarse grained to granular with an abundance of white clay matrix. Porosities deduced from the F.D.C. log generally vary from 18-30% - values that correspond favourably with measured porosities where cores are available. Measured permeabilities, although as high as 328 md, are generally of the order of 2 to 30 md. These low permeabilities are due to the high clay matrix content of the sands.

The 27 feet thick bed of argillaceous, very fine grained sandstone, occurring at the top of the Eocene section, has poor reservoir characteristics, with fair porosity (20%) and very poor permeability

## VIII

CONTRIBUTIONS TO GEOLOGICAL CONCEPTS AS RESULTING FROM DRILLING

Stratigraphic and paleontological studies have lead to several conclusions regarding the environmental conditions and the prospect of hydrocarbons occurring in the geological sequence penetrated in the Bass-3 well.

The basement consisting of dark, weathered metamorphics and volcanics was encountered at 7830 feet. Above this the non-marine sandstone-quartzite-shale-siltstone series, extending to approximately 7060 feet, attains a generally more lithic character than that observed in either Bass-1 or Bass-2. In all other respects this series remains consistent with equivalent intervals thus far encountered in the Bass Basin.

The deltaic sandstones and shales of the Upper Paleocene and Lower Eocene between 5336 and 7060 feet are ~~also~~ similar to those of the Bass-1 and Bass-2. They contain however, little or no coal. The wireline test at 6740 feet, recovering 29+ cubic feet of gas and 800 cc of condensate, indicates the capability of the shales of this interval to generate hydrocarbons. This is also the first valid hydrocarbon show in the basin.

The earliest traces of marine influence occurring in the uppermost middle Eocene is indicative of a marine encroachment in the non-marine environment of corresponding age observed in the other Bass wells. The dominance of arenaceous fossil assemblages during Upper Eocene give evidence of a 'barred basin'. Mixed fossil assemblages occurring sporadically at the close of the Eocene and in the lowermost Oligocene indicate periodic inundation from the open seas.

From the Oligocene through the Lower Miocene generally more open marine conditions prevailed than further to the east. The equivalent interval in the Bass-1 and Bass-2 reveals a restricted marine environment.



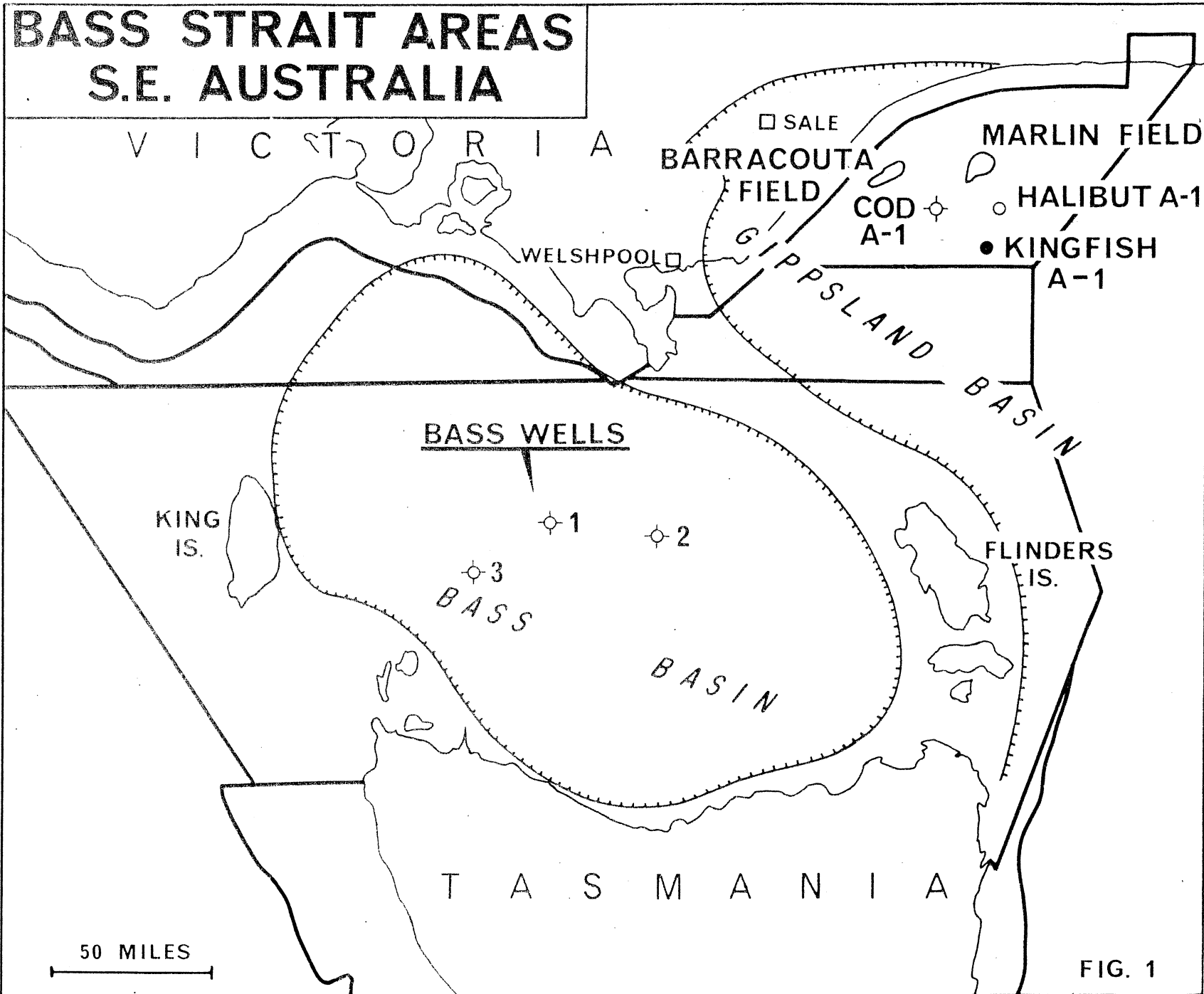
SELECTED REFERENCES

- Bowler, J.M., 1963      Tertiary Stratigraphy and sedimentation in the  
Geelong - Maude area, Victoria; Proceedings of  
the Royal Society of Victoria, Vol. 87, pp 69-132.
- Nixon, W.H. &  
Griffith, B.R., 1965      Esso Bass-1 Completion Report;  
Esso Exploration Subsidy Report to the Bureau of  
Mineral Resources.
- Nixon, W.H., 1966      Esso Bass-2 Completion Report;  
Esso Exploration Subsidy Report to the Bureau of  
Mineral Resources.
- Spry, Banks et al,  
1962      Geology of Tasmania;  
Geological Society of Australia, Vol.9 Pt. 2.
- Stanford, E.B. &  
Presley, W.C.,  
1965      Bass Marine Seismic Survey,  
Esso Exploration (Subsidy Report to Bureau of  
Mineral Resources).
- Presley, W.C., 1966      King Island Eastern Marine Seismic Survey  
Esso Exploration Australia, Inc.  
(Subsidy Report to the Bureau of Mineral Resources).

## X

ENCLOSURES

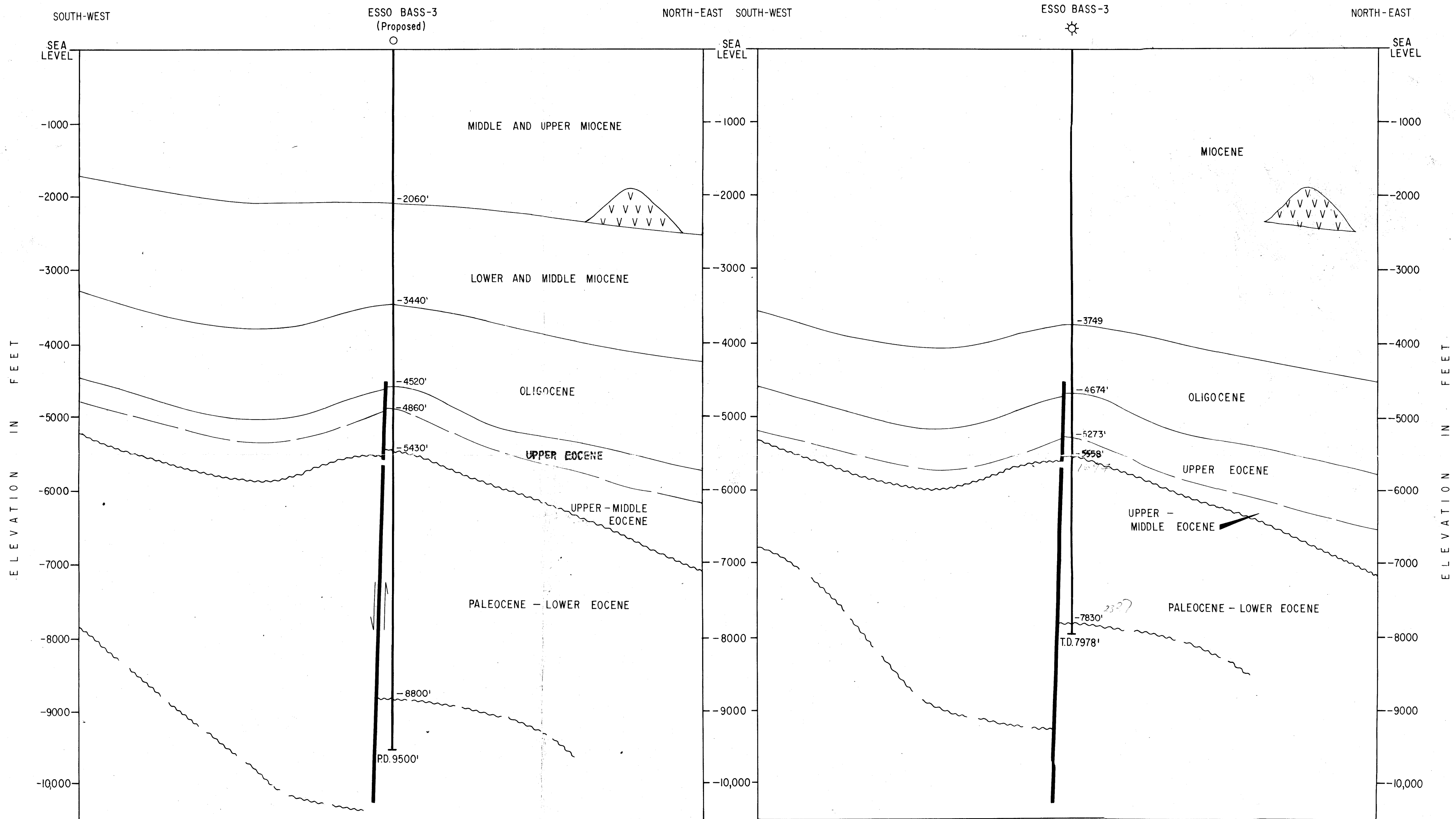
(in pocket)



67/4241

SECTION BEFORE DRILLING

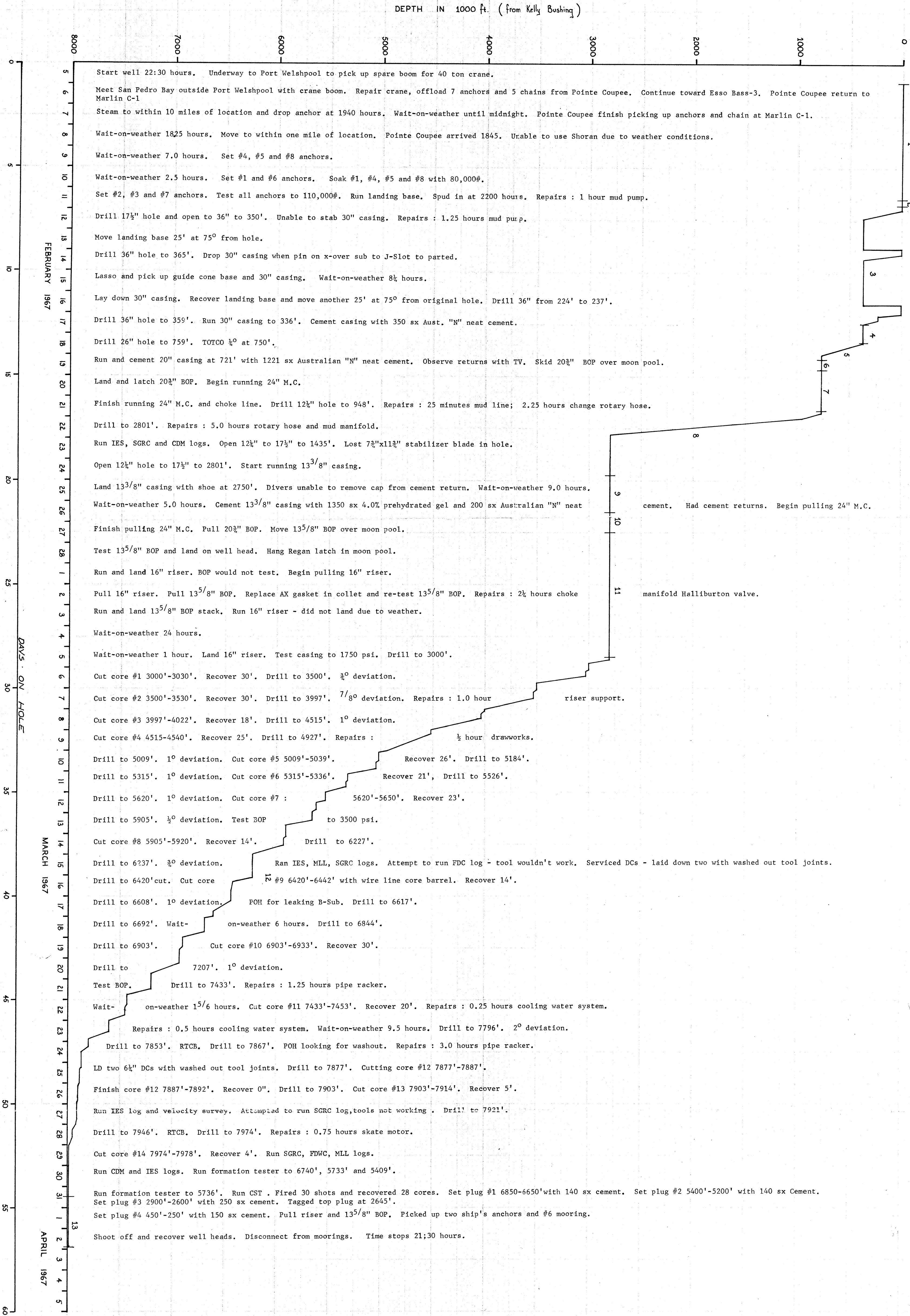
SECTION AFTER DRILLING



ESSO EXPLORATION AND PRODUCTION AUSTRALIA INC.

CROSS-SECTIONS BEFORE AND AFTER DRILLING  
ESSO BASS-3





DRILLING ANALYSIS

OPERATION	Total Days	Percent of Total Time
1. Install moorings	5.69	10.18
2. Install landing base	0.13	0.23
3. Drill 36" hole	5.71	10.20
4. Run and cement 30" conductor	0.69	1.20
5. Drill 26" hole	0.94	1.70
6. Run and cement 20" conductor	0.54	0.96
7. Install 20" BOP and marine conductor	1.98	3.49
8. Drill and log 17½" hole	3.25	5.72
9. Run and cement 13³⁄₈" casing	1.85	3.32
10. Retrieve marine conductor and 20" BOP	0.79	1.41
11. Run 13³⁄₈" BOP and marine conductor	5.84	10.42
12. Drill, core and log 12¾" hole	26.01	46.60
13. Plug, retrieve 16" marine conductor, 13⁵⁄₈" BOP, shoot well head and retrieve, release anchors.	2.54	4.57
	55.96	100.00
	=====	=====

NOTE : Wait-on-weather time of 4.67 days is included in the above operations.

ESSO BASS-3

LONGITUDE: 145°16'57" E  
LATITUDE: 39°59'51" S  
COORDS: X 332 972 Y 1071 798  
WATER DEPTH: 193'  
RIG R'USE PREVIOUS WELL: 2230 HRS ; 5 FEB 1967  
RIG R'USE THIS WELL: 2130 HRS ; 2 APR 1967  
TOTAL DEPTH: 7978'



67/4241

4176  
4559  
5504  
5930  
6114  
6367  
-  
6449  
6654  
7217  
7703  
5273

ONE WAY TIME BELOW SEA LEVEL  
TWO WAY TIME BELOW SEA LEVEL

FIG. 5

ESSO EXPLORATION AND PRODUCTION AUSTRALIA INC.

**BASS - 3** S.P. 3159  
LINE 18

TIME-DEPTH CURVE

DATUM: SEA LEVEL

AUTHOR: P.E. TOWEY

COORDINATES:

39° 59' 51" SOUTH  
145° 16' 57" EAST

ELEVATION: K.B. = 31'

LEGEND

WATER DEPT. = 202'

○ SHOT

All data for the Time Depth and Interval Velocity curves as well as average velocities above 2000' are taken from the Sonic Log tied to check shots.

DEPTH IN FEET BELOW SEA LEVEL

DEPTH IN FEET BELOW SEA LEVEL

AVERAGE VELOCITY

INTERVAL VELOCITY

TIME DEPTH CURVE

AVERAGE AND INTERVAL VELOCITY — FEET PER SECOND

TOF 7947'

67/4241

*David Taylor*

STRATIGRAPHIC / PALEONTOLOGIST

P.O. BOX 57 PARKVILLE VICTORIA PHONE 34 0484 ext 2343 HOME 513781

Subject: BASS - 3

18th April 1967

APPENDIX 1

# APPENDIX 1

## SUMMARY of

## BASS BASIN SEQUENCES:

ZONULE	*BASS - 1	*BASS - 2	*BASS - 3	AGE
A	?	?	?	UPPER MIOCENE
B	1200	?	?	
C	1500	?	1500	MIDDLE MIOCENE
D	2000	?	2040	
E	2300	2200	2430	
volcanic	2550	-	-	LOWER MIOCENE
F	3090	2505	2610	
G	?	?	2900?	
H	3300	?	3356?	
I-1	3890	3035	3700	OLIGOCENE
I-2	4400	3390	3999	
J	4850	3500	4300	
K	5300	3600?	4516	uppermost Eocene
base of zone	5382	3600?	4794	
base of sequence	5905?	3828?	5175 to ? 5336	

\*Depth in feet of approximate tops:  
datum (R.T.) +31'.

## INTRODUCTION

Esso BASS - 3 was drilled in the south eastern quadrant of the Bass Basin at latitude  $39^{\circ}53'09''$  and longitude  $146^{\circ}18'15''$ E, which is some 52 miles north of Stanley, Tasmania. The well was drilled in a water depth of 192' M.S.L.

Sample Detail: Rotary cutting samples were submitted at 30' intervals from 840' to 2800' and examined at 90' intervals. Below 2800' "canned cuttings" were examined every 100'. The  $13\frac{3}{8}$ " casing shoe was set at 2753'. Down-hole contamination was extremely heavy between 3400' and T.D. (7978').

Small samples were submitted from cores 1 to 11. Further samples were selected where necessary. Foraminifera were isolated from cores 1 to 5. Side wall core selection was partially based on this preliminary examination and 8 side wall cores were examined. Sealed position of cores and side wall cores are shown on Fig.1.

All depths discussed here were those shown on submitted samples: datum given as +31' M.S.L. (R.T.). The stated tops of all biostratigraphic units must be considered as approximate depths.

## FAUNAL SEQUENCE

No foraminifera were found between the top of the samples section (840') and 1290', where a sparse assemblage of upper Miocene benthonic species was recorded. There is an apparently uninterrupted sequence from there into the upper Eocene at 4653' (side wall 29). Core-3 and side wall cores 28 to 23 reveal sporadic faunas. The base of the sequence is taken as 5175' (side wall 24). No definite or diagnostic fauna was isolated below this level, although core-6 (5315' to 5335') contained glauconite pellets which have the form of globigerinid foraminifera.



The Bass - 3 sequence will be discussed in the terms of the zonule scheme applied to Bass - 1 by Taylor (1965). Depth comparison of biostratigraphic units is tabulated on page 1 of this report. Distribution of selected species is shown on Fig.1.

UPPER MIOCENE: ? to 1500' - Below 1290' there are sparse assemblages of Elphidiidae with species typical of the Victorian upper Miocene to lower Pliocene. A precise zonule or age cannot be assigned, partially because of sampling and partially because of facies.

MIDDLE MIOCENE: 1500' to 2610' - All 3 zonules of the middle Miocene can be distinguished and most ranges are consistent with those of the other Bass wells. As noted in the other Bass wells, the top of Zonule E is marked by the abundance of Globigerinoides spp., all of which are virtually absent above this unit. It is now considered that the sudden disappearance of Globigerinoides bisphaericus and G. ruber is of biostratigraphic value within the Bass Basin, even though these extinctions may be localized and due to decrease in water temperature. The first down-sequence appearance of these species in Bass - 3 is at 2430' and accompanied by the incoming of G. trilobus and Globoceras Schindleri. Sampling at 30' intervals confirms this "Globigerinoides level", so that the top of Zonule E is placed at 2430' as only rotary cutting samples were available it is impossible to identify the unit on the absence of Cibicides univerrae; a ubiquitous mud contaminant. The highest appearance of Globigerina eiporensis at 2400' is considered as confirmatory evidence for this boundary placement.

LOWER MIOCENE: 2610' - 3700' - There is a marked change in the benthonic assemblages; generally speaking the species are more robust. This especially applies to Cibicides spp. C. omali is replaced by its probable ancestral form C. perforatus, C. "vortex form" by C. "vortex form B", C. victoriensis (not noted in Bass - 3) by its probable ancestral form C. novozelandica. The former two "lineage fragmentation points" were picked at 2610'. C. novozelandica extends

100' higher.

Thus the top of Zone F is placed at 2610'. Uvigerina sp.12 ranges to the top of the unit, whilst U. sp.10, Bolivina sp.14, Anculinoides maculigera and Astronomenia contropax occur within this unit.

Core-1 (3000' - 3030') contains Globigerinoides trilobus without other species of the genus, indicating Zone G, which is confirmed by the presence of Bolivina sp.13 and Uvigerina sp.12. The top of the zone is placed arbitrarily at 2900'.

Core-2 (3500' - 3530') contains Globigerina cineoensis and G. woodi with Globigerinoides trilobus immaturus without Globigerinoides (S.S.). These factors indicate Zone H, but delimiting the Zone is difficult because of heavy contamination and the absence of diagnostic planktonic species in the side wall core at 3536'. However, this side wall core marks the highest record of Bolivina sp.12 and Cyrtoidinoides sp.4 which rarely range above Zone H. For this reason the top of Zone H is placed at 3536'. The scarcity of planktonics at this level will be discussed later.

UPPER CHINAGE: 3700' to 4300' - Despite heavy contamination the incoming of Globigerina eximius and Globorobula prima prima was recorded at 3700, with that of G. extans 100' lower. The top of Zone I is placed at 3700'.

Since the establishment of Taylor's scheme (1966), it appears that Zone I can be divided into 2 units. The top unit, I-1, has mainly lower Miocene benthonics associated with Oligocene planktonics. The lower Unit, I-2, contains a mixture of lower Miocene and lower Oligocene upper Eocene benthonic species. From a restudy of Bass-1 and 2, as well as study of this section and ones in the Otway Basin, the following benthonic species have their highest appearances in I-2; Ammonia ototara, Bolivina subensis, Pontulania sp.6, Uvigerina sp.13 and

Bolivina anastomosa before it develops into B. sp.13. The highest appearance of these species either corresponds with or is slightly above the apparent extinction level of "Guembelitra" sp. The distribution of this species is erratic, and though considered a planktonic species, its biostratigraphic and environmental significance is dubious.

In Bass-3, the highest appearance of the diagnostic I-2 species is 2' below the top of core-3 (3997' to 4022': rec. 18'), so that the top of I-2 has been placed at 3999'. The highest occurrence (=3999') is in "flood" proportions, with "Guembelitra" sp. comprising 30% of total fauna.

LOWER OLIGOCENE: 4300' to 4516' - A cutting sample at 4300' contains Globovalvulineria testarugosa and rare Chiloguembelina cubensis indicating proximity to the top of Zonule J. Normally the range of G. testarugosa extends some 50' above that of C. cubensis.

UPPERMOST EOCENE: 4516' to 4794' - The top of core-4 (4516' to 4539': rec. 100%) has a planktonic fauna dominated by Globigerina anguloroides Hornibrook (= G. angipora of previous reports), with a few Globigerina specimens probably referable to G. ampliapertura and G. linaperta. The two latter species are more discernible towards the base of the core. These two species have been regarded as the index of Zonule K. Hornibrook (1965) states that the typical form of G. anguloroides "occurs in the upper part of the range zone of Globigerina ampliapertura Bolli, i.e. in the lower part of the Whaingaroan Stage (uppermost Eocene to Lower Oligocene)" of the New Zealand Tertiary sequence.

It is concluded that core-4 probably represents the top of the Eocene and the top of Zonule K is thus placed at 4516'. Globigerina ampliapertura and G. linaperta are virtually absent at this level, and neither they nor G. anguloroides were isolated in cuttings at 4500'. At 4600' the typical Eocene benthonic species Bolivina pontis and Haukebergella ? sp. were noted. Side wall core at 4654' and at 4794' contain Zonule K planktonic

and benthonic species, but an intervening side wall core was barren. The presence of Cerobertina kakaheica was anticipated at 4700' but this upper Eocene species was not found, although it characterizes the equivalent level in Bass-1 & 2.

UPPER EOCENE facies fauna: 4794' to 5175' - An arenaceous Haplophragmoides fauna was present sporadically in both side wall cores and core-5 (5009' to 5039'). This equates with the "unnamed unit" in the previous Bass sections. The upper Eocene age for this interval is inferred as it is within the same lithological unit (ie. the Demons Bluff Formation) as the side wall core at 4794' which contains a diagnostic upper Eocene fauna.

BASE of FORAMINIFERAL SEQUENCE: The deepest level containing determinable foraminifera is at 5175'. Glauconitic moulds in the sandstone of core-6 (5315' to 5336') have globigerinid form, but this preservation precludes positive identification and thus comment regarding age. No trace of fauna was found in core below 5336' and the side wall cores were not examined because of the risk of wasting poor recoveries. No new fauna was isolated from cutting samples below 4800'.

#### DEPOSITIONAL HISTORY

The Bass-3 sequence will be compared with the Bass-1 sequence of 4 broad biofacies discussed by Taylor (1965).

In Bass-3, the earliest record of marine influence is the glauconite and glauconitic moulds in core 6 (5315' to 5336': rec.100%). This could indicate a marine embayment or tongue into the broadly non-marine environments encountered at equivalent levels in the other Bass sequences.

"Barred basin" conditions are evident between 5175' and 4794' from the dominance of the arenaceous Haplophragmoides assemblages.

Periodic breaching of the "barred basin" is evident at and above 4794'. Side wall cores at 4794' and 4654' have "mixed" faunas composed of two distinct faunal elements (i) arenaceous and cassidulinid species which could have withstood anaerobic conditions; (ii) planktonic species represented by small sized specimens. It is concluded that the sea floor had an anaerobic environment, but that oceanic currents washed in "size-sorted" planktonic specimens.

In Oligocene times the benthonic fauna was characterized by shallow water calcareous species of Anomalinoidea spp., Cibicides spp. and Notorotalia spp., as well as an abundance of arenaceous forms and miliolids. The sea floor was evidently well aerated. Even within one core, the planktonic percentage varies from 0 to 45%, and there is no pattern of gradual increase in planktonic percentage up the section. "Guenbelitra" sp. comprises 30% of the total fauna at 3999' to 4000', suggesting "swarming", if in fact this species is a true planktonic. It is probable that open ocean circulation was still inhibited by the remnants of a barrier which was evidently affective during upper Eocene times. Oceanic overflowing would have brought in bursts of the planktonic element. The circulation inhibitor must have been active into the lower Miocene. The side wall core at 3356' has a sparse shallow water fauna with only 2 planktonic specimens and an abundance of spherical pyrite bodies.

The Bass-1 & 2 sequences do not contain such abundant planktonic faunas at the top of the Eocene or in the lower Oligocene. Even if abundant planktonic faunas are intermittent in Bass-3, one can still conclude that the marine influence is greater than in the other Bass sections.

Above 3356', lower Miocene sedimentation was on a shallow, open shelf in all 3 sections. This is also true for the middle Miocene, with a relatively undisturbed sea floor. Sedimentation was probably below the wave base as glauconite is common and worn byrrhoeal fragments uncommon.

Reworking by wave action is suggested in the sediment above 2000' ( Zonule 6 - top of Middle Miocene). Foraminifera are infrequent and poorly preserved, glauconite is absent and worn, byrozoal fragments make up 90% of the prepared sample. As for the other Bass wells, shallowing of the late middle Miocene and upper Miocene seas is deduced. By the upper Miocene, foraminifera are extremely rare, becoming absent above 1290'. The prepared samples are composed entirely of worn byrozoal fragments. Heavy wave action and even exposure is suggested.

Note on "pyritic tubes": As mentioned in connection with the "barred basin" facies "pyritic tubes" are common in the upper Eocene sediment. Fragments of these tubes are up to 10mm long, with an average diameter of 1mm. The tubes are composed of fine grained pyrite with an irregular internal core of an opaque white, soft waxy substance. When placed in xylol the substance disseminates into fine grains which slowly dissolve. The shape of the tubes could suggest burrows or coprolites of mud-browsing animals. The tubes are always associated with foraminifera including the morphologically simple, non-septate, tube-like Bathysiphon angloceanensis which has finely arenaceous wall structure. This species tends to be transversely flattened apparently due to wall collapse through lack of cement cohesion. If initially the B. angloceanensis tubes were transversely circular, then the average diameter would have approximated that of the "pyritic tubes". These observations are consistent in all 3 Bass wells.

#### G E O L O G I C A L     S E T T I N G

The important conclusion regarding the geological setting of Bass-3 within the Bass Basin, is that the section was in close proximity to edge of the basin, when compared with Bass-1 & 2. This statement is based on the following facts:

- (1) Marine influence is evident earlier in the Bass-3 sequence.
- (2) Upper Eocene marine break-throughs are more widespread in the Bass-3 sequence.

(3) The upper Eocene Zonule K occupies a much thicker interval in Bass-3: 278' compared with 82' in Bass-1 and a very brief interval in Bass-2.

(4) Higher planktonic percentages in the Oligocene.

Above the Oligocene, the 3 sequences are similar, except that Bass-1 has volcanic flows in the lower Miocene.

It is not believed that Bass-3 was structurally separated from either of the other sections. However it is postulated that during the upper Eocene, oceanic water overflowed the apparent barrier in the west and did not extend far to the east. During the Oligocene the overflowing currents reached Bass-1 & 2, but not in the strength indicated in the Bass-3 section. Once again a water movement of west to east is the inference.

. . . . .

#### REFERENCES

- HORNIBROOK, N. deB., 1965. Globigerina angiporoides n.sp. from the Upper Eocene and Lower Oligocene of New Zealand and the status of Globigerina angipora Stache, 1865. N.Z. J. Geol. & Geophys., 8(5); 834-839.
- TAYLOR, D.J., 1965. The mid-Tertiary Foraminiferal sequence Esso Bass-1 Well, Tasmania. Appendix to completion report -Esso Bass-1 Well.
- TAYLOR, D.J., 1966. The mid-Tertiary Foraminiferal sequence Esso Gippsland Shelf No.1 Well. Appendix 2 in B.M.R. Aust., Petrol. Search Subsidy Acts Publ. 76.

. . . . .

APPENDIX 2

LIST & INTERPRETATIONS OF LOGS (ELECTRICAL)

Induction Electric Log	721-7985	Runs 1, 2, 3, 4.
Borehole Compensated Sonic Log - Gamma Ray Caliper	721-7976	Runs 1, 2, 3.
Compensated Formation Density Log	2753-7984	Run 1.
Microlaterolog	2753-7979	Runs 1 & 2.
Continuous Dipmeter	721-7987	Runs 1, 2.
Formation Tester	6740	Run 1.

Interpretation

NOTE: Wave compensating device used  
displacement 2 - 3 feet.

Rm = 1.70 @ 66° F.

Sonic Log Caliper registered 7.5 ft. shallow  
on runs 1 & 2

Rm = .57 @ 208° F. (B.H.T.)  
Rmf = 1.31 @ 68° F.

Formation Tester Runs 2, 3, & 4 on  
log - no hydrocarbon shows.

Rmf = .46 @ 208° F. (calculated)

Interval	SP	R <sub>t</sub>	$\rho_B$	$\gamma_t$	R <sub>w</sub>	$\phi_{FDC}$	$\phi_s$	R <sub>t</sub> / R <sub>o</sub>	Sw	Fr/ Fs	R <sub>wa</sub> / R <sub>w</sub>	R <sub>xo</sub>	$\phi_{MLL}$
5324-29	-43	0.5	2.2	101	0.15	30	34	0.5/ 1.2	100			5.7	27
5406-12	-42	0.6	2.2	100	0.15	29	33	0.6/ 1.2	100			5.0	29
5502-08	-40	1.1	2.32	96	0.16	23	30	1.1/ 2.2	100			7.5	24
5592-98	-55	0.5	2.22	99	.097	29	32	0.5/ 0.8	100			5.2	28
5920-30	-65	0.4	2.22	90	.07	29	30	0.4/ 0.6	100			2.5	40
6100-10	-68	0.4	2.23	96	.065	28	29	0.4/ 0.7	100			4.0	32
6562-70	-63	1.8	2.37	90	.085	19	26	1.8/ 1.7	100	0.74	2.3	3.8	32
6739-44		4.8	2.3	103	.09	21	35	3.0	55	1.00	9.0	2.8	36
6780-88	-62	2.0	2.3	92	.09	21	27	1.3	85	0.7	2.4	3.0	35
7046-52	-60	2.0	2.26	93	0.1	24	28	1.5	80	0.82	2.1	3.7	32
7288-92	-46	2.0	2.23	93	0.15	28	28	1.5	80	0.51	1.4	2.3	40
7536-42	-33	5.1	2.4	85	0.22	17	22	0.9	100	0.55	1.5	4.2	30
7760-66	-38	3.6	2.35	85	0.19	21	22	1.1	95	0.46	1.3	3.5	32



APPENDIX 3

CONVENTIONAL CORE DESCRIPTIONS

ESSO BASS-3

- Core No. 1      3000-3030    Recovery 30'
- Mudstone: light to dark grey-green, slightly arenaceous, calcareous, slightly micaceous, very fossiliferous (Lamellibranchs, bryozoa, gastropods, foraminifera). Pyritic, some intercalations of orange-brown pyritic concretionary nodules.
- Very faint irregular bedding showing no apparent dip, shown by more silt stringers. At 3005-3007' a slightly more indurated band is found. Probably due to its more siltier nature than above or below.
- Core No. 2      3500-3530    Recovery 30'
- Mudstone: dark to medium grey-green, silty in part, very fossiliferous, calcareous, pyritic, slightly glauconitic. Interbedded with shale are very thin ( $\frac{1}{4}$ " ) bands of mudstone: light grey-green, slightly fossiliferous, calcareous, also interbedded are irregular bands of light coloured, very fossiliferous, glauconitic shale. Bedding generally flat.
- Core No. 3      3997-4022    Cut 25'    Recovery 18'
- 3997-4015      Shale/mudstone with slumped laminae and lenses of siltstone and rare bands of limestone.
- Shale/mudstone: dark grey to dark grey-green, silty, slightly calcareous, sparsely glauconitic and pyritic, with sparse dissemination calcareous skeletal debris (consisting of poorly sorted, articulated pelycopods, foraminifera and bryozoa). Fairly soft, massive, with core breaking irregularly along poorly defined bedding planes.
- Siltstone: buff to light grey, argillaceous, calcareous, glauconitic with sparsely disseminated calcareous skeletal debris.
- Limestone: buff to light grey, micritic, argillaceous, in part silty, glauconitic and fossiliferous. Dense, hard and massive.
- The micritic limestone occurs as thin bands from 4004-4004.6; 4011-4011.6; 4014.6-4015. Section generally massive throughout with poorly defined bedding, generally sub horizontal. Slumping occurs throughout section, particularly from 4006-4007.6 where dips reach 10°.
- Core No. 4      4516-4539      Cut 23'    Recovery 23'
- 4516-4539      Shale: with rare laminae and lenses of limestone
- Shale: dark grey to dark grey-brown (dark brown streak), silty, sparsely pyritic, sparsely carbonaceous with sparsely disseminated calcareous skeletal debris. Thin bedded, hard, compact, fissile, breaking with splintery to sub-conchoidal fracture.
- Throughout occur numerous pyritised "worm" trails.
- Limestone: light brown to buff, argillaceous, micritic, sparsely fossiliferous, dense, hard and homogeneous. Bedding throughout horizontal.
- Core No. 5      Next page.

Core No. 8      5905-5920      Cut 15'      Recovery 14'

5905-5918.3      Siltstone: light grey to buff, argillaceous, very finely sandy in part, sparsely micaceous with lenses, laminae and thin bands of dark brown to black carbonaceous, micaceous, silty shale.

5918.3-5919      Sandstone: light grey to grey white, finely pebbly to granular, fine to coarse grained, sub angular to rounded, poorly sorted, moderately abundant white clay matrix, finely disseminated carbonaceous grains and streaks. Moderately hard. Porosity fair, permeability poor. No odour, taste or fluorescence.

Bedding throughout core sub-horizontal.

Core No. 9 - Wire Line Core Barrel

Run 1 6420-6429      Cut 9'      Recovery 2.5'

1'      Sandstone: light grey-brown, very fine, sub rounded to sub angular, fairly well sorted, few carbonaceous grains, white clay matrix, numerous laminae, shale, brown, carbonaceous, moderate discontinuous and wavy laminae.

3"      Dolomite: brown, micritic, slightly argillaceous.

1.25'      Sandstone: as above.  
No apparent dip.

Run 2 6429-6442      Cut 13'      Recovery 11'

2.5'      Shale: mottled, dark grey to brown, micritic, pyritic, with numerous coal grains included, and few sand grains, friable, non calcareous, with occasional thin discontinuous laminae, light grey siltstone.

.5'      Sandstone: light grey to brown, fine to medium, sub rounded to sub angular, fairly well sorted, with some clay matrix material, few coal grains, good porosity 25% and permeability.

1.5'      Sandstone: mottled brown to light grey, fine to coarse, sub rounded to sub angular, poor sorting, quartz, felspar, smoky quartz grains, with rounded nodules of clay after felspar, non calcareous, choked with clay material, porosity and permeability nil.

$\frac{1}{2}$       Sandstone: with numerous laminae, brown shale.

2'      Shale: brown, carbonaceous, micritic, with occasional thin discontinuous laminae of siltstone.

4'      Shale: mottled brown to dark grey, micritic, carbonaceous, with few discontinuous coal laminae and few leaf impressions, occasional thin laminae, light brown siltstone.  
No apparent dip.

Core No. 10      6903-6933      Cut 30'      Recovery 30'

6903-6905.5      Shale: light grey

6905.5-6906      Shale: light brown, very carbonaceous.

6906-6920      Shale: light grey.

6920-6922      Sandstone: light brown to black

6922-6926      Shale: light grey, with discontinuous carbonaceous laminae.

6926-6931      Sandstone: light brown, with rare discontinuous laminae, carbonaceous material and shale.

Core No. 5      5009-5039      Cut 30'      Recovery 26'  
 5009-5039      Shale with fine laminae of siltstone.  
Shale: dark chocolate brown, micaceous, pyritic, with sparsely disseminated calcareous skeletal debris. Massive, hard, breaking with irregular to sub-conchoidal fracture. Pyrite occurs as fine concretions, and as infilling of irregular "worm" trails and burrows.  
  
 Throughout occur very irregularly dispersed fine lamellae and patches of shale: light grey to grey-green and siltstone: light brown, to grey brown, very argillaceous.  
 Bedding throughout sub-horizontal.

Core No. 6      5315-5336      Cut 21'      Recovery 21'  
 5315-5325      Sandstone with irregular patches, stringers and lenses of shale.  
Sandstone: light brown, argillaceous, slightly dolomitic, very fine grained, sub angular to sub rounded, generally fairly well sorted but with scattered, rounded medium to very coarse grained quartz sand: moderately hard. Porosity fair, permeability poor to fair. No odour, taste or fluorescence.  
Shale: dark brown, silty.  
  
 This section contains numerous pyritised worm burrows.

5325-5327      Thinly interbedded and laminated sandstone and shale.  
Sandstone: light green to white, argillaceous, slightly glauconitic, very fine grained, sub angular to sub rounded, well sorted, moderately hard, porosity fair, permeability poor. No show.  
Shale: as above.

5327-5336      Sandstone with fine irregular laminae of shale.  
Sandstone: light green, very glauconitic, argillaceous, silty, very fine grained, sub angular to sub rounded, generally fairly well sorted; trace micaceous; soft and friable, porosity fair, permeability poor. No show.  
Shale: as above.  
  
 In this section sandstone contains numerous worm burrows filled with white non glauconitic fine grained sandstone, giving the rock a distinct mottled aspect.

Core No. 7      5620-5650      Cut 30'      Recovery 23'  
 5620-5650      Siltstone: light grey, slightly argillaceous in part very sandy, sparsely micaceous and pyritic with sparsely disseminated very fine grains and streaks of carbonaceous material. Porosity fair, permeability poor. No odour, taste or fluorescence. Bedding defined by very fine laminae of dark grey brown, carbonaceous, argillaceous siltstone and silty shale.  
  
 Laminae of silt and shale define micro cross bedding with foresets about 1" thick and foreset slopes up to 30°. Even bedding of sediment disturbed by rare worm burrows, and slumping with hydroplastic boudinage, microfaulting and balling.

6931-6932.5 Shale: as above (22-26)

6932.5-6933 Sandstone: as above  
No apparent dip.

Microscopic

6903-6905.5 Shale: mottled, light grey to light brown, micaceous, carbonaceous, carbonaceous material occurs as thin discontinuous laminae on film, sub parallel and vertical to the bedding plane, very slightly dolomitic.

6905.5-6906 Shale: medium grained, brown to black, micaceous, carbonaceous, some slickenside.

6906-6920 Shale: medium grained, micaceous, carbonaceous as 03-05.5

6920-6920.5 Sandstone: mottled black, medium grained, very fine to medium to coarse, very shaly, quartz grains, sub rounded to sub angular, poor sorting, numerous detrital coal grains, micaceous, very carbonaceous, tight, no fluorescence, no cut, no odour.

6920.5-6922 Sandstone: mottled, light grey to white, medium to fine, fair sorting to fairly well sorted, slightly calcareous, pink feldspar on dark mineral, smoky quartz (?), much clay matrix material, clay gives white mineral fluorescence, sandstone tight, no porosity or permeability.

6922-6923 Sandstone: as above, carbonaceous, carbonaceous material occurs as thin laminae and film, parallel to bedding.

6923-6924 Sandstone as above, (6920.5-6922), medium to fine to coarse, trace feldspar, pink, slightly calcareous, poor porosity, nil permeability.

6924-6926 Shale: light brown, micaceous, carbonaceous as above.

6926-6927 Sandstone: light grey, fine to coarse, sub rounded to sub angular, numerous coal and shale grains, poor sorting, clay choked, matrix 20%, tight, slightly calcareous.

6927-6930 Sandstone: light grey, coarse to fine, chiefly coarse, fair sorting, sub rounded to sub angular, slightly calcareous, numerous coal grains, clay choked, trace shotty, porosity and permeability low to nil.

6930-6931 Shale: light grey, micaceous, carbonaceous, silty.

6931-6932.5 Shale: brown, micaceous, carbonaceous as above.

6932.5-6933 Sandstone: light grey, fine to medium, sub rounded to sub angular, fair sorting, micaceous, clay choked (20%) slightly calcareous.

Core No. 11 7433-7453 Cut 20' Recovery 20'

7433-7438 Thinly interbedded shale and sandstone.

Shale: medium grey, in part silty to very finely sandy, micaceous, sparsely pyritic with fine carbonaceous streaks and rare carbonised plant debris.

Sandstone: grey white to buff, coarse grained to granular, sub angular to rounded, generally fairly well sorted, but with scattered rounded to sub rounded fine pebbles of quartz, trace dark grey shale and carbonaceous grains, micaceous, rare accessory tourmaline, moderately abundant white clay matrix. Moderately hard, porosity good, permeability fair, no odour, taste or fluorescence.

Sandstone: grey white to buff, fine to medium grained as above.

Section shows affects of hydroplastic flow with boudinage, microfaulting and in places complete intermixing of the lithologies, described above.

7438-7442 Sandstone: grey white to buff, coarse grained to granular, as above, becoming gradually coarser towards base of section with an increase in percentage of fine pebbles. Increase in grain size accompanied by presence of white clay grains up to 2 mm pseudomorphous after euhedral feldspar. Porosity good, permeability fair, no odour, taste or fluorescence.

7442-7450 Shale: medium grey, silty, very fine to coarsely sandy and conglomeratic, micaceous with abundant white clay grains up to 3 mm across, pseudomorphous after euhedral feldspar. Sparsely carbonaceous with trace carbonised plant debris.

This rock is very poorly sorted and obviously produced by intermixing of lithologies during slumping.

7450-7450'3" Fine pebble conglomerate - consisting of sub angular to rounded pebbles up to 1 cm across set in a very poorly sorted, light brown, argillaceous, silty, fine to coarsely sandy, micaceous and sparsely carbonaceous matrix. Abundant accessory tourmaline. Porosity good, permeability fair, no odour, taste or fluorescence.

Detrital Pebbles

Quartz (50%): sub angular to rounded grains, many composite grains of quartz and quartz feldspar.

Feldspar (40%): euhedral to sub hedral grains up to 5 mm across, completely replaced by kaolinite.

Remaining 10% pebbles made up of dark grey shale, acid to intermediate volcanics, and red haematite stained quartzite.

Volcanics, made up of a very fine grained quartz and feldspar, the latter replaced by clay. Certain volcanic grains have a definite andesitic texture.

Tourmaline: dark reddish brown, occurring as sub angular grains of vaguely prismatic form up to 2 to 3 mm.

7450-3" - 52'6"

As for interval 7442-7450 with a rafted angular block 4 cm across, of finely banded shale and coarse grained to granular quartz sandstone.

7452'6" - 53' Sandstone: grey white to buff, coarse grained to granular, as above.

Core No. 12 7877-7892 Cut 15' Recovery 0'

Core No. 13 7903-7914 Cut 11' Recovery 5'

Contact metamorphosed thinly banded and laminated sequence of quartzite shale and sandstone.

Quartzite Light to dark grey to black, very fine grained, sparsely pyritic, dense, very hard. Certain bands of quartzite have the appearance of a silicified breccia. No trace of original grain boundaries.

Shale Dark grey to black, in part silty, carbonaceous, very finely sandy, dense, moderately hard, having a definite baked appearance.

Sandstone Light to dark grey, argillaceous, fine to very fine grained, cemented in part by secondary silica cement, developing as overgrowths of quartz grains. On many grains such overgrowths have developed euhedral crystal faces. Moderately hard, finely granular texture, porosity fair, permeability nil.

Whole sequence peppered with irregular shaped vugs giving the core a rough scoriaceous texture. Many vugs lined with veneer of euhedral quartz crystals. Rare discontinuous discordant veins of coarsely crystalline quartz. Bedding flat throughout.

In hole with W7R, drilled 6 hours from 7914-7946'. Interbedded quartzite and shale as in Core 13.

Core No. 14      7974-7978'      Cut 4'      Recovery 4'

Contact metamorphosed thick shale - dense, hard with recrystallised segregations of quartz-calcite-biotite and irregular bodies up to 4" across of light to dark grey quartzite. Irregular veins and veinlets of quartz-calcite and mica. Minor pyrite and rare chalcopyrite mineralisation.

Bottom 6" of core finely banded with bands of re-crystallised quartz-calcite-mica dipping 40°. In this section plates of mica give the rock a peculiar Schiller effect.

N.B. More metamorphosed than Core No. 13.

CORE ANALYSIS RESULTS

ESSO BASS-3

Sample No.	Depth Feet	Permeability md	Porosity %	Residual Saturation Oil	Water Saturation
1 <sup>M</sup> 1620-32	5316	159	27.4	0.0	72.3
2 11846	5638	4.4	27.8	0.0	94
3 1804-11	5919	10.5	17.6	0.0	84.6
4 1960-47	6432	328.2	27.0	0.0	93.1
5	6921	10.28	22.2	0.0	78.1
6	6922	0.45	16.3	0.0	70.0
7	6925	28.39	16.0	0.0	71.1
8.	6926	18.24	22.3	0.0	85.0
9	6928	42.10	18.9	0.0	83.8
10	6929	0.45	25.8	0.0	81.0
11	6930	2.30	15.5	0.0	73.5
12	6932	1.30	15.4	0.0	69.5
13	7433	28	19.3	0.0	76
14	7438	26	19.5	0.0	67.6
15	7439	24	20	0.0	67
16	7441	5	18.9	0.0	71.5

SIDEWALL CORE DESCRIPTION

ESSO BASS-3

Shot 30      Recovered 26.

No. 1	No recovery	
No. 2	No recovery	
No. 3	Recovered 1"	Depth 7710'
	Shale: light grey, in part silty, micaceous.	
No. 4	Recovered 3/4"	Depth 7617'
	Siltstone: light grey, very argillaceous, very finely sandy, sparsely micritic and carbonaceous.	
No. 5	Recovery 1"	Depth 7311'
	Shale: medium to dark grey, sparsely micritic.	
No. 6	Recovery 3/4"	Depth 7207'
	Shale: as above.	
No. 7	Recovery 1"	Depth 7150'
	Shale: dark grey to dark grey-brown, sparsely micaceous.	
No. 8	Recovery 1/2"	Depth 7090'
	Shale: as above.	
No. 9	Recovery 1"	Depth 7006'
	Shale: dark grey, sparsely micaceous.	
No. 10	No recovery.	
No. 11	Recovery 1 1/2"	Depth 6740'
	Sandstone: grey white to buff, medium to very coarse grained, sub angular to rounded, generally fairly well sorted, abundant white to buff clay matrix, sparsely micaceous, carbonaceous, with trace dark grey to red lithic grains, trace argillaceous tourmaline?, friable, porosity fair to good, permeability poor, fair hydrocarbon odor, no fluorescence.	
No. 12	Recovery 1/2"	Depth 6710'
	Shale: dark grey, sparsely micaceous.	
No. 13	Recovery 1/2"	Depth 6600'
	Shale: as above.	
No. 14	Recovery 1/2"	Depth 6155'
	Shale: dark grey to dark grey-brown, in part silty, with very fine black carbonaceous streaks.	
No. 15	Recovery 1/2"	Depth 6021'
	Shale: dark brown, sparsely micaceous and pyritic, with very fine laminae of grey white, very argillaceous, sparsely micaceous siltstone.	
No. 16	Recovery 1"	Depth 5811'
	Shale: dark brown, silty, sparsely micaceous with very fine laminae of siltstone, as above.	
No. 17	Recovery 1"	Depth 5737'
	Sandstone: light brown, medium to very coarse grained, sub angular to rounded, generally fairly well sorted, but with scattered rounded granule to fine pebbly quartz sand, trace dark grey lithic grains, friable, porosity excellent, permeability excellent, colour due to filtrate staining.    No show.	
No. 18	Recovery 1/2"	Depth 5607'
	Finely laminated siltstone and shale. Shale: medium brown, silty, sparsely micaceous. Siltstone: grey white, very argillaceous, in part very finely sandy, sparsely micaceous.	
No. 19	Recovery 1"	Depth 5540'
	Irregular laminae, light to dark brown shale,	



- Shale: dark brown, silty, sparsely micaceous.  
Shale: light brown, very silty, sparsely micaceous.
- No. 20      Recovery 1"      Depth 5504'  
Laminated siltstone and shale.  
Siltstone: grey brown, argillaceous, very finely sandy, sparsely micaceous.  
Shale: medium brown, in part silty, sparsely micaceous.
- No. 21      Recovery 1½"      Depth 5405'  
Shale with fine laminae of siltstone.  
Shale: grey brown, in part silty, sparsely micaceous.  
Siltstone: grey white, very argillaceous, sparsely micaceous.
- No. 22      Recover 1½"      Depth 5409'  
Sandstone with very fine shale laminae  
Sandstone: buff, medium to coarse grained, sub angular to sub rounded, generally fairly well sorted, trace micrite, moderately abundant buff clay matrix, friable, porosity good, permeability fair, no show.  
Shale: dark brown, silty, sparsely micaceous.
- No. 23      No recovery.      Depth 5287'
- No. 24      Recovery 1½"      Depth 5175'  
Shale/mudstone: dark brown, silty, in part very finely sandy, sparsely micaceous, carbonaceous, trace pyritic and calcarenite.
- No. 25      Recover 1½"      Depth 5085'  
Shale: as above, noticeably more pyritic with very fine pyritic 'worm trails', trace calcite.
- No. 26      Recover 2"      Depth 4917'  
Mudstone: as above, noticeably more calcareous.
- No. 27      Recovery 2"      Depth 4794'  
Mudstone: dark brown, in part silty, pyritic, micaceous, calcareous.
- No. 28      Recovery 1"      Depth 4731'  
Mudstone: as above
- No. 29      Recovery 1½"      Depth 4654'  
Mudstone: dark brown, sparsely micaceous, calcareous.
- No. 30      Recovery 1½"      Depth 3356'  
Mudstone: dark grey generally, calcareous, sparsely micaceous (smell of H<sub>2</sub>S with acid).

ESSO BASS-3

CUTTING SAMPLE DESCRIPTIONS

- 810-1410 Calcarenite to fine calcirudite; composed of loose comminuted calcareous, skeletal debris; principally bryozoa with pelycopods and minor gastropods and foraminifera, and rare echinoid? spines. General size range 1 - 4 mm. Trace rounded to sub-rounded, medium to very coarse grained quartz sand, partly embedded in a light brown dolomitic? argillaceous matrix; grey-green, sparsely carbonaceous and glauconitic, calcareous mudstone.
- 1410-1440 50% calcarenite, as above.  
50% limestone, (biosparite); light grey, skeletal, argillaceous, micritic, fine to very finely crystalline, slightly carbonaceous and glauconitic, moderately hard to friable. Scattered, very coarse skeletal debris.  
  
NB These limestone cuttings first noticed as trace in samples from 1350 feet when samples became noticeably muddier.
- 1440-1500 80% Argillaceous limestone; as above.  
20% Calcarenite; as above.
- 1500-1530 90% Limestone; biomicrite, light grey, argillaceous, micritic, sparsely carbonaceous and glauconitic, fossiliferous (principally bryozoa and pelycopods).  
10% Calcarenite; as above.
- 1530-1560 90% Micritic limestone; (biomicrite), as above.  
10% Calcarenite; as above.
- 1560-1740 100% Micritic limestone; as above, very finely sandy in part.
- 1740-1770 60% Micritic limestone; as above  
40% Limestone; light grey to grey-white, trace micritic, skeletal, fine to very finely crystalline, very finely 'granular' or saccharoidal.
- 1770-1830 100% Limestone; skeletal, as above, variable white micritic 'chalky' matrix. Porosity good, permeability poor to fair, depending on amount of sparry calcite cement and micritic matrix. Very finely sandy in part.
- 1830-1860 80% Limestone; skeletal, finely crystalline, as above.  
20% Limestone; light to medium grey, argillaceous, micritic, sparsely carbonaceous, generally richly glauconitic, fossiliferous, very finely sandy in part. Moderately abundant disseminated microscopic foraminifera completely replaced by glauconite. Dense. Trace of very coarse, calcareous, skeletal debris.
- 1860-2250 100% Limestone; micritic, fossiliferous, as above.
- 2250-2310 100% Limestone; as above, but samples very muddy due probably to interstitial marl.
- 2310-2340 80% Limestone; as above.  
20% Marl; grey-green and light grey, silty in part, sparsely pyritic, richly fossiliferous.

2340-2370	60% <u>Limestone</u> ; as above. 40% <u>Marl</u> ; as above.
2370-2400	30% <u>Limestone</u> ; as above. 70% <u>Marl</u> ; as above.
2400-2450	<u>Marl</u> ; (approximately 60% grey-green, 40% light grey), as above, but becoming progressively more compact and less calcareous.
2450-2801	<u>Mudstone</u> ; dark grey to grey-green, sparsely pyritic and richly fossiliferous.
2801-2810	50% <u>Mudstone</u> ; light grey-green, slightly argillaceous, slightly calcareous, fossiliferous, glauconitic, pyritic. 50% <u>Marl</u> ; as above. Forams, bryozoa (Farestrella).
2810-2820	60% <u>Mudstone</u> ; as above. 40% <u>Marl</u> ; as above.
2820-2830	80% <u>Mudstone</u> ; (shale) light grey-green; slightly argillaceous, fossiliferous, becoming slightly calcareous. 20% <u>Marl</u> ; as above.
2830-2840	80% <u>Mudstone</u> ; as above. 20% <u>Marl</u> ; as above. Trace <u>siltstone</u> ; fine, light grey-green matrix, slightly calcareous.
2840-2850	80% <u>Mudstone</u> ; as above. 20% <u>Marl</u> ; as above. Trace <u>siltstone</u> ; as above.
2850-2860	90% <u>Mudstone</u> ; as above. 10% <u>Marl</u> ; as above.
2860-2870	30% <u>Mudstone</u> ; as above. 70% <u>Marl</u> ; as above.
2870-2880	80% <u>Marl</u> ; as above. 20% <u>Mudstone</u> ; as above.
2880-2890	As above.
2890-2900	70% <u>Mudstone</u> ; as above. 30% <u>Marl</u> ; as above. Trace <u>siltstone</u> .
2900-2910	80% <u>Mudstone</u> ; as above, grading into a siltstone, light brown, slightly calcareous matrix. 20% <u>Marl</u> ; as above. Extremely fossiliferous.
2910-2920	80% <u>Mudstone</u> ; as above, increasing amounts of siltstone as above. 20% <u>Marl</u> ; as above.
2920-2930	95% <u>Mudstone</u> ; grades into <u>siltstone</u> , as above, slightly calcareous. 5% <u>Marl</u> ; as above.
2930-2940	95% <u>Mudstone</u> ; as above, grading into <u>siltstone</u> , as above. 5% <u>Marl</u> ; fossiliferous marl.
2940-2960	90% <u>Mudstone</u> ; as above, grades into <u>siltstone</u> , as above. 10% <u>Marl</u> Trace dark black to red resinous material.

2960-3000	95% <u>Mudstone</u> ; slightly fossiliferous, grading to siltstone, pyritic. 5% <u>Marl</u> ; as above, very fossiliferous.
3000-3030	Ream samples.
3030-3040	90% <u>Mudstone</u> ; as above, tending to become fissile, grading into siltstone, as above. 10% <u>Marl</u> ; as above. Trace <u>siltstone</u> .
3040-3050	90% <u>Mudstone</u> ; as above. 10% <u>Marl</u> ; as above. Trace black shale.
3050-3060	As above. Trace of dark red-black resinous material, coaliferous.
3060-3070	50% <u>Mudstone</u> ; as above. 40% <u>Siltstone</u> ; slightly carbonaceous, light grey-brown, evenly grained. 10% <u>Marl</u> .
3070-3100	80% <u>Mudstone</u> ; as above. 20% <u>Marl</u> ; as above. Trace of <u>siltstone</u> , as above.
3100-3110	80% <u>Mudstone</u> ; as above. 20% <u>Marl</u> ; as above. Trace siltstone, as above. (Arenaceous, foraminifera types appearing, nor porcelaneous - indicate colder water).
3110-3120	80% <u>Mudstone</u> , as above. 20% <u>Marl</u> ; as above. Trace siltstone, as above.
3120-3130	90% <u>Mudstone</u> ; soft 10% <u>Marl</u> . Trace siltstone, light brown, white, slightly calcareous matrix. Evenly textured grains of quartz.
3130-3140	90% <u>Mudstone</u> ; as above. 10% <u>Marl</u> ; as above.
3140-3160	100% <u>Mudstone</u> ; as above. (? slight change ?)
3160-3170	100% <u>Mudstone</u> ; becoming very pale coloured, due to silty nature. Less calcareous than previously. Still very soft and puggy. Increase in amount of black specks.
3170-3180	100% <u>Mudstone</u> ; as above. Very light to pale green and grey. Slightly calcareous only.
3180-3190	100% <u>Mudstone</u> ; as above. Some mottling colouration of pale grey to green.
3190-3200	100% <u>Mudstone</u> ; as above, pale grey-green, slightly silty. (Trace <u>siltstone</u> ; light brown, pyritic, slightly arenaceous, large grains of sub rounded iron stained quartz).
3200-3210	100% <u>Mudstone</u> ; as above.
3210-3220	100% <u>Mudstone</u> ; as above. Some tending to be fissile. (unadulterated).
3220-3230	80% <u>Mudstone</u> ; as above. 20% <u>Siltstone</u> ; more fissile, calcareous, grey.

3230-3240 50% Mudstone; as above.  
50% Siltstone; as above, pale grey green, calcareous.

MARKED CHANGE - SPECKLED WITH BLACK COALIFEROUS

3240-3250 70% shale; dark grey, slightly micaceous, slightly calcareous, slightly arenaceous.  
30% Mudstone; as above.  
Trace of siltstone, as above.

3250-3260 40% Mudstone; as above.  
50% Shale; as above.  
10% Siltstone as above.

3260-3270 As above.

3270-3280 Even mixture of mudstone and shale, as above.  
Some siltstone as above (how much are cavings ?).

3280-3290 50% Mudstone; as above.  
50% Shale; as above.  
Trace of siltstone as above. Carbonaceous specks.

3300-3310 As above.

3310-3320 As above.

3320-3340 70% Shale; dark to medium grey, fissile, slightly calcareous, slightly micaceous, becoming silty in part.  
30% Mudstone; as above, very fossiliferous.  
Trace of siltstone.

3340-3350 80% Shale; as above. Very fossiliferous.  
20% Mudstone; as above.

3350-3360 As above.  
98% shale.

3360-3370 90% Shale; as above, light green.  
10% Mudstone.

3370-3380 95% Shale; as above.  
5% Siltstone; light brown, evenly textured grains, quartz.

3380-3390 95% Shale; as above.  
5% Siltstone; as above.

3390-3400 90% Shale; as above.  
10% Siltstone; as above.

3400-3410 As above.

3420-3430 95% Shale; as above.  
5% Siltstone; as above.  
Mudstone; pale grey, calcareous, very fossiliferous, very soft (caving).

3430-3440 90% Shale; as above.  
10% Siltstone.  
Mudstone as above.

3440-3450 90% Shale as above.  
10% Siltstone.  
Mudstone as above.

3450-3460 80% Shale.  
20% Siltstone; as above.  
Mudstone as above.

3460-3470 80% Shale; as above.  
20% Siltstone.  
Some mudstone.

3470-3480 90% Shale; as above.  
10% Siltstone: as above. Trace of mudstone.

3480-3490	90% <u>Shale</u> . 10% <u>Siltstone</u> . Some <u>Mudstone</u> .
3490-3500	As above.
3530-3540	20% <u>Shale</u> ; as above. 80% <u>Mudstone</u> ; as above, pale green, grey, very fossiliferous, calcareous.
3540-3550	20% <u>Shale</u> ; as above. 80% <u>Mudstone</u> ; Trace siltstone, light grey-green, speckled with
3550-3560	As above.
3560-3590	As above.
3590-3620	50% <u>Shale</u> ; as above. 50% <u>Mudstone</u> ; as above.
3620-3650	40% <u>Shale</u> ; becoming very silty. 40% <u>Mudstone</u> ; as above. 20% <u>Siltstone</u> ; light grey-green, speckled with dark green glauconite, calcareous.
3650-3660	50% <u>Mudstone</u> ; as above. 50% <u>Shale</u> . Trace of siltstone.
3660-3670	80% Silty <u>shale</u> ; slightly glauconitic. 10% <u>Mudstone</u> .
3670-3680	90% <u>Shale</u> ; silty, light to medium grey-green, fissile, very fossiliferous, slightly glauconitic. 10% <u>Mudstone</u> ; as above.
3680-3690	90% <u>Shale</u> ; as above. 10% <u>Mudstone</u> ; as above.
3690-3700	80% <u>Shale</u> ; silty, slightly glauconitic. 20% <u>Mudstone</u> .
3700-3760	As above, trace <u>siltstone</u> .
3760-3770	80% <u>Shale</u> ; very silty, as above. 20% <u>Mudstone</u> . Trace of <u>siltstone</u> as above.
3770-3780	As above.
3800-3810	90% Silty <u>shale</u> . 10% <u>Mudstone</u> .
3810-3820	60% Silty <u>Shale</u> ; white, calcareous, siltstone matrix. 30% <u>Mudstone</u> ; as above. Trace of siltstone.
3820-3830	As above.
3830-3840	As above. <u>Siltstone</u> ; white matrix, speckled with dark green glauconite, slightly calcareous, argillaceous.
3840-3850	90% <u>Mudstone</u> ; as above, very pale grey, arenaceous, speckled with green, glauconite, slightly calcareous, very soft. 10% <u>Shale</u> ; silty, as above. Trace of siltstone, as above.
3850-3860	50% <u>Mudstone</u> ; as above. 50% <u>Shale</u> ; as above. Trace of siltstone.

3860-3870	As above.
3870-3880	As above.
3880-3890	As above.
3890-3900	50% <u>Shale</u> ; as above, pale 40% <u>Siltstone</u> ; light grey, very argillaceous, calcareous, speckled and glauconitic. 10% <u>Mudstone</u> .
3900-3910	As above.
3910-3920	70% <u>Siltstone</u> ; as above. 20% <u>Shale</u> ; as above, very glauconitic. 10% <u>Mudstone</u> .
3920-3930	90% <u>Siltstone</u> ; light grey to brown, very argillaceous, slightly calcareous, fossiliferous, glauconitic, pyritic. 10% <u>Shale</u> ; as above. Trace of <u>mudstone</u> .
3930-3940	80% <u>Siltstone</u> ; pyritic. 20% <u>Shale</u> Trace of <u>mudstone</u> .
3940-3950	50% <u>Shale</u> ; very silty. 50% <u>Siltstone</u> , as above.
3950-3960	70% <u>Siltstone</u> , as above. 30% <u>Shale</u> ; as above. Trace of <u>mudstone</u> .
3960-3970	90% <u>Siltstone</u> ; as above. 10% <u>Shale</u> ; as above.
3970-3980	50% <u>Siltstone</u> . 50% very silty <u>shale</u> .
3980-3990	As above.
4020-4030	As above.
4030-4040	As above. 90% <u>Shale</u> . 10% <u>Siltstone</u> . Trace of <u>sandstone</u> , very fine grained, very argillaceous, calcareous, glauconitic.
4040-4050	70% <u>Siltstone</u> ; as above. 20% <u>Sandstone</u> ; as above. 10% <u>Shale</u> , as above.
4050-4060	70% <u>Siltstone</u> ; as above. 20% <u>Shale</u> ; as above. 10% <u>Sandstone</u> ; as above, occasional coarse, rounded quartz grains.
4060-4070	50% <u>Siltstone</u> ; as above. 40% <u>Shale</u> ; as above. 10% <u>Sandstone</u> ; as above, some fragments are illsorted. Some very soft white arenaceous, glauconitic clay.
4070-4080	80% <u>Shale</u> , very silty. 20% <u>Sandstone</u> ; as above.
4080-4090	80% <u>Shale</u> ; very silty, as above. 20% <u>Siltstone</u> ; as above. Trace of <u>sandstone</u> , as above.
4090-4100	Predominantly silty <u>shales</u> as above. Trace of <u>sandstone</u> , as above.
4100-4110	Silty <u>shale</u> , as above. Very glauconitic. Trace of <u>sandstone</u> as above.

4110-4120 As above. Silty shale.  
Sandstone; very fine grained with occasional rounded coarse grained quartz, medium coarse grains of glauconite, very argillaceous, calcareous, fossiliferous.

4120-4130 As above.

4130-4140 As above.

4140-4150 As above, increase in amount of the mudstone (?) to 80%.

4150-4160 As above, trace of sandstone, as above.

4160-4170 50% Mudstone; white, arenaceous, glauconitic, calcareous, fossiliferous.  
50% silty shale.

4170-4180 As above.

4180-4190 90% Siltstone; as above.  
10% Shale; as above.

4190-4200 As above.

4200-4210 80% Shale; silty.  
20% Siltstone; as above.

4210-4220 As above.

4220-4230 As above.

4230-4240 90% Shale; silty, pyritic, glauconitic, fossiliferous  
10% Mudstone; trace of sandstone.

4240-4250 As above.

4250-5260 As above. (Marginopora).

4260-4270 As above.

4270-4280 As above.

4280-4290 As above.

4290-4300 90% Shale; silty, as above.  
10% Mudstone; as above, trace of sandstone, as above.

4310-4320 90% Silty shale; very calcareous, fossiliferous, glauconitic, pyritic.  
10% siltstone; as above.

4320-4330 As above.

4330-4340 100% Shale; dark grey to brown, silty, calcareous, fossiliferous, glauconitic, pyritic, as above.  
Trace of siltstone, as above.  
Shale; light to medium grey, calcareous, fossiliferous, sparsely glauconitic to pyritic, moderately soft.

4340-4350 90% Shale; silty, as above.  
10% Shale; light to medium grey, calcareous, fossiliferous, sparsely glauconitic and pyritic, as above.  
Trace of rounded to sub rounded, coarse grained quartz sand. Siltstone; light brown to buff, argillaceous, calcareous, glauconitic and sparsely pyritic, fossiliferous.

4350-4360 90% Shale; silty, as above.  
10% Shale; light to medium grey, as above.  
Trace of siltstone, as above.

4360-4370 100% Shale; dark grey, silty, as above.  
Fossils, forams, bryozoa, rare gastropod (Turitella).



4370-4380 100% Shale; dark grey, silty, as above.  
Trace of grey-green, very soft, calcareous mudstone.  
Sub rounded, coarse to very coarse quartz sand.

4380-4390 100% As above.

4390-4400 As above.  
Trace of sandstone, very fine, argillaceous.

4400-4410 Siltstone and shale as above.  
Trace of limestone, very argillaceous.

4410-4420 90% Shale; silty as above.  
10% Limestone; as above, dark grey, very argillaceous,  
obviously interbedded with above.

4420-4430 As above.

4430-4440 100% Shale; silty, trace of limestone and sandstone.

4440-4450 As above.

4450-4460 As above.

4460-4470 As above.

4470-4480 100% Shale; silty, dark grey, very fossiliferous, pyritic,  
fissile, trace of limestone, as above.

4480-4490 100% Shale; very silty in part.  
Trace of limestone and sandstone, as above.

4490-4500 100% Shale; very silty.  
Trace of limestone, and sandstone, as above.

4500-4510 As above.

4540-4550 70% Shale; dark grey, silty, trace of calcarenite,  
sparsely carboniferous and pyritic, fossiliferous, as  
in Core No.4.  
30% Siltstone; light grey, argillaceous, calcareous, slightly  
glaucinitic, fossiliferous, dolomite; light brown, dense  
very hard, cryptocrystalline. Calcareous, fossiliferous  
debris.

4550-4560 50% Shale; dark grey as above.  
50% Shale; light grey, in part silty, calcareous, sparsely  
pyritic, very fossiliferous and calcareous. Trace of  
dolomite as above.

4560-4570 50% Shale; dark brown, as above.  
50% Shale; light grey, as above.

4570-4580 30% shale; dark grey.  
70% Shale; light grey in part silty.

4580-4590 40% Shale; dark grey.  
50% Shale; light grey as above.  
10% Limestone; possibly carbonaceous rock, light brown,  
dense, hard, cryptocrystalline, micritic dolomite (?)  
argillaceous, pyritic.

4590-4600 60% Shale; dark grey to dark grey-brown, silty, trace of  
calcarenite fossiliferous, sparsely pyritic.  
30% Shale; light grey, in part silty and slightly  
glaucinitic, sparsely pyritic, calcareous, fossiliferous.  
10% Limestone; light brown, possibly dolomitic as above.  
Trace of pyrite.  
Sandstone, grey-white, calcareous, argillaceous, sub angular  
to rounded, fairly well sorted, trace of glauconite to  
pyrite, fossiliferous, moderately hard, no porosity or  
permeability, calcareous skeletal debris.

4600-4610 60% shale; light grey as above.  
30% Shale; dark grey as above.  
10% Limestone; as above, slightly pyritic, trace of pyrite; sub rounded, very coarse grained quartz sand.

4610-4620 As above.  
Trace of siltstone, light grey, argillaceous, calcareous, possibly slightly dolomitic ? slightly glauconitic and pyritic.

4620-4630 As above.

4630-4640 70% Shale; light grey as above.  
15% Shale; dark grey as above.  
15% Limestone; as above, pyritic, trace of pyrite, calcareous skeletal debris, dry foram pelycopod.

4640-4650 50% Shale; light grey as above.  
40% Shale; dark grey to dark grey-brown as above.  
10% Limestone; (light brown under light,) medium grey, micritic, argillaceous, dolomitic in part ? dense, hard, cryptocrystalline, hardness varying according to argillaceous content, grading to medium grey, fairly soft, calcareous mudstone. Trace of pyrite. Sandstone.

4650-4660 70% Shale; dark grey to dark grey brown.  
Silty, trace of calcarenite; sparsely pyritic, sparsely carbonaceous, fossiliferous, as above.  
20% Shale; light grey to light grey-green, silty, calcareous, fossiliferous, as above.  
10% Limestone; medium grey (light brown under scope), Trace of pyrite.

4660-4670 90% Shale; dark grey to dark grey-brown, as above.  
10% Shale; light grey as above.  
Trace of medium grey limestone (dolomitic ?), as above.  
Shale - grey-green, sparsely pyritic, glauconitic, calcareous, pyrite.

4670-4680 70% Shale; dark grey to brown, slightly calcareous, fossiliferous, pyritic.  
30% Shale; light grey to grey green, silty, calcareous, fossiliferous.  
Trace of limestone, as above, dolomite ? argillaceous, arenaceous.

4680-4690 40% Shale; dark grey to brown.  
30% Shale; light grey to green.  
20% Dolomite; light brown, very hard, argillaceous.  
10% Siltstone; and silty shale.

4690-4700 50% Shale; as above.  
40% Shale; as above.  
10% light brown, argillaceous, slightly calcareous, very compactive, pyritic.

4700-4710 70% Shale; dark grey.  
20% Shale; light grey to green.  
10% Dolomite; light brown, trace of siltstone.  
Numerous coarse to very coarse, rounded quartz grains.

4710-4720 70% Shale and dark grey, slightly calcareous.  
20% Shale.  
10% Siltstone; buff to light brown, pyritic, glauconitic, very argillaceous, calcareous.  
Trace of sandstone, very fine grained, buff to light brown, slightly argillaceous, glauconitic, no porosity, fossiliferous.  
Numerous free coarse to very coarse, rounded quartz grains, some are milky and frosted.

4720-4730 70% Shale; dark grey to very dark brown, slightly calcareous, fossiliferous, as above.  
20% Shale; light grey to green, as above.

10% Siltstone; as above.  
Trace of sandstone as above, and numerous free quartz grains.

4730-4740 80% Shale; dark grey to very dark brown, as above.  
10% shale; light grey to green.  
10% Siltstone; as above.

4740-4750 80% Shale; dark grey to dark grey-brown, silty, trace of calcarenite, slightly pyritic, sparsely fossiliferous, as above.  
20% Shale; light grey to light grey-green, in part silty, sparsely glauconitic to pyritic in part, soft, fossiliferous, calcareous, as above.  
Trace of sub rounded, coarse grained quartz sand.  
Limestone ? medium grey, in part silty.  
Pyrite, argillaceous, pyritic, hard, cryptocrystalline, dense, possibly representing areas of carbonatization.  
Calcareous, skeletal debris (Hystricho).

4750-4760 80% Shale; dark grey to dark grey-brown, as above.  
20% Shale; light grey, in part silty, as above.  
Trace of sub rounded to rounded, coarse to very coarse grained, quartz sand. Dolomitic limestone as above ??  
Pyrite.  
Sandstone; light grey to grey-white, silty, argillaceous, calcareous, fine to very fine grained, angular to sub angular, sparsely glauconitic, pyritic to fossiliferous.  
Hard. No porosity or permeability.

4760-4770 80% Shale; dark grey to dark grey-brown, as above.  
20% Limestone; light to medium grey (light brown in scope), silty in part, pyritic, argillaceous, possibly slightly dolomitic, dense, very hard, as above.  
Trace of shale: light grey-green, sparsely glauconitic, calcareous, fossiliferous.  
Quartz sand, as above.

4770-4780 50% Shale; light grey-green, trace of glauconite, fossiliferous, slightly calcareous.  
(bad sample) 30% Shale; dark grey to grey-brown, as above.  
20% Limestone; as above.  
Trace of rounded to sub rounded, medium to very coarse grained quartz sand.

4780-4790 50% Shale; light grey green, slightly calcareous, fossiliferous.  
30% Shale; as above.  
10%: Limestone; as above. Trace of siltstone.

4790-4800 50% Shale; dark grey as above.  
40% Shale; light grey-green, as above.  
10% Dolomite; very argillaceous, light brown, very hard. Trace of siltstone, and very fine grained sandstone.

4800-4810 50% Shale; as above.  
40% Shale; as above.  
10% Siltstone; light brown to buff coloured, very argillaceous, slightly calcareous, glauconitic. Trace of limestone.

4810-4820 40% Shale; as above.  
30% Shale; as above.  
20% Siltstone; as above.  
10% Limestone.  
Loose quartz grains and nodules of pyrite common.

4820-4830 60% Shale; light grey to brown and green.  
30% Shale; dark grey.  
10% Siltstone; as above.  
Loose quartz grains and nodules of pyrite common.

4830-4840 70% Shale; dark grey to dark grey-brown, silty, trace of calcarenite, sparsely pyritic, sparsely fossiliferous, as above.  
20% Shale; light grey to grey-green, silty, calcareous, fossiliferous, sparsely glauconitic in part, soft.  
10% Siltstone; light grey to grey-white, calcareous, very argillaceous, sparsely glauconitic and pyritic, fossiliferous.  
Trace of sandstone; grey white to buff, silty, fine to very fine grained, sub angular to sub rounded, calcareous, sparsely glauconitic, moderately hard, no porosity or permeability.  
Trace of rounded to sub rounded, coarse to very coarse grained quartz sand to pyrite, as above.  
Calcareous skeletal debris.  
Principally foram to bryozoa.

4840-4850 50% Shale; dark grey, as above.  
40% Shale; light grey to grey-green, as above.  
10% Siltstone, as above.  
Trace sandstone, as above; light brown, dense, hard, cryptocrystalline, dolomitic to silty dolomitic limestone rock, as above. Quartz sand and pyrite as above.

4850-4860 70% Shale; light to medium grey to grey-green, calcareous, in part slightly silty, sparsely fossiliferous to pyritic, moderately soft.  
30% Shale; dark grey to dark grey-brown, as above.  
Trace of siltstone, as above, to calcareous sandstone, as above. No porosity or permeability. Light grey, dense, argillaceous dolomite ?? micritic, limestone as above, in part silty.

4860-4870 60% Shale; dark grey to dark grey-brown, trace of calcarenite, sparsely fossiliferous, as above.  
40% Shale; light to medium grey to grey-green, as above.  
Trace of siltstone as above and micritic, slightly dolomitic, limestone, as above.

4870-4880 80% Shale; dark grey to dark grey-brown.  
20% Shale; light to medium grey to grey-green.

4880-4890 60% Shale; dark grey as above.  
30% Shale; light to medium grey to grey=green, as above.  
10% Limestone; medium grey (light brown under scope) argillaceous, slightly dolomitic in part, silty, dense, very hard, with scattered sub-rounded, coarse to very coarse grained quartz sand.  
Trace of coarse to very coarse grained quartz sand as above.

4890-4900 20% Shale; dark grey, as above.  
80% Shale; medium grey to grey-green, silty in part, sparsely pyritic, rarely glauconitic, calcareous, as above.  
Trace of limestone, as above.  
Rounded to sub-rounded, coarse to very coarse grained quartz sand. Calcareous skeletal debris (foram, bryozoa).

4900-4910 80% Shale; medium grey to grey-green, as above.  
20% Shale; dark grey, as above.  
Trace limestone and quartz sand, as above.

4910-4920 60% Shale; dark grey brown as above.  
40% Shale; medium grey to grey-green, as above.  
Trace of limestone and quartz sand, siltstone, as above.

4920-4930 50% Shale; dark grey to dark grey-brown, as above.  
50% Shale; light to medium grey to green.  
Trace of quartz sand, limestone and pyrite to calcareous, as above.

(5000-5100 no descriptions)	4930-4940	80% <u>Shale</u> ; dark grey to dark grey-brown, as above. 20% <u>Shale</u> ; light to medium grey to grey-green, as above. Trace of <u>quartz sand</u> etc.. as above.
	4940-4950	80% <u>Shale</u> ; dark grey as above. 20% <u>Shale</u> ; light to medium grey to grey-green, as above.
	4950-4960	30% <u>Shale</u> ; dark grey, as above. 70% <u>Shale</u> ; light to medium grey, as above. Trace of <u>siltstone</u> as above, and <u>sandstone</u> , as above. <u>Limestone</u> ; dolomitic, argillaceous, micritic, sparsely glauconitic to silty, as above.
	4960-4970	50% <u>Shale</u> ; as above. 50% <u>Shale</u> ; as above. Trace of <u>limestone</u> , <u>sandstone</u> and <u>siltstone</u> as above.
	5060-5070	50% <u>Shale</u> ; as above becoming very silty in part. 40% <u>Shale</u> ; buff to light grey, as above. 10% <u>Siltstone</u> ; as above. Trace of dolomite as above (caving?)
	4970-4980	As above.
	4980-4990	As above.
	4990-5100	As above.
	5100-5110	50% <u>Shale</u> ; dark grey to dark brown. 40% <u>Shale</u> ; light grey to buff, glauconitic. 10% <u>Siltstone</u> ; as above.
	5110-5120	50% <u>Shale</u> ; as above. 40% <u>Shale</u> ; as above. 10% <u>Siltstone</u> ; as above. Trace of light to dark brown, very fine grained sandstone, very argillaceous, no porosity or permeability.
	5120-5130	50% <u>Shale</u> ; as above, very silty. 30% <u>Shale</u> ; as above. 10% <u>Siltstone</u> ; as above. 10% <u>Sandstone</u> ; very fine grained, dark brown to buff, very argillaceous.
	5130-5140	50% <u>Shale</u> ; dark brown, silty, as above. 50% <u>Shale</u> ; light grey to buff, calcareous, glauconitic, as above.
	5140-5150	30% <u>Shale</u> ; dark brown, as above. 70% <u>Shale</u> ; light grey to buff, calcareous, sparsely glauconitic, fossiliferous, as above.
	5150-5160	30% <u>Shale</u> ; dark brown. 70% <u>Shale</u> ; light grey.
	5160-5170	50% <u>Shale</u> ; dark brown. 50% <u>Shale</u> ; light coloured.
	5170-5180	70% <u>Shale</u> 30% <u>Shale</u>
	5180-5190	60% <u>Shale</u> ; 40% <u>Shale</u> ; Much caved material, dolomite, etc.. light brown, argillaceous, calcareous, silt.
	5190-5200	80% <u>Shale</u> ; dark brown, as above. 10% <u>Shale</u> ; light grey. 10% <u>Siltstone</u> ; light brown, in part very finely sandy, possibly slightly dolomitic, calcareous, argillaceous, dense, medium hard.
	5200-5210	80% <u>Shale</u> ; dark brown, trace calcarenite, silty, in part very finely sand.

20% Shale; light grey, as above.  
Trace of siltstone, as above.

5210-5220 As above.

5220-5230 75% Shale; dark brown, silty, trace calcarenite, sparsely fossiliferous, pyritic.  
25% Shale; light grey, silty, as above.  
Trace of dense, hard, cryptocrystalline, dolomitic, siltstone, as above.

5230-5240 30% Shale; dark brown, as above.  
60% Shale; light grey, as above, calcareous, sparsely glauconitic.  
10% Siltstone; medium brown, calcareous, argillaceous, in part very finely sandy.

5240-5250 40% Shale; dark brown, as above.  
60% Shale; light grey, as above.  
Trace siltstone.

5250-5260 40% Shale; dark brown, as above.  
60% Shale; light grey as above.

5260-5270 40% Shale; dark brown, as above.  
60% Shale; light grey, as above.  
Trace of siltstone, as above and light brown dolomite.

5270-5280 As above.

5280-5290 90% Shale; dark brown, as above.  
10% Shale; light grey as above.

5330-5340 20% Shale; dark brown, silty, as above.  
80% Shale; light grey to grey-blue, silty, calcareous, fossiliferous.

Cave in  
Trace of dark brown, dolomitic siltstone, sandstone, light grey, silty, argillaceous, calcareous, sparsely glauconitic, fossiliferous.

5340-5350 (Bad sample - multitude of rock types).  
80% Shale; dark brown, silty as above.  
20% Shale; light grey, silty, calcareous, as above.  
Sub angular to rounded, medium to very coarse grained quartz sand, dolomitic.

5350-5360 50% Shale; as above.  
50% Shale; as above.  
Trace of sub angular to rounded to very coarse grained quartz sand. Sandstone; light green, silty, very fine grained, sub angular to sub rounded, fairly well sorted, abundant glauconite, moderately hard to friable, porosity fair, permeability poor.

5360-5370 50% poorly sorted, sub angular to rounded quartz silt and fine to very fine grained quartz sand, (milky to clear grains),  
10% sandstone; light green, quartzose, sub angular to sub rounded, fairly well sorted, abundant glauconite, micritic and becoming light brown when dolomitic, moderately hard, porosity fair, permeability poor. No fluorescence.  
30% cuttings - dark brown shale etc..  
Trace of light brown dolomitic very fine grained sandstone, hard, no porosity or permeability, dolomitic, equivalent of above siltstone.

5370-5380 60% sand; fine to very coarse grained to granule, sub angular to rounded, quartz sand (dominantly coarse to very coarse grained).  
10% Sandstone; glauconitic, as above.  
30% Cavings, dark brown to light grey shale.  
Trace of sandstone, medium brown, quartzose, dolomitic, very fine grained, sub angular to sub rounded, fairly well sorted, sparsely glauconitic and micaceous, hard, no porosity or permeability.

5380-5390 70% quartz sand; as above (80% milky, 20% clear).  
20% sand; light green, glauconitic, as above.  
10% cavings, dark brown shale as above.

5390-5400 100% Quartz sand, as above.  
Trace of light green glauconitic, micritic sandstone.  
Trace of shale, medium brown, micronic, in part silty, sparsely carbonaceous.

5400-5410 60% Quartz sand; as above, with trace of light brown dolomitic cement.  
10% Quartzose; light green, glauconitic sandstone.  
10% Sandstone; medium brown, quartzose, dolomitic, very fine grained, sub angular to sub rounded, fairly well sorted, trace of glauconite and micritic. Hard, no porosity or permeability.  
20% Cavings; dark brown shale and light grey shale as above.

5410-5420 40% Quartz sand; very fine grained, granule (dominantly coarse grained).  
10% Sandstone; light brown to medium brown, dolomitic, as above, with scattered sub rounded, coarse grained quartz sand.  
10% Sandstone; light green, glauconitic, as above.  
40% Cavings; dark brown and light grey shale.

5420-5430 30% Quartz sand as above.  
10% Shale; medium brown, in part silty, micronic, sparsely carbonaceous.  
10% Sandstone; light to medium brown, dolomitic, as above.  
50% Cavings; dark brown and light grey, calcareous shale as above.

5430-5440 10% Quartz sand; as above.  
10% Shale; medium brown as above.  
10% Sandstone; light brown, dolomitic, very hard, as above.  
70% Cavings; dark brown and light grey, calcareous shale,  
Trace of sandstone; grey-white to buff, quartzose, calcareous, fine to very fine grained, sub angular to sub rounded, well sorted, medium hard. Porosity and permeability poor to fair.

5440-5450 Trace loose quartz grains as above.  
Trace of sandstone; as above, light green to white.  
100% shale; dark grey to brown, light grey to buff, glauconitic, fossiliferous.

5450-5460 5% Sandstone; as above.  
Trace of loose quartz grains.  
95% shale; as above, cavings.

5460-5470 10% Loose quartz grains.  
10% Sandstone; as above.  
80% Shale; as above (cavings predominantly).

5470-5480 10% Loose quartz grains.  
40% Sandstone (i) light green, well sorted.  
(ii) White " "  
(iii) Light brown, dolomitic, illsorted.  
50% Shale; as above.

5480-5490 10% Loose quartz sand.  
90% Shale; dark brown to light grey, calcareous, cavings.  
Trace of dolomitic sandstone, pyrite.

5490-5500 As above.

5500-5510 Trace of loose quartz grains.  
10% Sandstone; 3 types.  
90% Shale; dark grey, chocolate, buff, (cavings),  
to light grey, silty shale.

5510-5520 No description.

5510-5520 Trip sample.  
100% cavings, shale.

5520-5530 100% Cavings? composed of dark brown, silty shale and  
light grey, silty, fossiliferous, calcareous shale and  
calcareous, skeletal debris.  
Trace of sub angular to sub rounded medium to very coarse  
grained quartz sand.  
Sandstone; medium brown, calcareous, dolomitic, argillaceous,  
micritic, fine to very fine grained, angular to sub rounded,  
fairly well sorted, but with scattered, medium grained  
quartz sand, very hard and dense, porosity and permeability  
nil.  
Sandstone; grey-white, calcareous, fine grained, sub angular,  
to sub rounded, well sorted, in hard to friable, porosity  
and permeability fair.

5530-5540 100% Cavings, as above.  
Trace of sandstone; medium brown, calcareous and dolomitic,  
as above.  
Sandstone; light grey, calcareous, silty, very fine grained,  
sub angular to sub rounded, fairly well sorted, argillaceous,  
sparsely glauconitic, friable, porosity fair, permeability  
poor.  
Sand; quartz as above.

5540-5550 100% Cavings, as above.  
60% dark brown, silty shale.  
40% light grey silty, calcareous, shale, sparsely glauconitic.  
Trace quartz sand, as above.  
Sandstone; medium brown, calcareous and dolomitic, as above.  
Sandstone; light grey, calcareous, silty, very fine grained,  
as above.

5550-5560 100% Cavings.  
70% dark brown, silty shale, sparsely pyritic, moderately  
micaceous.  
30% Shale; light grey, calcareous, sparsely fossiliferous,  
glauconitic.  
Quartz sand; as above.  
Siltstone; light grey, brown, slightly calcareous, very  
argillaceous, soft.  
Sandstone; medium brown, dolomitic, as above.

5560-5570 Siltstone; light to medium brown, in part very finely sandy,  
argillaceous, moderately micritic, trace of dolomite.  
Sandstone; medium brown, argillaceous, silty, fine to very fine,  
sub angular to sub rounded. Trace micrite, friable,  
porosity fair, permeability poor,  
Sandstone; light to medium brown, dolomitic, as above.  
Sand; as above.  
Dolomite; light brown, dense, cryptocrystalline, very hard.  
60% dark brown shale )  
40% light grey calcareous shale ) as above.

5570-5580 Sandstone; light brown, argillaceous, slightly dolomitic,  
silty, very fine grained sandstone, subangular to sub rounded  
fairly well sorted, friable, porosity fair, permeability poor,  
Grading to a siltstone.



- 10% Siltstone; dark grey-brown, very argillaceous, in part very finely sandy, sparsely pyritic, and micritic, sparsely carbonaceous, with thin light grey silty, very fine grained sandstone streaks.  
Trace sandstone; medium brown, dolomitic, fine to coarse grained, angular to sub rounded, poor sorting, dense, hard, no porosity or permeability.  
10% Siltstone; light brown, in part very finely sandy, argillaceous, calcareous.  
60% light blue-grey, calcareous shale, in part silty.  
20% Dark brown shale, as above.  
Trace of quartz sand, as above.
- 5580-5590 10% Siltstone; dark grey brown, argillaceous, in part very finely sandy, as above.  
10% Sandstone; light grey to grey-white, argillaceous, slightly calcareous, silty, fine to very fine grained, friable, porosity fair, no fluorescence, permeability fair. Interbedded with siltstone, as above.  
80% Cavings; principally light bluish grey, calcareous shale, trace of quartz sand.
- 5590-5600 20% Siltstone; as above.  
10% Sandstone; light grey to grey-white, argillaceous, slightly calcareous, as above.  
70% light bluish grey, calcareous shale.  
Trace of quartz sand.
- 5600-5610 20% Siltstone; as above.  
10% Sandstone; as above.  
10% Sandstone; light brown, argillaceous, slightly dolomitic, silty, very fine grained, sparsely micaceous, medium hard, porosity fair, permeability poor, trace quartz sand, as above. Trace of medium brown, dolomitic sandstone, as above.  
Cuttings?  
50% bluish grey calcareous shale, as above.  
10% dark brown silty shale, as above.
- 5610-5620 20% Siltstone; as above.  
10% Siltstone; medium brown, slightly dolomitic, in part very finely sandy, sparsely micaceous, carbonaceous.  
20% sandstone, light grey to grey-white, slightly calcareous, argillaceous, silty, grading to Siltstone; fine to very fine grained, sub angular to sub rounded, fairly well sorted, trace of micrite, friable, porosity fair, permeability fair, trace of quartz sand, as above.  
50% bluish grey to light grey, calcareous shale.
- 5640-5650 20% Siltstone; light grey, slightly argillaceous, sparsely micromicaceous, in part very finely sandy, as in Core No.7.  
Cavings;  
80% shale; light grey, silty, calcareous, fossiliferous,  
20% shale; dark brown, silty, as above.
- 5650-5660 30% Siltstone; as above, grading to a silty, very fine grained sandstone, sub angular to sub rounded, with small trace micrite and carbonate. No show.  
70% Shale, cavings.
- 5660-5670 30% Siltstone; light grey, slightly argillaceous, slightly micaceous, some very fine grained sandstone.  
70% shale; as above, cavings.
- 5670-5680 40% Siltstone; white to light grey, as above, interbedded with silt, is a dark grey to black, carbonaceous ? material as stringers.  
60% Shale; as above minor loose quartz grains.
- 5680-5690 40% Siltstone; as above, slightly micaceous.  
60% shale; as above.

5690-5700 30% Siltstone; as above.  
70% Shale; as above (cavings)

5700-5710 30% Siltstone; as above, light grey to white, argillaceous, interbedded with dark brown material.  
70% Shale; as above, light grey to green, dark brown, slightly calcareous, silty in part, fossiliferous.

5710-5720 80% Shale; light grey, slightly silty and fossiliferous, slightly calcareous.  
10% Shale; dark brown.  
10% Siltstone; as above.  
Trace of very fine grained sandstone, very argillaceous with interbedded carbonaceous material, as thin irregular stringers, slightly micaceous.

5720-5730 40% Coal; (fragments) black conchoidal fracture.  
10% Siltstone; as above. Sandstone, as above.  
40% light grey, shale, silty, glauconitic, slightly calcareous.  
10% Shale; dark brown, no porosity, permeability.  
Interbedded with coal fragments.

5730-5740 90% Shale, 70% light grey  
20% dark brown  
10% siltstone; as above, and sandstone as above.  
Trace, 10%, coal, as above.  
No porosity or permeability.

5740-5750 95% Shale; light grey and dark brown.  
5% Siltstone and sandstone; light grey to buff, very argillaceous, slightly micaceous, speckled.

5750-5780 10% Coal; as above.  
80% Shale; dark brown, tending to become silty, light brown, as above.  
10% Siltstone; as above, sandstone, very fine grained argillaceous, slightly micaceous, sometimes pyritized.  
Occasional loose very coarse granular quartz grains.  
No porosity or permeability.

5780-5790 10% Coal; black, brittle to sub conchoidal fracture.  
10% Shale; as above.  
80% Cavings; light grey, calcareous, silty shale.  
Trace of sub angular to rounded, coarse grained quartz sand.  
Siltstone; as above (abundant trace).  
Sandstone; light grey to grey-white, quartzose, silty, fine to very fine grained, sub angular to sub rounded, fairly well sorted, trace of carbon, micritic, moderately hard to friable, porosity fair, permeability fair to poor.

5790-5800 As above.

----- FIRST GOOD SANDSTONE -----

5800-5810 80% Sandstone; composed of very coarse to granular, sub rounded to rounded quartz, milky and clear.  
Some grains have pyrite adhering. Probably high porosity and permeability.  
20% Shale; light grey, silty, slightly calcareous.  
Trace of coal fragments (cavings).  
Trace of siltstone, as above.

5810-5820 80% Shale; (40% light grey, 40% chocolate brown), slightly carbonaceous layers.  
10% Siltstone and sandstone; as above.  
10% loose quartz grains, as above.

5820-5830 80% Shale; as above.  
10% Sandstone; very fine grained, argillaceous, white to buff.  
10% Siltstone; dark brown to brown, interbedded with chocolate shale.

5830-5840 10% Coal; as above, probably more, but floated off.  
60% Shale; light grey to chocolate brown, (satiny golden and resinous lustre).  
Interbedded carbonaceous flecks and mica.  
30% Siltstone and sandstone found to be interbedded with shale; loose quartz grains common.

5480-5490 60% Shale; light grey (cavings), with a predominantly dark brown carbonaceous material.  
30% Sandstone; very fine to fine, non calcareous, argillaceous, white clay matrix, found interbedded with the dark brown to black carbonaceous shale, slightly micaceous.  
10% Loose quartz grains, as above.

5850-5860 30% Coal, as above.  
40% Quartz grains; loose.  
20% Shale; as above.  
10% Sandstone; very fine to fine grained, as above.

5860-5870 50% Sand; sub rounded to rounded, coarse grained to granular, to pebbly (dominantly coarse grained to granular), milky and clear.  
50% Coal; as above.

5870-5880 20% Coal  
10% Quartz sand  
20% Shale; dark brown, carbonaceous, as above.  
50% Cavings.  
Trace of sandstone; light grey to buff, quartzose, argillaceous, fine grained, sub angular to sub rounded, well sorted, sparsely micaceous and carbonaceous, friable, porosity good, permeability fair.

5880-5890 70% Shale  
10% Quartz grains  
20% Siltstone and sandstone, mainly cavings ?

5920-5930 Trip Sample.  
90% Shale; light grey to dark brown (cavings)  
10% Siltstone; and loose quartz grains as in Core No.8 (representative of drilled lithology).

5930-5940 20% Shale; as above, some dark chocolate brown carbonaceous shale as in  
20% Siltstone; light grey, argillaceous, grading into very fine sandstone.  
60% Loose quartz grains; sub angular to sub rounded, medium to very coarse to granular in size. (Clay matrix washed).

5940-5950 10% Shale; dark brown to light grey.  
90% Loose quartz grains, as above.  
Trace of very fine grained sandstone and siltstone, as above. Trace of carbonaceous fragments.

5950-5960 100% Loose quartz grains, as above.  
Trace of siltstone and very fine grained sand as above.  
Trace of carbonaceous shale.

5960-5970 90% Loose sandstone; as above.  
10% Shale; as above.  
Trace of siltstone and very fine sandstone.

5970-5980 30% Loose grains.  
20% Sandstone; white, fine grained.  
Very argillaceous, (white clay matrix) calcareous.  
Porosity low, permeability low to medium.  
40% shale; light grey to brown, as above.  
10% Siltstone; grading to very fine grained sand.

7980-7990 40% Quartz sand; sub angular to rounded, coarse grained to granule, argillaceous.  
20% Sandstone; grey white, calcareous, fine to medium grained, angular to sub rounded, generally fairly well sorted, but with scattered sub rounded to rounded trace lithic grains, coarse grained to granular quartz sand, moderately hard, porosity fair, permeability poor.  
40% Cavings; as above.

5990-6000 20% Shale; dark brown, micaceous, carbonaceous.  
20% Shale; cavings, light grey to green.  
20% Loose quartz grains, as above.  
20% Siltstone; and fine to medium grained sandstone, as above. Trace of carbonaceous fragments.

6000-6010 80% Shale.  
20% Sandstone; as loose grains and as fine to medium argillaceous aggregates.  
Trace of siltstone; light grey, very argillaceous.

6010-6020 30% Sandstone; Loose sand as above.  
10% Sandstone; aggregates as above.  
60% Shale; brown as above.  
Trace of carbonaceous fragments.

6020-6030 80% Shale as above.  
10% Siltstone; light brown to grey, argillaceous, sandy in part.  
10% Sandstone; fine to very fine, argillaceous, slightly calcareous, light grey to white.  
Trace of carbonate.

6030-6040 80% Shale; predominantly light grey.  
10% Loose grains.  
10% Sandstone aggregates, white as above.

6040-6050 80% Shale; grey to green, cavings, dark brown and carbonaceous and very fine grained sandstone interbeds.  
10% Loose quartz grains as above.  
10% Sandstone; very fine to silty and slightly calcareous. (or lithic fragments).

6050-6060 90% Shale; as above.  
10% Sandstone; white and light brown, very fine grained. Argillaceous, slightly calcareous (lithic fragments).  
Two sandstone types; white and light brown, glauconitic type.  
Trace of siltstone, as above.

6060-6070 20% Quartz sand; granule, sub angular to rounded, (milky and clear quartz) as above.  
20% Sandstone; grey white, fine to medium grained, angular to sub rounded, calcareous, argillaceous, white clay matrix, generally fairly well sorted, but with scattered, sub rounded, coarse grained and granule quartz sand. Moderately hard, porosity fair, permeability poor to fair.  
10% Sandstone; grey white, trace of calcareous, argillaceous, white clay, silty, very fine grained, sub angular to sub rounded, fairly well sorted, moderately hard, porosity fair, permeability poor.

6070-6080 10% Quartz sand; as above.  
Trace of sandstone; grey white, fair to medium grained, calcareous, as above.  
Trace of sandstone; grey white, silty, very fine grained, as above.  
20% Shale; as above.  
70% Cavings; light grey shale (calcareous, as above).  
Trace of finely crystalline pyrite with scattered, sub angular, to rounded, medium grained to very coarse grained quartz sand.  
Coal; black, brilliant lustre, irregular fracture.

6080-6090 80% Shale; composed mainly of cavings, light grey to green. Chocolate brown, slightly micaceous, slightly carbonaceous, interbedded with fine grained, argillaceous sandstone.  
10% Sandstone; as loose grains of medium to very coarse quartz and as aggregates of white, fine to medium to very coarse quartz and as aggregates of white, fine to very fine quartz with clay matrix and brown argillaceous, slightly micritic, fine to medium grained quartz.  
10% Siltstone; light to dark brown, argillaceous.

6090-6100 80% Sandstone; as loose grains, very coarse to granular, sub angular to rounded.  
Sandstone; as aggregates, as above.  
20% Shale; light brown, chocolate brown, carbonaceous fragments.

6100-6110 50% Loose sand grains as above.  
50% Shale; cavings and dark brown, micaceous shale, with interbedded, very fine to fine grained argillaceous sandstone, slightly carbonaceous, trace of dolomite matrix.

6110-6120 100% Sand; loose grains as above, trace pyritized matrix (no dolomite).

6120-6130 90% Sand; as above.  
10% Shale; predominantly light grey, (cavings). Some dark brown.  
Trace of siltstone and very fine grained sandstone; light buff to brown.

6130-6140 60% Shale; cavings mainly.  
30% Sandstone; loose grains as above.  
10% Shale; dark brown, with interbedded very fine grained sandstone; slightly micaceous, carbonaceous.

6140-6150 80% Shale; light grey to grey-green, cavings, small amount of dark brown.  
20% Sandstone; loose grains.

6150-6160 80% Shale; as above (cavings) (30% dark brown).  
20% Loose quartz grains.

6160-6170 30% Quartz sand, as above.  
20% Shale; dark brown, carbonaceous, silty, as above.  
50% Cavings;  
Trace of pyrite, as above with embedded medium to coarse grained quartz sand.  
Dolomite; light brown, dense, very hard, cryptocrystalline.  
Sandstone; light grey, quartzose, medium to fine grained, angular to sub rounded, fairly well sorted, composed of a tightly packed framework of grains cemented by clear silica cement. Dense, very hard, no porosity, permeability almost a 'quartzite'.  
  
Samples becoming badly cut.

6170-6180 10% Coal  
40% Quartz sand; sub angular to rounded, coarse grained to granular (dominantly very coarse grained)  
50% Cavings, as above.

6180-6190 70% Quartz sand; as above with trace of white clay matrix and pyrite cement.  
30% Cavings, as above.  
Trace of pyrite.

6190-6200 10% Quartz sand.  
90% Cavings; light grey, calcareous shale.  
Trace of shale; medium brown, silty, speckled sandstone, grey white, argillaceous, silty, very fine grained, sub angular, to sub rounded, fairly well sorted, friable, porosity fair and permeability poor.  
Pyrite; white clay.

6200-6210 40% Sandstone; grey white, calcareous, argillaceous.  
(white clay matrix) silty, very fine grained, sub angular to sub rounded, fairly well sorted, sparsely carbonaceous, and micritic. Moderately hard to friable, porosity fair, permeability poor; grading to very finely sandy siltstone.  
20% Quartz sand, as above.  
10% Shale; as above, dark brown, silty, carbonaceous, pyritic in part, as above.  
30% Cavings, as above.

6210-6220 50% Sandstone; grading to siltstone, as above.  
20% Shale; dark brown, silty, carbonaceous, as above.  
10% Quartz sand, as above.  
20% Cavings, as above, light grey, calcareous shale.

6220-6230 40% Quartz sand; as above.  
20% Sandstone; as above, grading to siltstone.  
70% Shale; as above.  
30% Cavings, as above.

6250-6260 50% Shale; medium grey to light green, calcareous, trace glauconite, in part, fossiliferous.  
40% Shale; brown, carbonaceous, slightly calcareous, pyritic, in part silty.  
10% Marl; grey-green, fossiliferous, argillaceous.  
Trace of quartz grains, sub angular, pebble to very coarse grained. Trace of sandstone, light grey, very fine, fairly well sorted, sub angular to sub rounded, carbonaceous, clay matrix, porosity very poor, permeability very poor.

6260-6270 50% Shale; brown as above.  
40% Marl; grey-green, as above.  
10% Sandstone; loose grains, coarse, sub rounded to angular, fairly well sorted.

6270-6280 60% Brown shale; as above.  
40% Marl; as above.  
Trace of sandstone grains, as above. Medium to coarse grained.

6280-6290 70% Brown shale as above.  
10% Sandstone; light grey, very fine to fine, sub rounded, to sub angular, fairly well sorted, with trace disseminated carbonaceous grains.  
20% Clay matrix material, porosity and permeability nil.  
20% Marl.

6290-6300 50% Brown Shale; silty as above.  
50% Marl; trace sandstone as above.

6300-6310 80% Shale; brown, as above.  
10% Sandstone; light grey as above, with laminae of carbonaceous material. Trace of light grey, fine to medium, sub rounded to sub angular, fossiliferous, dolomitic, tight.

6310-6320 70% Shale; as above.  
20% Sandstone, as above, with numerous shale laminae, brown, as above; porosity fair, permeability poor to nil.  
10% Marl.

6320-6330 70% Shale; as above.  
20% Sandstone, becoming fine;  
Porosity and permeability as above.

6330-6340 50% Siltstone; as above.  
10% Sandstone; as above.  
10% Marl; as above.  
Trace of coarse, loose sand grains.

6340-6350 90% Shale; as above.  
10% Marl; trace of loose, coarse sand grains, pyritic.

6350-6360 90% Shale; as above.  
10% Marl; as above.  
Trace of loose coarse sand grains.

6360-6370 As above.

6370-6380 80% Shale; as above.  
10% Marl  
10% Loose sand grains, sub rounded to sub angular, fairly well sorted, pyritic.

6380-6390 60% Sandstone; loose grains, coarse, sub rounded to sub-angular, fairly well sorted.  
40% Shale; brown, as above.

6390-6400 40% Sandstone; as above.  
40% Coal; black, shaly in part.  
70% Shale; as above, brown.

6400-6410 60% Coal  
30% Shale; brown.  
10% Cavings.

6410-6420 60% Coal  
10% Sandstone; shale as above.  
20% Shale; brown.  
10% Cavings.

6440-6450 50% Shale; brown, micritic, carbonaceous, laminae discontinuous.  
10% Sandstone; loose grains, medium to coarse, fairly well sorted, sub rounded to sub angular.  
30% Cavings, marl.  
10% Coal.

6450-6460 50% Shale; as above.  
10% Sandstone; as above.  
10% Sandstone; light brown, fine to very fine, fair sorting sub angular to sub rounded, choked with clay matrix. Porosity and permeability nil.  
10% Coal.  
20% Marl; as above.

6460-6470 30% Sandstone; light green, fine to very fine, sub angular, to sub rounded, fair sorting, carbonaceous in part, interstices choked with clay matrix and thin shale laminae.  
30% Sandstone; loose quartz, coarse, fairly well sorted, sub rounded to sub angular.  
20% Marl; as above.  
20% Shale; brown, as above.

6470-6480 40% Sandstone; light grey as above, some clean and porous with laminae, brown shale as above.  
40% Shale; brown as above.  
20% Marl; as above, trace dolomite, micritic.

6480-6490 50% Shale; brown, trace of sandstone as above.  
20% Shale; light grey-green, fossiliferous, marly, glauconitic (cavings).

6490-6500 20% Shale; as above.  
20% Glauconitic shale, marly as above.

6500-6510 50% Shale; as above, pyritic  
10% Sandstone; loose grained, micritic, fairly well sorted, sub angular to sub rounded.  
40% Marl and shale cavings.  
Trace of dolomite, brown, micritic.

6510-6520 50% Shale; brown as above.  
10% Sandstone; light grey, fine to very fine, tight.  
40% Marl and shale cavings, trace of dolomite, brown, micritic.

6520-6530 70% Sandstone; light grey, fine to very fine, sub rounded to sub angular, fair sorting, with trace glauconite, dolomitic in part, most clay choked, with some clean, good porosity and permeability poor, 25%.  
30% Shale; brown, interbedded with sandstone as above, in part pyritic.

6530-6540 70% Sandstone; as above.  
30% Shale; as above.

6540-6550 70% Sandstone; as above.  
20% Shale; as above.  
10% Sandstone; loose grains, medium to coarse, sub rounded, to sub angular, trace of brown micritic dolomite.

6550-6560 40% Sandstone; as above.  
40% Shale; brown, medium, carbonaceous as above, with thin laminae, light grey siltstone.  
20% Marl; as above  
Trace of brown dolomite.

6560-6570 50% Sandstone; as above.  
20% Shale; as above.  
Trace of dolomite ?  
30% Marl; as above.

6570-6580 50% Sandstone; as above, slightly glauconitic, some clean.  
20% Marl; as above (25%).  
30% Shale; brown.

6580-6590 30% Shale; as above.  
50% Sandstone; as above.  
20% Marl; and shale, as above.

6590-6600 30% Shale; as above.  
20% Sandstone; as above.  
50% Marl; as above.

6600-6610 40% Brown shale; as above.  
60% Marl and shale cavings. Trace of sandstone as above.

6610-6620 60% Shale; as above.  
Trace of sandstone, as above, dolomitic.  
40% Marl.

6620-6630 60% Shale/ as above, with coal laminae, slightly silty.  
40% Marl; as above,  
Trace of sandstone.

6630-6640 As above.

6640-6650 Some with excellent porosity and permeability (30% shale as above, fairly well sorted, sub rounded to sub angular, friable, dolomitic).  
70% Sandstone; loose and clusters, light grey, medium to fine to coarse.

6650-6660 10% Sandstone; as above.  
40% Shale; as above.  
50% Marl.

6660-6670 50% Shale; brown, as above.  
Marl; as above.  
Trace of sandstone, as above, and trace of dolomite.

6670-6680 70% Marl; cavings as above.  
30% Shale, as above.  
Trace of dolomite.

6680-6690 40% Shale; as above.  
60% Cavings.  
Trace of sandstone, light grey, very fine, fairly well sorted, clay choked, tight, slightly calcareous.



6690-6700	As above.
6700-6710	Some micrite; some in good porosity and permeability. 30% <u>Sandstone</u> ; light green, very fine to fine, as above. 20% <u>Shale</u> ; brown, as above. Dolomitic in part. 50% <u>Cavings</u> , trace of <u>dolomite</u> , occasional <u>sand grains</u> .
6710-6720	30% <u>Shale</u> ; as above. 70% <u>Cavings</u> as above. Trace of loose, medium sand grains.
6720-6730	Mostly <u>cavings</u> , 5% dolomitic, brown, argillaceous, micritic, some pyrite, Trace of <u>sandstone</u> , as above. 70% <u>Shale</u> , brown, micaceous, shale, silty, 30% <u>Cavings</u> , etc.. Trace <u>dolomite</u> , brown micritic, argillaceous, pyritic, trace coal.
6730-6740	70% <u>Shale</u> ; brown, micaceous, slightly silty. 30% <u>Cavings</u> ; trace <u>dolomite</u> , brown, micritic, argillaceous, pyrite, Trace of <u>coal</u> .
6740-6750	20% <u>Sandstone</u> ; loose quartz grains, medium, with few coarse grains, fair to well sorted, sub rounded to sub angular, no fluorescence, no cut. Possible very slight odour. 70% <u>shale</u> ; as above. 10% <u>Cavings</u> , as above. No fluorescence, No cut.
6750-6760	70% Loose <u>quartz sandstone</u> grains, medium to well sorted, sub rounded to sub angular, occasional coarse to angular grain, slightly calcareous. 30% <u>Shale</u> ; as above. No fluorescence, no cut.
6760-6770	70% <u>Sandstone</u> ; as above, becoming medium to coarse grained, and fairly well sorted. 20% <u>Shale</u> , as above. 10% <u>Cavings</u> . No fluorescence, no cut.
6770-6780	70% <u>Sandstone</u> ; as above. Becoming coarse grained. 30% <u>Shale</u> ; as above, no fluorescence, no cut.
6780-6790	100% <u>Sandstone</u> ; as above, becoming well sorted.
6790-6800	<u>Sandstone</u> (100%) as above, becoming coarse to granule.
6800-6810	100% <u>Sandstone</u> ; as above, with some smoky quartz grains.
6810-6820	100% <u>Sandstone</u> ; as above, becoming medium to coarse to granule, with trace of black rock fragments, probably basalt.
6820-6830	90% <u>Sandstone</u> ; as above. 10% <u>Shale</u> ; brown, silty, carbonaceous and micaceous.
6830-6840	50% <u>Sandstone</u> ; as above. 50% <u>Shale</u> ; as above with discontinuous coal laminae.
6840-6850	70% <u>Sandstone</u> ; as above, becoming medium to coarse. 30% <u>Shale</u> ; as above.
6850-6860	70% <u>Sandstone</u> ; becoming medium grained. 20% <u>Shale</u> ; as above. 10% <u>Cavings</u> .
6860-6870	20% <u>Sandstone</u> ; as above. 40% <u>Shale</u> ; as above. 40% <u>Cavings</u> .

6870-6880	10% <u>Sandstone</u> ; as above. 50% <u>Sandstone</u> ; light grey, fine to very fine to silty, fair sorting, sub rounded to sub angular, slightly calcareous with thin laminae (carbonaceous). Clay choked and tight, for the most part with sparse amount, having good porosity and permeability. 30% <u>Shale</u> ; brown as above. 10% <u>Cavings</u> .
6880-6890	As above.
6890-6900	As above.
6930-6940	90% <u>Sandstone</u> ; light grey, loose grains, medium to coarse to fine, sub rounded to sub angular, fairly well sorted, 10% <u>Shale</u> , light grey, micaceous.
6940-6950	40% <u>Shale</u> ; brown, micaceous, carbonaceous, slightly silty, as above. 30% <u>Shale</u> ; light grey as above. 30% <u>Sandstone</u> ; as above.
6950-6960	40% <u>Coal</u> 40% <u>Shale</u> , brown, as above. 20% <u>Shale</u> ; light grey, as above.
6960-6970	70% <u>Coal</u> 30% <u>Shale</u> ; brown, as above, trace of <u>dolomite</u> ; micritic, sandy, silty, with occasional nodules of clay.
6970-6980	50% <u>Shale</u> , brown, as above. 50% <u>Shale</u> ; light grey, carbonaceous as above. Trace of <u>dolomite</u> , as above.
6980-6990	50% <u>Sandstone</u> ; loose grains, medium to coarse, sub rounded to sub angular, fairly well sorted, trace sandstone; light grey, fine fairly well sorted, sub rounded to sub angular, clay choked, with some carbonaceous grains. 50% <u>Shale</u> ; light grey, micaceous, carbonaceous, silty.
6990-7000	20% <u>Sandstone</u> ; as above. 10% <u>Siltstone</u> ; light grey to light brown, dolomitic in part, and clayey in part. 70% <u>Shale</u> ; brown and light grey, as above.
7000-7010	20% <u>Siltstone</u> ; brown, slightly sandy, with few clay nodules dolomitic and hard. 50% <u>Sandstone</u> ; as above. 30% <u>Cavings</u> as above.
7010-7020	90% <u>Shale</u> ; as above. 10% <u>Siltstone</u> ; as above.
7020-7070	Chiefly <u>sandstone</u> , loose <u>quartz grains</u> , as above. becoming medium to coarse, slightly dolomitic and slightly siliceous, some with clay matrix.
7070-7080	80% <u>Shale</u> ; light grey to brown, as above. 10% <u>Sandstone</u> ; as above, becoming medium grained. 10% <u>Siltstone</u> ; as above, becoming slightly dolomitic.
7080-7170	Primarily <u>shale</u> , with a fine grained <u>sand streak</u> at approximately 7140 feet, composed of loose sand quartz grains, medium grained, sub rounded to sub angular, fairly well sorted.
7170-7180	90% <u>Shale</u> ; as above. 10% <u>Sandstone</u> ; as above and <u>sandstone</u> ; light grey, very fine to fine, sub rounded to sub angular, fair sorting with a few shale and coal grains, very calcareous in part.

- 7180-7190 40% Sandstone; light grey to medium dark grey, very fine to fine, loose, fair sorting, sub rounded to sub angular, very carbonaceous, slightly calcareous, much clay matrix material, tight.  
60% Shale; as above.
- 7190-7200 90% Shale; as above.  
10% Sandstone; as above and loose, medium quartz grains, trace of dolomite.
- 7200-7210 50% Shale; medium grey; sparsely micaceous in part silty and sparsely pyritic.  
50% Shale; dark grey-brown, dark brown, silty, sparsely pyritic, trace sand, medium grained to very coarse grained, angular to sub rounded.
- 7210-7220 70% Shale; medium grey, in part silty, sparsely pyritic,  
20% Shale; dark brown, as above.  
10% Sandstone; grey-white to light grey, fine to very fine grained, slightly dolomitic, sub angular to sub rounded, fairly well sorted, trace lithic grains (dark grey) moderately abundant white clay matrix, moderately hard, porosity fair, permeability poor.  
Trace of sand, as above.
- 7220-7230 60% Shale; dark grey, as above.  
30% Shale; dark brown, as above.  
10% Sandstone; as above.  
Trace of sand as above.
- 7230-7240 20% Sandstone; light grey-white to buff, slightly dolomitic, fine to very fine grained, angular to sub rounded, generally fairly well sorted, but with scattered angular to sub rounded, medium to very coarse grained quartz sand, trace of dark grey lithic grains, moderately abundant white clay matrix, moderately hard, porosity fair, permeability poor to fair, no sorting.  
50% Shale; dark grey-brown, to dark brown, silty, sparsely pyritic, sparsely carbonaceous.  
30% Shale; dark to medium grey, in part silty and sparsely pyritic, trace of coal; black, brilliant lustre, sub conchoidal fracture.  
Dolomite; light brown, dense, very hard, cryptocrystalline,  
Trace of sand, as below.
- 7240-7250 10% Sand; medium grained to very coarse grained, sub angular to sub rounded, trace white clay matrix.  
10% Sandstone; light grey to grey-white, quartzose angular to sub rounded, medium to very coarse grained, poor sorting, trace to moderately abundant and trace dark grey lithic grains. White clay matrix, and pyritic cement, moderately hard to friable, porosity fair to good, permeability poor to fair.  
10% Sandstone; as above.  
20% Shale; dark grey, as above.  
50% Shale; dark grey-brown, as above.  
Trace of coal; dolomitic, as above.  
Trace of siltstone; medium brown, in part very finely sandy, argillaceous, sparsely carbonaceous, sparsely micritic.
- 7250-7260 40% Shale; dark grey-brown, to dark brown, silty, sparsely carbonaceous, micromicaceous and pyritic, as above.  
40% Shale; medium to dark grey, in part silty, sparsely micritic, carbonaceous and pyritic.  
Sand as above.  
10% Sandstone; light grey to grey-white, medium to very coarse grained, angular to sub rounded, as above.  
No sorting.  
10% Sandstone; light grey to buff, dolomitic, fine to very fine grained, as above.  
Trace of coal; possibly higher percentage washed away.

7260-7270 50% Shale; dark grey-brown to dark brown, as above.  
40% Shale; dark to medium grey, as above.  
10% Siltstone; light grey to buff, argillaceous, in part very finely sandy, sparsely micro micaceous and pyritic, carbonaceous.

7270-7280 50% Shale; dark grey-brown, to dark brown, argillaceous, in part very finely sandy, lithic, sparsely micro micaceous, pyritic and carbonaceous.  
30% Shale; medium to dark grey, in part silty, sparsely micro micaceous and carbonaceous.  
10% Siltstone; light grey to buff, argillaceous, sparsely micro micaceous, pyritic and carbonaceous.  
10% Coal; black, brilliant lustre, brittle, irregular to sub conchoidal fracture.

7280-7290 80% Shale; dark brown, as above.  
20% Shale; dark grey, as above.  
Trace of medium to very coarse grained, angular to sub rounded quartz sand.  
Sandstone; grey white, fine grained to very fine grained, sub angular to sub rounded, generally fairly well sorted, moderately abundant, white clay matrix, moderately hard, porosity fair, permeability poor.

7290-7300 (Lithological break with siltstones to light grey silty shale).  
40% Shale; dark brown, as above.  
10% Siltstone; light grey to buff, argillaceous, very finely sandy, sparsely carbonaceous, slightly dolomitic in part, grading to a very fine grained sandstone, sub angular to sub rounded.  
20% Sandstone; grey white, slightly calcareous to dolomitic in part, fine to very fine grained, sub angular to sub rounded, fairly well sorted, but with scattered angular to sub angular, medium to very coarse grained quartz sand, moderately abundant white clay matrix, moderately hard, porosity fair, permeability poor.  
20% Shale; medium grey, silty, sparsely carbonaceous micro-micaceous and pyritic.  
Trace angular to sub rounded, coarse to very coarse grained quartz sand.

7300-7310 50% Siltstone; light grey to buff, in part very finely sandy, argillaceous, sparsely carbonaceous, micro-micaceous.  
20% Shale; light grey to medium grey, silty, sparsely carbonaceous (as flecks and streaks), sparsely micro-micaceous, massive.  
30% Shale; dark brown, as above.  
Trace sand to sandstone, as above.

7310-7320 70% Shale; medium grey, in part silty, sparsely carbonaceous, micro micaceous, with scattered coarse grained to medium grained sub rounded quartz sand.  
20% Siltstone; as above.  
10% Shale; dark brown, as above.  
Trace of quartz sand, as above.  
Coal, sandstone; grey white, calcareous, fine grained sub-angular to sub rounded, fairly well sorted, moderately abundant, white clay matrix, moderately hard, porosity fair, permeability poor.

7320-7330 20% Sandstone; grey white, calcareous and slightly dolomitic, fine to very fine grained, angular to sub rounded, generally fairly well sorted, sparsely micro micaceous, trace carbonaceous to lithic, moderately hard, porosity fair, permeability poor, no show.  
10% Sandstone; grey white, medium to very coarse grained, angular to sub rounded, poor sorting, trace calcarenite, moderately abundant white clay matrix, moderately hard to friable, porosity fair to good, permeability poor, no show.  
10% Sand, SUB ANGULAR TO ROUNDED, COARSE to granule quartz sand,

- 30% Shale; as above.  
 20% Siltstone; as above.  
 10% Shale; dark brown, as above.  
 Trace of dolomite.
- 7330-7340      70% Shale; medium grey to grey brown, in part silty, sparsely micaceous, carbonaceous as above.  
 20% Shale; dark brown, to dark grey brown, silty, carbonaceous, micro micaceous and pyritic as above.  
 10% Quartz sand; sub angular to rounded, coarse grained to granule as above.
- 7340-7350      60% Shale; medium grey as above.  
 10% Sandstone; grey white, quartzose, trace of dolomite and calcarenite, fine to very fine grained, angular to sub rounded, generally fairly well sorted, trace micrite and carbonate, but with scattered sub angular to rounded coarse grained to medium grained quartz sand, moderately hard, moderately abundant white clay matrix. Porosity good, permeability poor.  
 20% Siltstone; light grey, very finely sandy, argillaceous, sparsely micritic and carbonaceous with scattered sub angular to rounded, medium to coarse grained quartz sand, abundant white clay matrix,  
 10% Sand; medium grained, granule, sub angular to rounded as above.  
 Trace of white opaque calcite cement and white clay matrix, many grains are cemented together showing poor sorting nature of sandstone.  
 Trace of coal; as above.
- 7350-7360      10% Sandstone; as above.  
 40% Sand; as above with trace of pyrite and dolomitic cement. Again, several very poor sorted composite grains with fine to granule grained quartz sand, cemented together.  
 40% Shale; medium grey as above.  
 10% Shale; dark brown, carbonaceous, with coal streaks, satin lustre.  
 Trace of coal.
- 7360-7370      Quartz sand, as above.  
 10% Sandstone; grey white, quartzose, slightly calcareous, fine to medium grained, sub angular to sub rounded, generally poorly sorted, with scattered coarse grained to granule quartz sand, trace lithic grains and carbonaceous grains.  
 10% Shale; dark brown, sparsely micro micaceous, carbonaceous, trace of sandstone; grey white, fine to very fine grained, as above.
- 7370-7380      90% Quartz sand; coarse grained to fine pebbles, some very coarse grained to granule, sub angular to rounded (dominantly clear quartz), with trace of white clay matrix.  
 10% Sandstone; grey white, fine to medium grained as above.
- 7380-7390      10% Quartz sand; as above.  
 70% Shale; medium grey, silty, sparsely carbonaceous and micaceous, with scattered rounded to sub rounded coarse grained to granule quartz sand.  
 10% Shale; dark brown, as above.  
 10% Siltstone; grey brown, argillaceous, sparsely carbonaceous and micro micaceous, in part very finely sandy.
- 7390-7400      50% Shale; medium grey, silty, as above.  
 50% Shale; medium brown, silty, sparsely pyritic, carbonaceous, micro micaceous.  
 Trace of quartz sand and sandstone, as above.

- 7450-7460 60% Sand; quartz, sub angular to rounded, coarse grained, trace of white clay matrix.  
20% Sandstone; light grey to grey white, fine to medium grained, sub angular to sub rounded, generally fairly well sorted, but with scattered granule to coarse grained quartz sand, trace of lithic grains, micritic, moderately abundant with clay matrix, moderately hard, porosity good, permeability fair.  
20% Shale; medium grey, silty in part very sandy, sparsely carbonaceous, micro micaceous.
- Trace of dolomite, light brown, dense very hard, cryptocrystalline.
- 6460-6470 30% Sand; as above.  
20% Sandstone; as above.  
50% Shale; medium grey to grey brown, silty, as above with trace of pyrite, worm trails.
- 7470-7480 20% Sand; as above.  
10% Sandstone; as above.  
70% Shale; as above, dark grey brown, silty, in part very finely sandy, sparsely carbonaceous and micritic.
- 7480-7490 20% Sand; as above.  
10% Sandstone; as above, with trace dolomitic cement.  
10% Sandstone; grey white, silty, fine to very fine grained, argillaceous, sub angular to sub rounded, fairly well sorted, but with scattered medium to coarse grained sub rounded quartz sand, moderately abundant white clay matrix, moderately hard, porosity fair, permeability poor.  
70% Shale; as above.
- 7490-7500 20% Sand; as above.  
10% Sandstone; grey white, silty argillaceous, very fine to fine grained, as above.  
70% Shale; as above, dark brown, to dark grey brown.
- 7500-7510 10% Sand; as above.  
10% Sandstone; grey white, silty, very fine grained, as above.  
10% Siltstone; light grey to buff, argillaceous, very finely sandy in part, sparsely micritic and feldspar, sparsely carbonaceous and pyritic.  
20% Shale; medium grey, silty, sparsely carbonaceous micro micaceous.  
50% Shale; dark brown to dark grey brown, silty in part and very finely sandy, sparsely micritic and pyritic.
- 7510-7520 70% Sand; sub angular to rounded, coarse grained to fine pebbly trace white clay matrix. Certain quartz grains have a very dull fluorescence, no cut.  
10% Shale; medium grey brown, silty, carbonaceous, micritic,  
10% Siltstone, as above.  
10% Shale; dark brown as above.
- 7520-7530 10% Sand; as above.  
10% Sandstone; grey white, medium to coarse grained, sub angular to rounded, generally fairly well sorted, but with scattered sub rounded, very coarse grained to granule quartz sand, trace of dark grey lithic grains (volcanic ?), to red haem. rt. "quartzite", moderately abundant white clay matrix, porosity good, permeability fair.  
60% Shale; medium grey to grey brown, silty, carbonaceous, micritic to sparsely pyritic.  
10% Shale; dark brown, as above.  
10% Siltstone; as above.
- 7530-7540 10% Sand; as above.  
60% Shale; grey brown, silty in part, very finely sandy.

sparsely feldspathic, carbonaceous, micritic, with scattered lithic grains.  
30% Shale; dark brown, carbonaceous, sparsely micritic.

- 7550-7560 10% Sand; coarse grained to granule, sub angular to rounded, trace white clay matrix, as above.  
10% Sandstone; grey white, medium grained to coarse grained, sub angular to rounded, generally fairly well sorted, but with scattered granule to pebbly quartz sand, moderately abundant white clay matrix, trace of micrite and dark grey lithic grains, moderately hard, porosity good, permeability poor.  
20% Shale; dark brown, in part silty, carbonaceous.  
60% Shale; medium to dark grey, silty, in part very finely sandy, sparsely micaceous and carbonaceous.  
Trace of dolomite, light brown, dense, very hard, pyritic, cryptocrystalline.
- 7560-7570 Bad sample, contaminated with light grey to black grey calcareous fossiliferous shale, traces of sand, sandstone and shale as above.
- 7570-7590 As above, badly contaminated with traces of sand, sandstone shale and coal, as above.
- 7590-7600 100% Shale; dark grey brown, silty in part, very finely sandy, sparsely micritic, pyritic and carbonaceous to sparsely calcareous, badly contaminated with cavings, as above, traces of coal.
- 7600-7610 50% Shale; dark brown, slightly calcareous, as above.  
25% Shale; grey, calcareous, silty, fossiliferous.  
25% Shale; light grey, grey blue, calcareous, fossiliferous.
- 7610-7620 10% Sand; as above.  
10% Sandstone; grey white, silty, fine to very fine grained, sub angular to sub rounded, fairly well sorted, moderately abundant white clay matrix, trace of micaceous to red and dark grey lithic grains, porosity fair, permeability poor.  
10% Sandstone; light grey to grey white, medium to coarse grained, as above.  
70% Shale; dark brown, dark grey brown, silty, sparsely carbonaceous, micritic and pyritic, very finely sandy, in part and slightly calcareous.
- 7620-7630 80% Shale; as above.  
10% Sand; as above.  
10% Sandstone; light grey to grey white, coarse to very coarse grained to granule, as above, trace of pyrite cement.  
Trace of sandstone; grey white, silty, fine to very fine grained as above.
- 7630-7640 70% Shale; as above.  
10% Sand; as above.  
10% Sandstone; light grey, grey-white, medium to coarse grained, sub angular to rounded, poor sorting with scattered sub rounded grains and pebbly quartz sand, moderately abundant white clay matrix. Trace of dark grey lithic grains, micritic, moderately hard, trace of pyritic cement, porosity fair, permeability poor.  
10% Sandstone; grey white, silty, fine to very fine grained as above.
- 7640-7650 80% Shale; dark brown to dark grey-brown, as above.  
20% Shale; medium grey, silty, sparsely micritic and carbonaceous and pyritic.

- 7650-7660 100% Shale; dark brown, to dark grey-brown, silty in part, very finely sandy, micro micaceous, sparsely carbonaceous, pyritic, grading to argillaceous siltstone, trace of green to dark grey lithic grains. Trace quartz sand to sandstone as above.
- 7660-7670 90% Shale; as above.  
10% Siltstone; light grey to buff, argillaceous, very finely sandy, sparsely carbonaceous and micritic.  
Trace of quartz sand and sandstone, pyrite and pyritized worm tubes as above.
- 7670-7680 90% Shale; as above, pyritic in part.  
10% Siltstone; as above.  
Trace of sandstone, light grey to buff, silty, fine to very fine grained, argillaceous, trace dolomite, sub angular to sub rounded, fairly well sorted, trace micrite and carbonaceous grains, moderately abundant, buff argillaceous matrix, porosity fair, permeability poor. Trace of pyrite.
- 7680-7690 30% Shale; dark brown, as above, slightly calcareous.  
40% Shale; buff, silty in part, very finely sandy, calcareous and sparsely fossiliferous, slightly glauconitic.  
30% Shale; light grey to light grey black, silty in part, fossiliferous, calcareous. Trace of sand, as above.
- 7690-7700 50% Shale; dark brown, dark grey brown, slightly calcareous, silty in part very finely sandy, sparsely carbonaceous, micritic, and pyritic with rare scattered dark green lithic grains.  
50% Shale; buff, as above.  
Trace of sand, coarse grained quartz sand.
- 7700-7710 60% Shale; dark brown to dark grey brown, silty, in part very finely sandy, trace calcarenite, sparsely carbonaceous and micritic.  
40% Shale; buff, as above, cavings ?  
Trace of sandstone, grey white, silty, very fine grained, sub angular to sub rounded, abundant white clay matrix, trace micrite, moderately hard, porosity fair, permeability poor. Sand as above.
- 7710-7720 50% Shale; dark brown to dark grey brown, as above.  
10% Sandstone; grey white, fine to medium grained, sub angular to sub rounded, poor sorting with scattered sub angular to sub rounded coarse grained to granule quartz sand, trace of dark grey lithic grains.  
10% Sand, as above, trace white clay matrix.  
30% Shale; buff, to light grey, silty, calcareous, fossiliferous as above.  
Moderately abundant white clay matrix, porosity fair, permeability poor. Cavings ?
- 7720-7730 40% Shale; dark brown, to dark grey brown, as above.  
10% Siltstone; light brown, argillaceous, in part very finely sandy, scattered very fine grained and dark grey lithic material, sparsely carbonaceous, micritic, and pyritic.  
10% Sandstone; as above.  
20% Sand, as above.  
20% Shale; buff as above, cavings.  
Trace of pyrite to pyritized worm tubes.
- 7730-7740 20% Sand; as above, trace white clay matrix and pyritic cement.  
20% Sandstone; as above.  
30% Shale; dark brown to dark grey brown, as above.  
30% Shale; buff to light grey, silty in part, calcareous, fossiliferous.
- 7740-7750 10% Sand; as above.  
10% Sandstone; as above.  
10% Sandstone; light grey to grey white, fine to very fine grained, sub angular to sub rounded, generally fairly well sorted, lithic, micaceous, moderately abundant white clay



- matrix, moderately hard, porosity fair, permeability poor.  
 40% Shale; dark grey brown, as above.  
 Cavings?  
 30% Shale; buff to light grey, silty, in part very finely sandy, sparsely glauconitic, calcareous, fossiliferous.  
 Trace of scattered calcareous skeletal debris, bryozoa gastropods.
- 7750-7760      70% Sand; coarse grained to granule, fine pebbles, sub angular, to rounded, trace white clay matrix, pyritic cement, trace rounded dark grey chert.  
 10% Sandstone; light grey to grey white, fine to very fine.  
 20% Shale; dark grey brown, as above.  
 Dull gold fluorescence in some grains, no cut.
- 7760-7770      100% Sand; as above.
- 7770-7780      70% Sand; coarse grained to granule, fine to pebbly, sub angular to rounded, trace white clay matrix, certain percentage of grains fluoresce, dull gold, no cut, transparent grains fluoresce, opaque grains do not - inclusion fluorescence.  
 30% Cavings; light grey to grey blue, calcareous shale.  
 Trace of dark brown shale as above.
- 7780-7790      100% light grey to grey blue, calcareous, silty in part, fossiliferous, cavings.  
 Trace of quartz sand and dark brown silty shale.
- 7790-7800      30% Quartz sand, coarse grained to granule, fine to pebbly angular to rounded, trace white clay matrix, certain grains have a perfect crystal form.  
 10% Buff calcareous shale; as above, cavings.  
 30% Shale; light grey, calcareous, as above.  
 10% "Metaquartzite" grains - dark grey, angular (broken), to rounded, dense.
- 7800-7810      90% Quartz sand.  
 10% Angular to rounded grains, dark grey, dense 'metaquartzite'. sparsely pyritic, very hard.  
 Trace of sandstone, light grey to grey-white, fine to coarse grained, angular to sub rounded, poor sorting, trace white clay matrix abundant.
- 7810-7820      90% Quartz sand; as above.  
 10% 'Metaquartzite' as above.  
 Trace of sandstone, light grey, fine to medium grained to coarse grained, angular to sub rounded, poor sorting, trace of white clay matrix, dense siliceous cement, trace dark grey, sub rounded metaquartzite pebbles (5 mm), hard, dense, no porosity or permeability. Certain quartz grains fluoresce dull gold, no cut.
- 7820-7830      60% Quartz sand; coarse grained, fine to pebbly, angular to sub rounded, as above. Trace white clay matrix.  
 10% 'Metaquartzite'; dark grey, dense, sparsely pyritic, very fine grained.  
 10% Sandstone; grey white to light grey, fine to medium grained, sub angular to sub rounded, poor sorting with scattered grains of fine pebbly quartz sand and sub rounded dark grey 'metaquartzite' pebbles (5 mm), trace of white clay matrix, siliceous and partly dolomitic cement, very hard, no porosity or permeability.  
 20% Shale; dark brown to dark grey brown, as above.
- 7830-7840      70% Quartz sand; angular to sub angular, coarse grained to granule with trace siliceous cement.  
 20% Quartzite; dark to light grey, mottled, dense, very hard, sparsely pyritic, occurring as argillaceous fragments and splinters, generally some have sub rounded aspect, one has trace of white siliceous cement.

## FORMATION TEST RESULTS

### Test 1 at 6740 feet

Pressure in chamber 1380 psi.

Pressure in chamber after filling 2 bombs and bleeding for analysis 1000 psi.

After filling 3rd bomb, pressure 800 psi.

Opened tool - gauged total of 29 cubic feet of gas and recovered 12,250 cc. water to 800 cc condensate (liquids placed in 5-gallon drum).

#### Gas Analysis (Core Lab.)

<u>C1</u>	<u>C2</u>	<u>C3</u>	<u>C4</u>	<u>C5</u>	<u>CO<sub>2</sub></u>
100	30	14	7	3	0.5

#### Water

Resistivity = 1.78 @ 74° F. (calculated 3200 ppm).

NaCl (Chem) = 2100 ppm.

### Test 2 at 5737 feet

Pressure in chamber 400 psi. Filled one bomb, pressure dropped to < 200 psi, then tool plugged. Attempt to fill second bomb with indefinite results. Open tool - recovered 20,000 cc muddy water - placed in 5-gallon drum.

Resistivity = 1.27 @ 78° F. (calculated 4200 ppm).

NaCl (Chem) = 2150 ppm.

### Test 3 at 5409 feet.

Pressure in chamber 9 psi.

Filled one bomb, opened tool, recovered 20,000 cc of salt water - placed in 1-gallon drum.

#### Water Analysis

Core Lab. - resistivity = 0.41 @ 72° F. (calculated 15,000 ppm).

Schlumberger " = 0.34 @ 74° F. ( " 19,000 ppm).

Chem. Analysis = 20,500 ppm.

Waving Blender Analysis 38 H<sub>1</sub> OL<sub>O</sub>

Trace C<sub>1</sub> on hot wore, 1 C<sub>1</sub> on PHD

### Test 4 at 5736 feet.

Pressure in chamber approximately 80 psi - full of mud.

## APPENDIX 4

### VELOCITY SURVEY

ESSO BASS # 3

by

P.E. Towey

#### A. INTRODUCTION

Esso Australia contracted Western Geophysical Co. to perform the velocity survey. Under the contract, Western agreed to furnish the following:

##### (1) Instruments

- a. SSC Model GCE101 Pressure Sensitive Well Geophones
- b. Twelve SIE GA-11 Amplifiers, Input Switching and Power Supply
- c. Western 30 Channel Camera
- d. Three 12 volt Batteries and Charger
- e. Portable Developing System
- f. Two 300 volt Blasters
- g. Three Kaar TR 327 CB Radios
- h. Two RC-5 Remote Control Units for Shooters Radio
- i. Two TA-12 Break amplifier units
- j. Adequate spare parts

##### (2) Personnel

One Marine Shooter, G. Jones and one Instrument Operator, A. Paar.

##### (3) One Licenced Shooting Boat

All equipment and personnel were assembled on March 26, 1967 and the survey was made on March 27.

#### B. SURVEY PROCEDURES

Weather was very good during the survey and no operational difficulties were encountered.

##### (1) Shot Positioning

The orientation of Glomar III was E-W during the survey. Buoys were positioned at 500 and 1000 feet on the north side of the boat and at 1000 feet on the south side. The position of shot point D was estimated by the shooter. Exact shot positions were obtained from water arrivals at the well, measured by a geophone in the moonpool.

##### (2) Shot Size

All shots were 25 lbs.

##### (3) Well Geophone Positioning

All depth measurements were made using the Schlumberger depth indicator. To minimize rig noise the marine riser was disconnected from the derrick floor and lowered to the casing top. The cable was clamped with a T-bar device which rested on the casing top at each geophone position.

(4) Time

The first shot was made at 1.25 p.m. and the last one at 4.05 p.m.  
All told the survey occupied four hours of rig time.

C. RESULTS

Eleven shots were made at six different levels. Shotholes B and D were used only for the shallowest shot.

The quality of the timebreak trace was variable and in the case of the first shot, so bad that the record was not used. Some rig noise was experienced on the well 'phone traces, for example, shot # 6, but did not effect the breaks. It will be noticed that there is a refraction break on all the records of shots above 5000 feet. Once it was recognised as such, no difficulties were experienced with it.

Copies of all records are included below.

The final checkshot times and the integrated sonic times are considered to be in good agreement as is shown by the error chart, Fig. 1.

D. CONCLUSIONS

The velocity survey was successful in tying the integrated sonic log into absolute time values.

ESSO BASS # 3

FIGURE I

<u>Depth below Sea Level in feet</u>	<u>Average Vertical Travel Time from Check Shots</u>	<u>Interval Time from Check Shots</u>	<u>Interval Time from Sonic Log</u>	<u>Difference in Miliseconds</u>	<u>Interval Size in feet</u>	<u>Error in Microseconds per foot</u>
2003	.284					
		.201	.2045	-3.5	1498	-2.3
3501	.485					
		.147	.1470	0	1200	0
4701	.632					
		.088	.0870	+1.0	858	+1.2
5559	.720					
		.131	.1330	-2.0	1471	-1.4
7030	.851					
		.068	.0665	+1.5	809	+0.2
7839	.919					

Shot hole information: - Elevation, Distance & Direction from Well										Company		Well		Elevation		Total Depth		LOCATION							
										ESSO EXPLORATION AND PRODUCTION AUSTRALIA INC.		Bass # 3		31'		7978'		Coordinates 39°59'51" 145°16'57"		Section, Township, Range		County		Area or Field	
																		DATUM : Sea Level		Bass Basin Tasmania					
Record Number	Shot hole Number	Time of Shot	Dgm	Ds	tus	tr	T			Dgs	H	TAN i	Cos i	Tgs	Δsd	$\frac{\Delta sd}{V}$	Tgd	Tgd Average	Dgd	Δ Dgd	Δ Tgd	Vi Interval Velocity	Va Average Velocity		
							Reading	Polarity	Grade																
1	B	1325	2034	5			NOISEY TIME BREAK TRACE																		
11	D	1605	2034	5	001	105	293	D	P	1998	525	2628	9672	283	5	001	284	284	2003	1498	201	7453	7053		
2	C	1335	3532	5	001	199	503	D	F	3496	995	2847	9617	484	5	001	485	485	3501	1200	147	8163	7219		
3	C	1353	4732	5	001	201	647	D	G	4696	1005	2140	9778	633	5	001	634	632	4710				7438		
10	A	1550	4732	5	001	215	644	D	G	4696	1075	2289	9747	628	5	001	629			858	088	9750			
4	C	1410	5590	5	001	198	731	D	G	5554	990	1783	9844	720	5	001	721	720	5559				7721		
9	A	1525	5590	5	001	201	729	D	G	5554	1005	1810	9840	717	5	001	718			1471	131	11230			
5	C	1430	7061	5	001	203	859	D	G	7025	1015	1445	9897	830	5	001	851	851	7030				8261		
6	C	1450	7870	5	001	205	928	D	G	7834	1025	1308	9915	920	5	001	921			809	068	11897			
7	C	1455	7870	5	001	199	926	D	G	7834	995	1270	9920	919	5	001	920	919	7839				8530		
8	A	1505	7870	5	001	200	921	D	G	7834	1000	1276	9920	914	5	001	915								

Dgm = Geophone depth measured from well elevation

Dgs = " " " " shot "

Dgd = " " " " datum "

Ds = Depth of shot

De = Shot hole elevation to datum plane

H = Horizontal distance from well to shotpoint

S = Straight line travel path from shot to well geophone

tus = Uphole time at shotpoint

T = Observed time from shotpoint to well geophone.

tr = " " to reference geophone.

Δe = Difference in elevation between well & shotpoint.

Δsd = " " " " shot & datum plane

Δsd = Ds - De

Dgs = Dgm - Ds ± Δe;  $\tan i = \frac{H}{Dgs}$

Tgs =  $\cos i$  T = Vert. travel time from shot elev. to geophone

Tgd =  $Tgs \pm \frac{\Delta sd}{V}$  = " " " datum plane "

Dgd = Dgm - Δmd

Vi = Interval velocity =  $\frac{\Delta Dgd}{\Delta Tgd}$

Va = Average =  $\frac{Dgd}{Tgd}$

Surveyed by: Western Geophysical

Date: March 27, 1967

Weathering Data:

Water Depth: 202'

Cas: Record 2750'

# ESSO BASS-3

## WELL VELOCITY RECORDS

Shot No 1

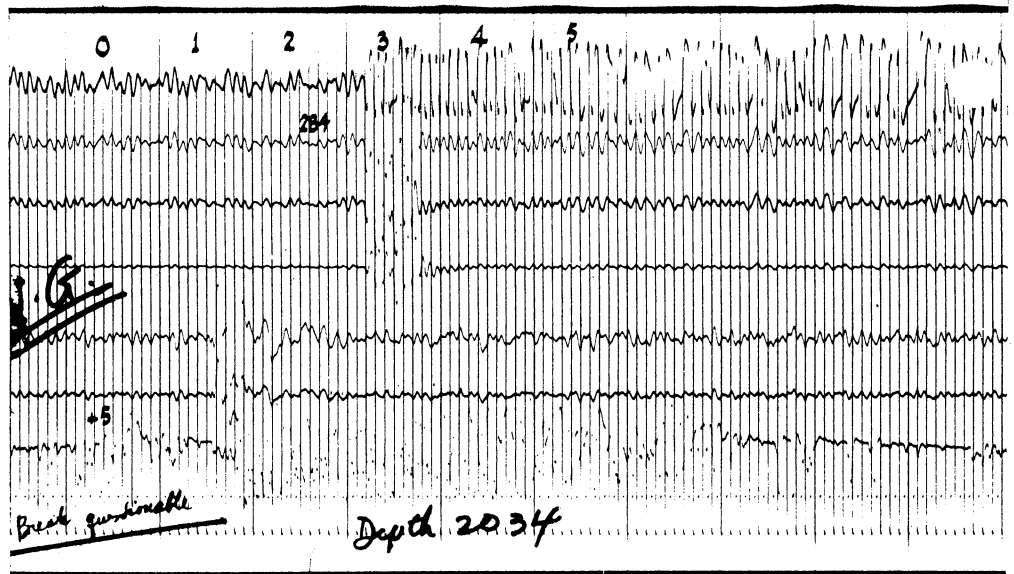
Depth: 2034' Below K.D.

25 lbs. @ 5'

Offset:

Time: 27-3-1967

BASS - 3



Shot No 2

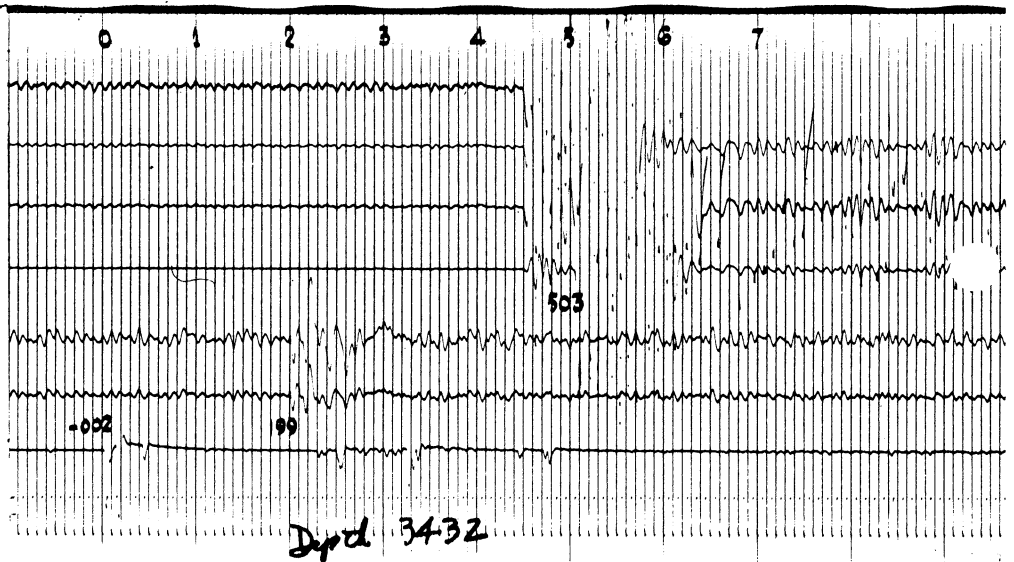
Depth: 3432' Below K.D.

25 lbs. @ 5'

Offset:

Time: 13:35 27-3-1967

BASS - 3



Shot No 3

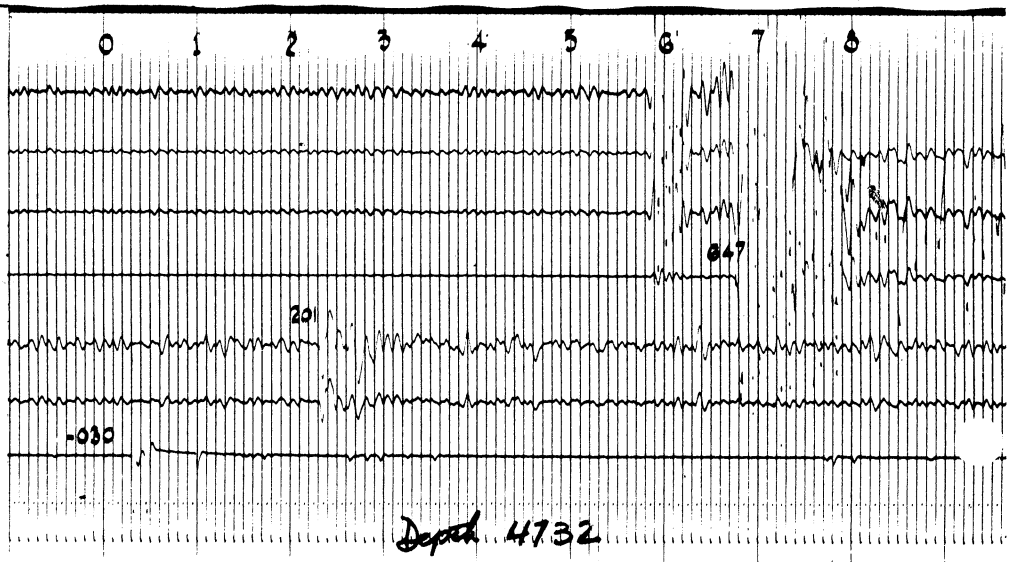
Depth: 4732' Below K.D.

25 lbs. @ 5'

Offset:

Time: 13:53 27-3-1967

BASS - 3



# 

### 

Shot No 4

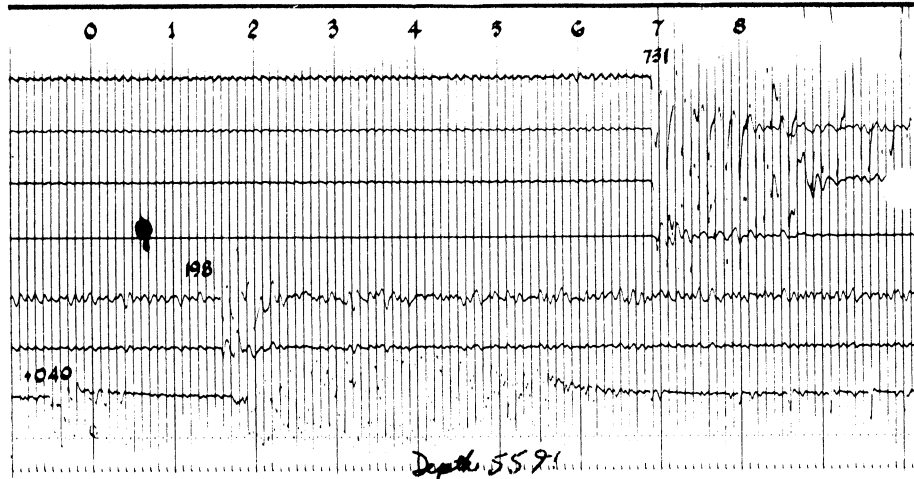
Depth: 5591' Below K.D.

25 lbs. @ 5'

Offset:

Time: 14:10 27-3-1967

BASS - 3



Shot No 5

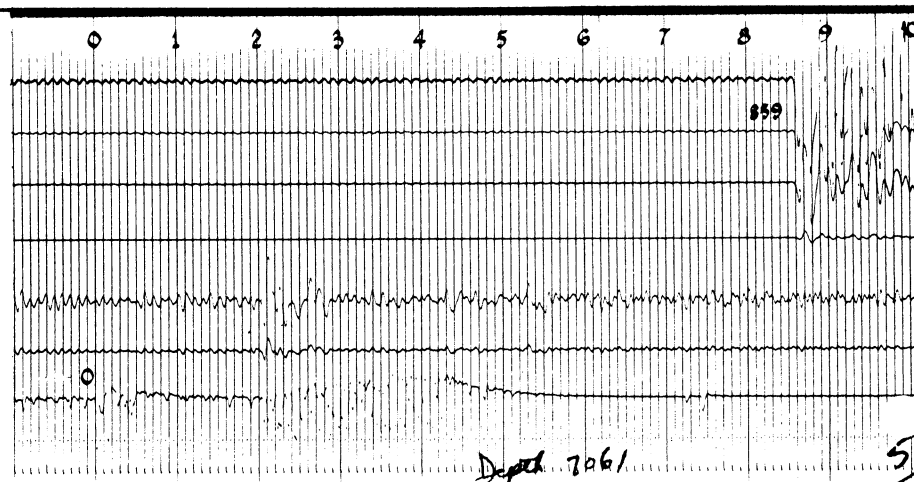
Depth: 7061' Below K.D.

25 lbs. @ 5'

Offset:

Time: 14:30 27-3-1967

BASS - 3



Shot No 6

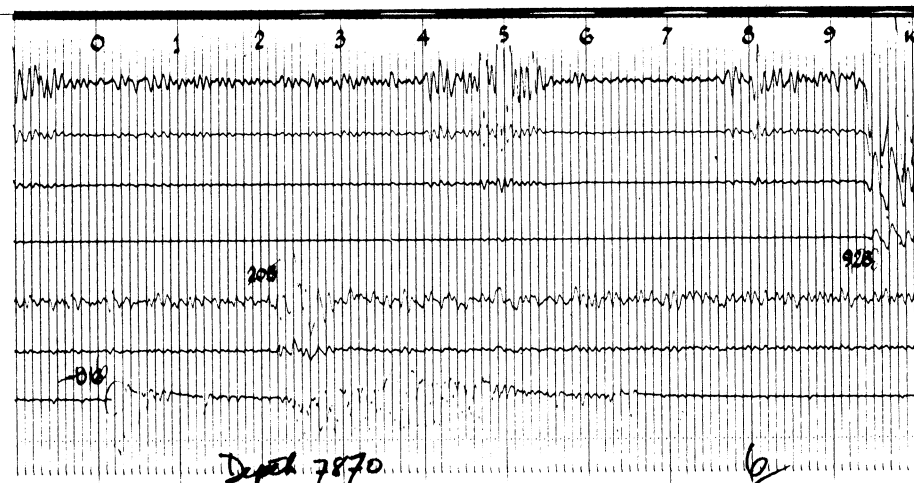
Depth: 7870' Below K.D.

25 lbs. @ 5'

Offset:

Time: 14:50 27-3-1967

BASS - 3



Shot No 7

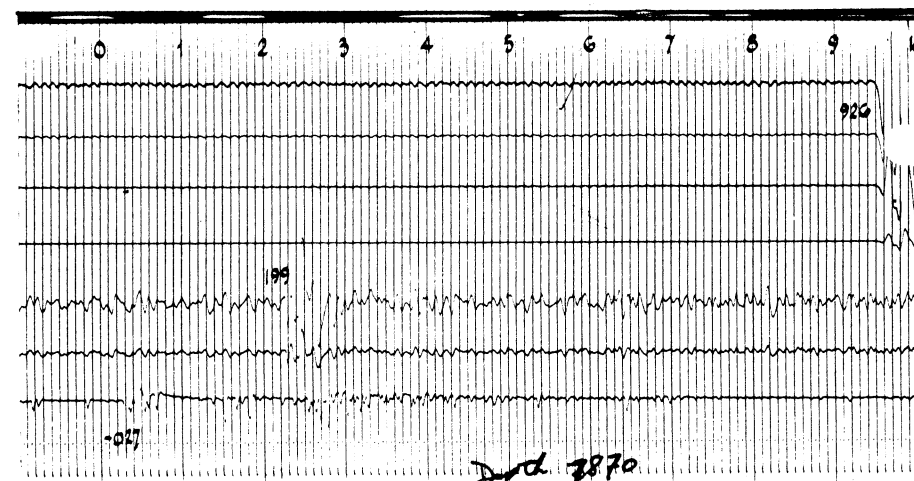
Depth: 7870' Below K.D.

25 lbs. @ 5'

Offset:

Time: 14:55 27-3-1967

BASS - 3





# ESSO BASS - 3

## WELL VELOCITY RECORDS

Shot No 8

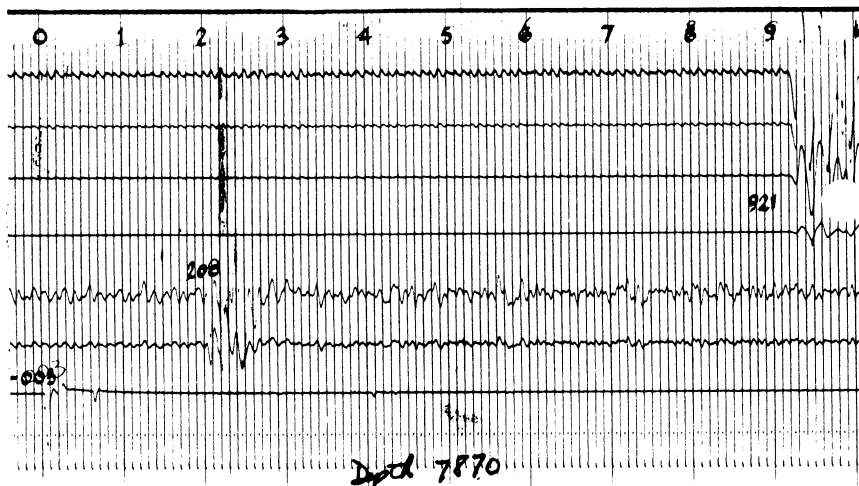
Depth: 7870' Below K.D.

25 lbs. @ 5'

Offset:

Time: 15:05 27-3-1967

BASS - 3



Shot No 9

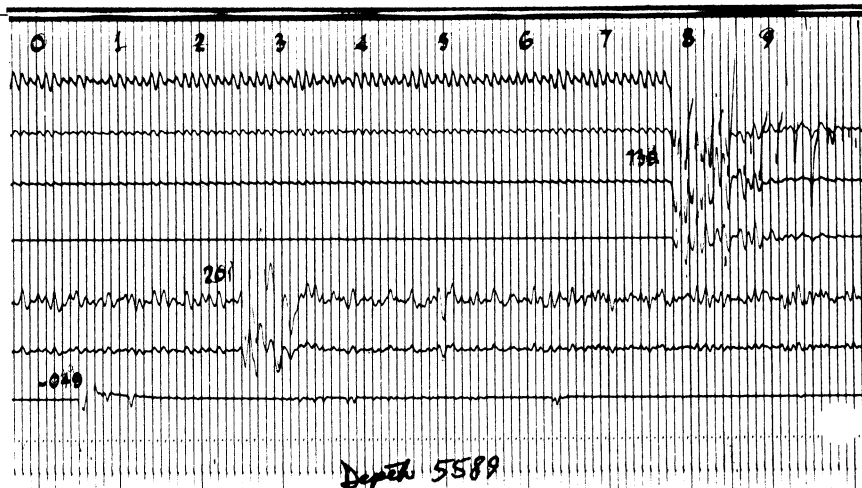
Depth: 5589' Below K.D.

25 lbs. @ 5'

Offset:

Time: 15:25 27-3-1967

BASS - 3



Shot No 10

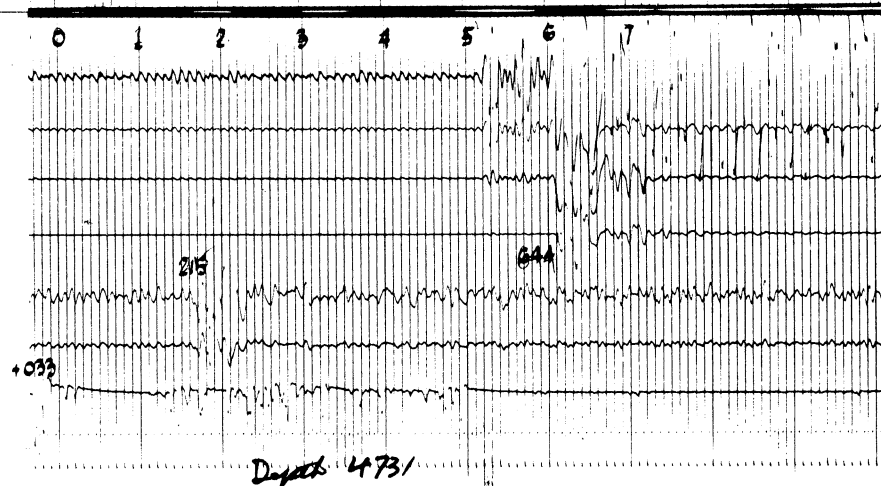
Depth: 4731' Below K.D.

25 lbs. @ 5'

Offset:

Time: 15:50 27-3-1967

BASS - 3



Shot No 11

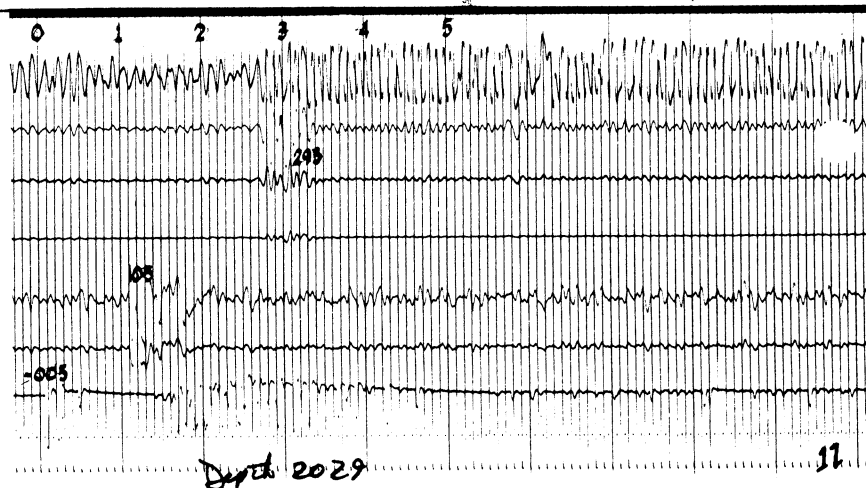
Depth: 2029' Below K.D.

25 lbs. @ 5'

Offset:

Time: 16:05 27-3-1967

BASS - 3



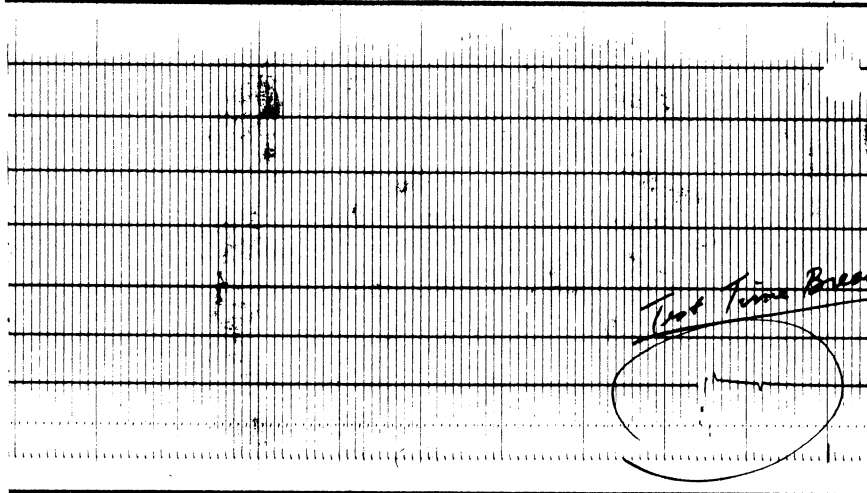
# ESSO BASS-3

WELL VELOCITY RECORDS

TIME BREAK TEST

27-3-67

BASS-3



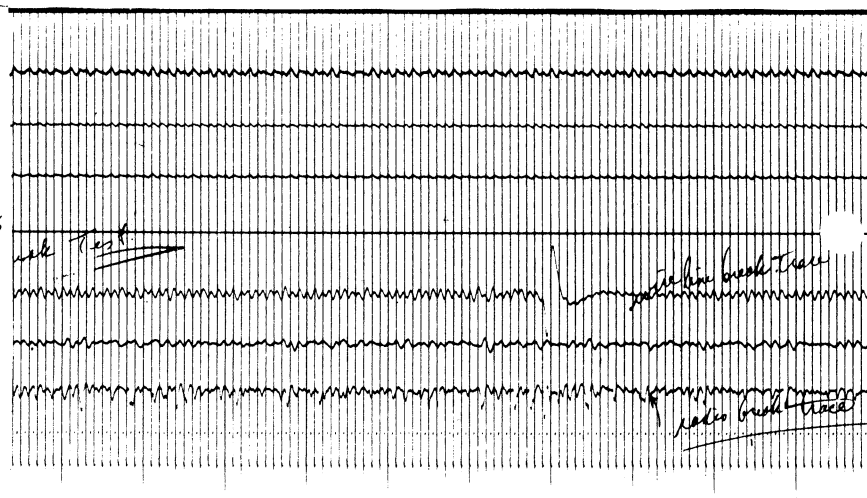
TIME BREAK TEST

27-3-67

Trace 7 - Radio T.B

Trace 5 - Wire line break  
through  
Amplifier

BASS-3

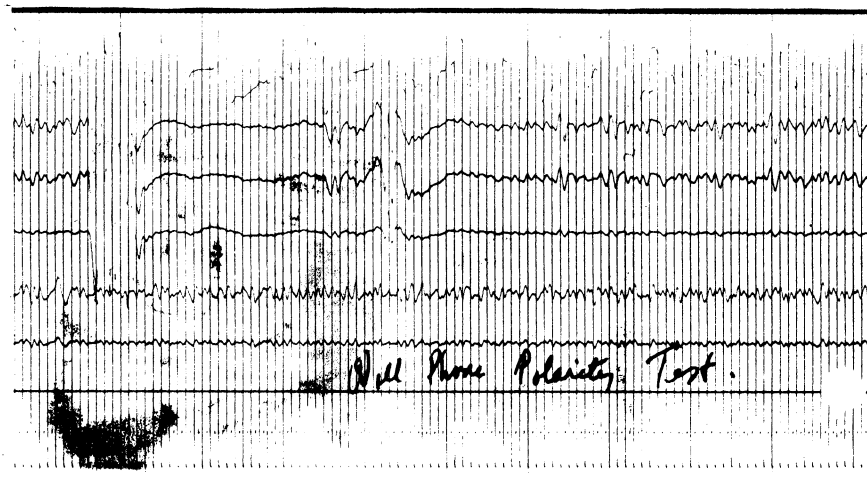


TAP TEST OF WELL  
PHONE FOR POLARITY

12:55 27/3/67

All Power still on  
on Rig.

BASS-3



APPENDIX 5.

24468

NOTE.—All communications on Departmental business to be Addressed to the Director of Mines, G.P.O., Box 1249, Hobart.



Department of Mines, Tasmania

Hobart, 18th April, 1967.

TELEPHONES:

303011

Chief Inspector of Mines  
Chief Inspector of Explosives  
Chief Geologist  
Secretary and Accountant  
Registrar of Mines  
General Office  
Director of Mines

B-4041, B-4042  
A-4043, A-4044

B 3138

✓ Copy in EB-3 321.3

14/4 { and Petrology file  
also copy to R. Hopkin

Mr. A. Phillips,  
ESSO Standard Australia Ltd.,  
G.P.O. Box 4249,  
SYDNEY, N.S.W.

Dear Sir,

We have cut a further three sections from Core 13 of Bass No. 3. These sections, when examined petrologically, consist of chert and disaggregated chert.

The spots on the slides you examined in Hobart have not been determined precisely but are considered to be possible cordierite. We could not detect any trace of volcanic material.

Yours faithfully,

(J.G. Symons)  
DIRECTOR OF MINES