WELL COMPLETION REPORT
FLAXMANS - 1

W466

86 Pages
+ ENCLOSURES.

FROME-BROKEN HILL COMPANY PTY. LTD.

Report No. 7200-G-85

WELL COMPLETION REPORT

FLAXMANS NO. 1

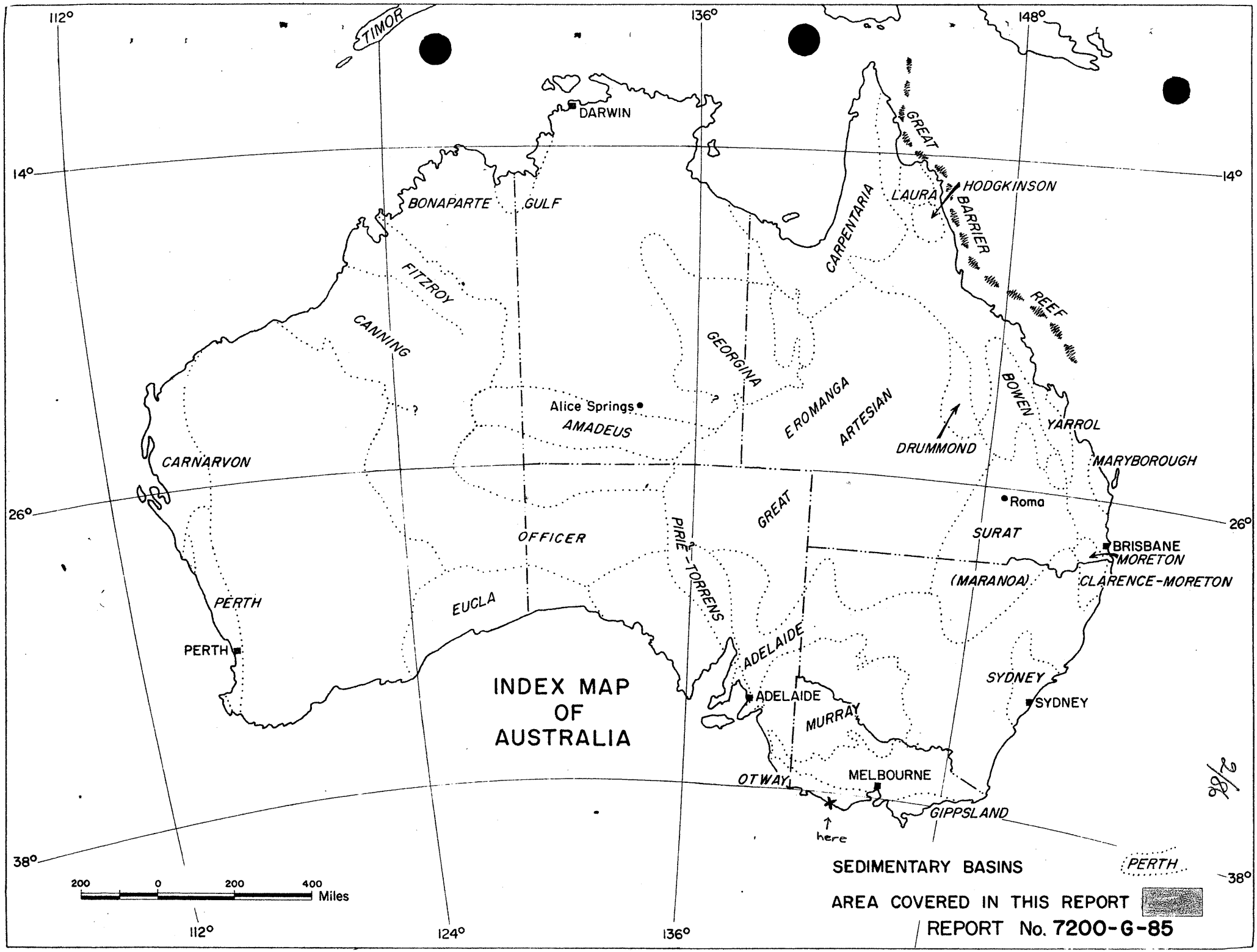
SOUTHWEST VICTORIA

by

J. S. Bain

Melbourne

December, 1961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PERTH
PERTH
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SYDNEY
OTWAY
MELBOURNE
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OF
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200 0 200 400 Miles
SEDIMENTARY BASINS
AREA COVERED IN THIS REPORT
REPORT No. 7200-G-85

3/86

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I SUMMARY

Flaxmans No. 1 well was drilled to a total depth of 11,528 feet within the southeastern part of the Otway Basin.

The well penetrated the Tertiary section and bottomed in sediments of the Otway Group, similar in lithology to those in outcrop sections within the Otway Ranges. The age of these sediments is still indefinite but they are generally regarded as Cretaceous-Jurassic. The lithology cut in the well is similar to that cut in the wells on the Port Campbell Structure and in particular Port Campbell No. 2.

It is apparent from this well that in the deeper part of the basin there are no unconformities between the Otway Group and intervening formations into the Belfast Mudstone. The Waarre Formation and Flaxmans Beds appear to be transitional members from the dominantly freshwater sediments deposited during Otway time into the marine Belfast Mudstone.

Free hydrocarbons evident in the Otway Group, are believed to have been derived from fractures within these sediments. On testing, free gas, up to 250 Mcf/day and some condensate was obtained, but production could not be sustained, and it was apparent that the fractures were a part of, or in communication with, a reservoir of only limited size. Whether the source of these hydrocarbons lies below the Otway is not known, but it would appear that the fractures are related to the extensive faulting within the deeper sediments in the area.

Other reservoirs tested in the well yielded only small amounts of petroliferous gas, probably from solution in formation water. Although this lack of production could be attributed to structural conditions it is also possible that the Flaxmans structure was formed under conditions unfavourable for the retention of hydrocarbons.

II INTRODUCTION

Flaxmans No. 1 was drilled by Frome-Broken Hill Company Pty. Ltd. to further evaluate the petroleum possibilities of the eastern part of the Otway Basin.

The well was located by seismic methods on the southernmost culmination on land of the Curdie Vale trend, a roughly northeast-southwest trending high, situated approximately eleven miles to the west of the previously drilled Port Campbell structure. The structure showed good east-west relief, and north dip into a normal fault on land. The amount of closure on the structure could not be estimated because closure to the south on deeper horizons under the sea could not be mapped. A marine seismic (gas gun) survey showed closure to the south in upper horizons, and it was inferred that there would be closure in the deeper horizons also.

The Commonwealth Government agreed to share the cost of drilling of all sediments penetrated below the base of the Tertiary section, that is from the top of the Paaratte Formation downwards.

III WELL HISTORY

1. General Data

(a) Well Name and Number

Flaxmans No. 1

(b) Location

2850 feet south 30° east from southwest corner of Allotment 50a, Parish of Nirranda, County of Heytesbury, State of Victoria.
Latitude: ~~38° 33'~~ 38 32 40 S Longitude: 142° 4' 6" 142 45 15 E.

E652 933·974
N5731 833·847

(c) Name and Address of Tenement Holder

Frome-Broken Hill Co. Pty. Ltd.,
53 Flemington Road,
NORTH MELBOURNE, N.1.

(d) Details of Petroleum Tenement

Petroleum Exploration Permit No. 5 issued by the State of Victoria.

(e) District

Southwest Victoria

(f) Total Depth

11,523 feet.

(g) Date Drilling Commenced

May 3, 1961

(h) Date Drilling Completed

August 25, 1961

(i) Date Well Suspended

November 8, 1961

(j) Date Rig Released

November 8, 1961

(k) Drilling Time in Days to Total Depth

115 days

(l) Elevation

Ground Level:	206 feet
Derrick Floor:	220 "
Rotary Table:	221 "
Kelly Bushing:	223 "

(m) Status

Well abandoned and cement plug dumped in the top of the $9\frac{5}{8}$" casing.
No casing recovered

(n) Cost of Well

Expenditure charged against Flaxmans No. 1 well operations in Frome's books to April 30, 1962. These figures do not include Melbourne office technical or administration costs.

Road construction, site preparation and clean-up	£3,499
Transport of material and personnel to and from site	20,263
Rigging up and rigging down (including rig holding rate)	11,302
Drilling contractor's charges (drilling, coring, running casing, testing and fishing)	126,065
Logging, perforating, etc.	30,536
Hire of equipment	5,687
Drilling fluid	7,886
Fuels	12,117
Casing	27,483
Bits and coreheads	16,010
Cement and parts	3,726
Miscellaneous spare parts, etc.	4,190
Technical supervision and laboratory operations at wellsite, including general field assistant accommodation, telephone, etc.	16,351
Depreciation - Motor vehicles and equipment	2,285
TOTAL :	£287,400

2. Drilling Data

(a) Name and Address of Drilling Contractors

Oil Drilling and Exploration Limited,
93 York Street,
Sydney, N.S.W.

(b) Drilling Plant

Make: National
Type: 55
Rated Capacity with $4\frac{1}{2}$" drill pipe - 10,000 feet
" " " $3\frac{1}{2}$" " " - 14,000 feet

Motors:

Make: Caterpillar
Type: D375
B.H.P.: 284

(c) Mast/Derrick

Make: Muskogee Standard Derrick
Type: 136' x 30' base
Rated Capacity: 800,000 lbs.

(d) Pumps

Make: Gardner-Denver
Type: GR-GXP
Size: $7\frac{3}{4}$" x 16"
Motors: Caterpillar D375

(e) Blowout Preventor Equipment

Make: Cameron (2) Q.R.C.
Size: 12"
Series: (A.P.I.) 900

(f) Hole Sizes and Depths

(1) (i) 25" hole to 76 feet
(ii) Drilled 17" hole from 76 to 1045 feet
(iii) Set $13\frac{3}{8}$" casing at 1038 feet

(2) $12\frac{1}{4}$" hole to 7000 feet
(i) Drilled $12\frac{1}{4}$" hole to 5546 feet
(ii) Drilled $8\frac{3}{4}$" hole to 7000 feet
(iii) Reamed $8\frac{3}{4}$" hole with $12\frac{1}{4}$" bit to 7000 feet
(iv) Set $9\frac{5}{8}$" casing at 6996 feet

(3) (i) Drilled $8\frac{3}{4}$" hole to 11,528 feet (T.D.)
(ii) Set $5\frac{1}{2}$" liner at 11,528 feet

(g) Casing and Liner Details:

Size:	$13\frac{3}{8}$"
Weight:	48 lb/foot
Grade:	H.40
Range:	2
Setting Depth:	1038 feet
Size:	$9\frac{5}{8}$"
Weight:	36 lb/foot
Grade:	J.55
Range:	2
Setting Depth:	6996 feet - 5 centralisers run
Size:	$5\frac{1}{2}$" liner
Weight:	17 lbs/foot
Grade:	N.80
Range:	2
Setting Depth:	6942 to 11,528 feet - 25 centralisers and scratchers run

(h) Casing and Liner Cementing Details

Size:	$13\frac{3}{8}$"
Setting Depth:	1038 feet
Quantity Cement Used:	591 sacks
Cemented to:	Surface
Method Used:	Single stage cementing with plugs by O.D.E. cementing truck
Size:	$9\frac{5}{8}$"
Setting Depth:	6996 feet
Quantity Cement Used:	1237 sacks. Later pumped 216 sacks to $9\frac{5}{8}$" - $13\frac{3}{8}$" annulus
Cemented to:	1180 feet (Temperature Log)
Method Used:	Single stage cementing with plugs by O.D.E. cementing truck.
Size:	$5\frac{1}{2}$" liner
Setting Depth:	11,528 feet. Top of liner 6942 feet
Quantity Cement Used:	1st stage: 203 sacks. 2nd stage: 1100 sacks
Cemented to:	1st stage: 10,842 to 10,262 feet (Temperature Log) 2nd stage: 9719 to 7906 feet (calculated top)
Method Used:	Two stage. 1st stage through drill pipe and casing float collar and pre-drilled holes at 10,842 to 10,844 feet. 2nd stage through perforations shot at 9719 to 9721 feet and 'K' Retainer set at 9695 feet with R.T. cementer set at 6954 feet on tubing. Both jobs circulated by O.D.E. cementing truck.

(i) Drilling Fluids

A water base Bentonite mud was used throughout the drilling of Flaxmans No. 1, the condition of the mud and its general characteristics being better in this well than in any of the previous wells drilled by Frome in the area.

To $9\frac{5}{8}$" casing point main additives were water, caustic soda, myrtan and minor amounts of C.M.C. and American Driscose. Mud properties were as follows:-

Weight	10-11 lbs/gal - mainly 10 lbs towards 6996 feet
Viscosity	32-70 secs. and 40-50 secs. towards 6996 feet
Water Loss	15-30 cc and 10-15 cc towards 6996 feet
Filter Cake	3-4/32" and approximately 2/32" towards 6996 feet
pH	8 to 9
Sand Content	Up to 7% in Wangerrip Group. Below this 1% to 3%

After setting of $9\frac{5}{8}$" casing and drilling out cement the old mud was dumped and new bentonite mud mixed. Additives were the same, and from this point to 11,388 feet characteristics were as below:

Weight	9 to 10 lb/gal.
Viscosity	32 to 50 secs.
Water Loss	11 to 17 cc and below 7500 feet 8 to 11 cc
Filter Cake	2/32"
pH	8 to 9
Sand Content	$\frac{1}{2}$ to 1%

Barytes was added at 11,388 feet to control gas cutting of the mud, the weight being brought from 10 lbs/gal up to 11.3 to 11.5 lbs/gal for the remainder of the hole to T.D. Other properties remained unchanged.

It was apparent from this well that a freshwater base mud can be used with good results in the section to be expected in the Otway Basin. Periodic cleaning out and by-passing of the tanks enabled the sand content and inert solids (and hence weight) to be kept as low as possible, so as not to hinder penetration. Water loss, the main problem in previous wells, was reduced below 7,500 feet generally to less than 10 cc in this well (probably about as low as a freshwater mud will tolerate), by judicial use of bentonite, and C.M.C. Viscosity was never a problem and was kept low by water, myrtan and caustic.

(j) Water Supply

Water was pumped to the well from a lake in a sinkhole about ½ mile from the rig and stored in a 20,000 gallon tank on site. Salinity of this water was 2000 to 3000 ppm chlorides.

(k) Perforation and Shooting Record (See Plate No. 6)

Casing Perforation

(a) For Testing

1.	First Zone	11,341	to	11,351	feet
		11,230	to	11,236	"
		11,219	to	11,225	"
		11,178	to	11,184	"
		11,090	to	11,096	"
		10,949	to	10,959	"
		10,922	to	10,928	"
	and later	11,380	to	11,386	"
		11,366	to	11,372	"
		10,837	to	10,847	"
2.	Second Zone	10,120	to	10,130	"
		10,000	to	10,010	"
		9,900	to	9,910	"
		9,780	to	9,790	"
		9,720	to	9,730	"
3.		9,240	to	9,258	"
4.		8,518	to	8,528	"
		8,462	to	8,480	"
5.		6,875	to	6,881	"

(b) For Cementing Purposes

1.	10,842	to	10,844	feet	(pre-drilled holes in casing)
2.	9,719	to	9,721	"	
3.	6,891	to	6,892	"	

Perforations except for (b) 1 above, were made with Schlumberger 4" and 3" shaped charge guns at a density of 4 shots per foot.

No open hole shooting was undertaken.

(l) Plugging Back and Squeeze Cementation Jobs (See Plate No. 6)

In conjunction with primary cementing:

(a) K Retainer set at 9695 feet. This was later drilled out.

In conjunction with testing:

(a) K. Retainer set at 10,500 feet as a bridge plug.
(b) K. Retainer set at 8,300 feet as a bridge plug.
(c) Attempt squeeze through perforations at 6891 to 6892 feet without being able to break formation down.
(d) Spot 46 sack plug from 6792 to 6942 feet.
(e) Spot 50 sack plug from 150 feet to surface.

(m) Fishing Operations

(i) At total depth of 2827 feet.
Lost one cone off bit. Ran a junk basket unsuccessfully in an attempt to pick up the cone. Drilled and broke up cone with a Security H7W bit. Continued drilling ahead without further trouble.

(ii) At total depth of 6881 feet
Lost core catcher out of Hughes core barrel. Drilled and broke up catcher with hard formation bit and recovered junk in a junk sub. Cored ahead.

(iii) At total depth of 11,081 feet
Lost cone off bit. Drilled and broke up cone with hard formation bit and caught steel in junk sub. Cored ahead.

(iv) At total depth of 11,235 feet.
After running an electric log, Schlumberger stopped in the open hole at 8115 feet to check the camera. On attempting to move the electric log sonde was found to be stuck. Ran side door overshot on drill pipe and recovered logging sonde.

(v) At total depth of 11,528 feet
After setting $5\frac{1}{2}$" liner and carrying out second stage cementing from 9720 feet. On circulating cement through R.T. cementer set at 6954 feet, 'K' Retainer set at 9695 feet and perforations 9719 to 9721 feet, the R.T. cementer came loose and was cemented into the top of the $5\frac{1}{2}$" liner. Also found 3511 feet of tubing plus R.T. cementer, 290 feet of $9\frac{5}{8}$" casing plus the whole of the $5\frac{1}{2}$" casing down to 9721 feet filled with cement. Backed off 54 stands of tubing (48 full of cement).

Ran tubing overshot and backed off and recovered 56 joints of tubing. Remainder of tubing was cemented in the $9\frac{5}{8}$" casing. Attempted run $5\frac{1}{2}$" washover string without success as tubing not centred in the hole. Washed over tubing with $7\frac{5}{8}$" Hydril washover pipe to 6933 feet. On tripping to change washover shoe, washover string stuck at 6880 feet. Spotted 22 bbls. diesel without success, and with aid of Schlumberger string shot backed off at 6529 feet. Made back up to fish with jars and sixteen $6\frac{1}{2}$" drill collars and jarred washover string loose. Bottom joint of wash pipe and shoe filled with mashed tubing.

Washed over again with 7⅝" wash pipe to 6941 feet. Shoe appeared to be working on top of the liner sub. Attempted pick up remainder of fish with overshot with 3 1/16" and 2⅜" grapples without success. Attempted pick up fish with 5⅜" Bowen overshot with 3½" grapples and mill guide with 7" bell skirt. Overshot parted above bowl.

After several attempts with 7" overshot managed to recover 5⅜" overshot as well as slips and outer barrel of circulating joint which was on top of the R.T. cementer.

Attempted recover junk with a fabricated reverse circulation basket, with Johnston tester breaker sub in string. This was not successful due to sub and jars becoming blocked with junk.

Fabricated ten foot junk sub from 3½" D.P. and 7" casing and ran this above a made up piece of 5½" washover (salvaged from casing) with coarse hard faced mill teeth on the bottom. Also ran normal junk sub between these two fabricated pieces. Circulated with both pumps and washed over to top of liner. Recovered both junk subs full of iron.

Attempted mill and break off the mandrel to top of liner with 8½" Servco mill without success. Ran magnetic junk basket on wire line and recovered more metal but magnet hitting the top of the fish.

Fabricated a washover mill from a 12-foot length of 4½" D.P. and milled and washed over to 6949 feet with junk subs in string. Recovered more metal including parts of the R.T. cementer. Made three runs with 3⅞" overshot and retrieved the cementer less slips, centralizers and bottom portion of tool.

Built up 4¾" bit with hard facing and ran it as a flat bottom mill and milled to 6953 feet but the remainder of tool appeared to be turning in the casing with the mill. Attempted mill again with W7R and 4½" drill collars, again without much success.

Fabricated another longer length of 4½" drill pipe into a washover mill and milled to 6956 feet. Attempted pick up remainder of fish without success. Fabricated a 3' x 3½" O.D. junk sub around a short 3½" drill collar with a 4¾" bit in the end with one cone cut off. Picked up the remainder of the junk in this sub. Drilled ahead normally in the 5½" liner until all the cement and the K. Retainer at 9695 feet had been drilled out.

(n) Side-tracked Hole

None

3. Logging and Testing

(a) Ditch Cuttings

Cuttings were taken over a normal shale shaker. Interval sampled was every 10 feet to total depth, with bottom hole circulated samples at various depths.

(b) Coring (See Appendix 3 for core descriptions.)

Original coring program outlined cores to be taken on the occurrence of hydrocarbon shows, at lithologic changes, and at drilling breaks. In addition, Commonwealth Government Subsidy agreement stipulated routine cores to be taken at 200 foot intervals, this interval being extended to 500 feet for drilling within a section of uniform lithology.

Forty-four cores were taken altogether for a total footage of 538 feet 6 inches. Recovery was 379 feet 7 inches, or 70%.

Thirtyfive $3\frac{1}{2}$" diameter cores were cut with a conventional Hughes Type J barrel with total footage of 474 feet. Recovery was 339 feet 10 inches or 72%. Both $8\frac{3}{4}$" and $7\frac{7}{8}$" hard and soft core heads were used.

Nine cores were taken with Reed PDD-BR wire line coring equipment. Total footage cut with this equipment was 64 feet 6 inches for a recovery of 39 feet 9 inches or 61%. Diameter of core recovered was approximately $1\frac{1}{2}$" and maximum length 10 feet for each core.

(c) Side Wall Sampling

No sidewall cores were attempted in Flaxmans No. 1 well.

(d) Electrical and Other Logging

Logging was carried out by Schlumberger Seaco Inc., permanent site engineer being Mr. John White. Logs run were as follows:

Electric Logs			Laterologs		
1,038	to	2,819 feet	1,038	to	2,816 feet
2,619	to	4,362 "	2,610	to	4,357 "
4,162	to	6,344 "	4,157	to	5,390 "
6,143	to	6,903 "	5,190	to	6,335 "
6,702	to	6,989 "	6,135	to	6,900 "
6,996	to	9,449 "	6,699	to	6,984 "
9,249	to	11,231 "	6,994,	to	7,658 "
10,050	to	11,518 "	7,456	to	9,447 "
			9,247	to	11,514 "

Micrologs

1,038 to 2,815 feet
2,615 to 4,357 "
4,157 to 5,391 "
5,190 to 6,343 "
6,140 to 6,900 "
6,140 to 6,986 "
7,660 to 6,994 "
6,994 to 8,135 "
7,934 to 9,446 "
9,242 to 11,520 "

Continuous Dipmeter

5,700 to 3,734 feet
4,700 to 3,550 "
5,704 to 3,752 "
5,238 to 3,550 "
10,694 to 6,992 "

Temperature Logs

Surface to 6546 feet
9,950 to 10,326 "

Sonic Log

6,994 to 10,121 feet

Cement Bond Log

1,000 to 6,996 feet

Gamma Ray - Casing Collar Log

4,500 to 7,500 feet

Scales of all the logs run except the Continuous Dipmeter were 1" = 100 feet and 5" = 100 feet. The Continuous Dipmeter was run at scales of 1" = 100 feet and 1" = 2 feet.

(e) Drilling Time Log

A Geolograph Continuous Time Depth Recorder was used during the drilling of Flaxmans No. 1, which recorded the time taken for each foot penetrated. A Drilling Time Log was drawn up from the Geolograph charts and is included in the Composite Log.

(f) Formation Testing

(For details see Appendix No. 4)

Open Hole Testing

D.S.T. Nos. 1, 4 and 5 were carried out using a Johnston $7\frac{7}{8}$" - 9" Type X open hole packer.

D.S.T. Nos. 2 and 3 were carried out using two Johnston $7\frac{7}{8}$" - 9" Type X open hole packers.

D.S.T. No. 1	5347 to 5396 feet	Packer failed to hold.
D.S.T. No. 2	5356 to 5396 feet	Packer seat failed after 16 minutes. Recovered gas-cut water.
D.S.T. No. 3	6891 to 6913 feet	Recovered gas-cut water.
D.S.T. No. 4	8103 to 8139 feet	Recovered drilling mud. Zone tight and impermeable.
D.S.T. No. 5	10898 to 10974 feet	Packer failed to hold.

Intervals Tested Through Casing

D.S.T. Nos. 6 through 16 were carried out with a 5½" Lane Wells (Johnston) B.O.E. 6 casing hookwall packer.

Production Tests Nos. 1 through 5 were carried out with a 5½" Guiberson K.V. 30 production packer.

Production Tests Nos. 6 through 10 were carried out with a 5½" Halliburton R.T.T.S. packer.

Note: After Production Test No. 5 - the fluid in the hole was displaced with a saturated brine solution and all the following tests were carried out using this salt water.

D.S.T. No. 6	10,842 to 11,528 feet		Recovered free gas until packer failed.
Production Test No. 1	10,842 to 11,528	"	Produced free petroliferous gas. Maximum flow rate approximately 250 MCF/day with a small amount of condensate of 51.2° A.P.I. Gravity @ 60°F. No formation water.
Production Test No. 2	10,842 to 11,528	"	Swabbed to 9500 feet without fluid rise when sand line broke and test pulled.
Production Test No. 3	10,842 to 11,528	"	Swabbed to 7700 feet without fluid rise. Test pulled.
Production Test No. 4	10,842 to 11,528	"	Swabbed to 7425 feet without fluid rise. Test pulled.
Production Test No. 5	10,842 to 11,528	"	Swabbed to 10,725 feet. No fluid rise. Test pulled.
Production Test No. 6	10,837 to 11,528	"	Swabbed 62 bbls water. Packer not holding.
Production Test No. 7	10,837 to 11,528	"	Swabbed 11.5 bbls Tubing leak. Test pulled.

Production Test No. 8	10,837 to 11,528 feet		Swabbed 14 bbls Packer not holding.
D.S.T. No. 7	10,837 to 11,528	"	Tubing leak, string full of fluid from annulus and disc not broken.
D.S.T. No. 8	10,837 to 11,528	"	Swabbed 9½ bbls very slightly gas-cut water. Swab line broke. Pulled test.
Production Test No. 9	10,837 to 11,528	"	Swabbed 27 bbls water when swab line broke. No fluid rise.
D.S.T. No. 9	9,720 to 10,130	"	Recovered 3000 feet gas-cut mud.
Production Test No. 10	9,720 to 10,130	"	Swabbed 4½ bbls Packer not holding.
D.S.T. No. 10	9,720 to 10,130	"	Test showed zone to be dry.
D.S.T. No. 11	9,240 to 9,258	"	Tubing leaked. No formation fluid recovered.
D.S.T. No. 12	9,240 to 9,258	"	Tubing leaked. Pulled test.
D.S.T. No. 13	9,240 to 9,258	"	Recovered slightly gas-cut water.
D.S.T. No. 14	8,518 to 8,528 8,462 to 8,480	" "	Recovered gas-cut water and a little wax in tail pipe before packer failed.
D.S.T. No. 15	8,518 to 8,528 8,462 to 8,480	" "	Recovered slightly gas-cut water.
D.S.T. No. 16	6,875 to 6,881	"	Recovered gas-cut formation water.

(g) Deviation Surveys

(See Appendix No. 6 for details)

Deviation surveys were carried out with the Totco instrument and in conjunction with the Schlumberger Continuous Dipmeter runs.

In general, deviation was up to 1° to 4000 feet, 2° to 6500 feet, from 1° to 3° to 10,000 feet and increased from 4° to 7° below 10,000 feet to total depth.

Azimuth of deviation was shown from the Continuous Dipmeter to be all towards the southern quadrant (i.e. between southeast and southwest) confirming previous ideas of a north dip being present over the structure.

(h) Temperature Surveys

Temperature surveys were carried out after cementing both the $9\frac{5}{8}$" and $5\frac{1}{2}$" casing strings to determine the cement top behind the casing. Top of the cement behind the $9\frac{5}{8}$" casing was found to be at 1180 feet with good cement from 1180 to 3260 feet and channelled cement from 3260 to 4460 feet. From 4460 to 6546 feet, the condition of the cement is not determinable from the log.

The second Temperature Log was run after the first stage cementing of the $5\frac{1}{2}$" liner from 10,326 feet and determined the cement top at 10,262 feet.

Bottom hole temperature was 228°F at 11,518 feet.

(i) Other Well Surveys

Two well geophone velocity surveys were run in conjunction with the Robert H. Ray seismic party operating in the area. The first at total depth of 7000 feet and the second at total depth of 10,000 feet. Shots were taken at formation breaks and at selected intervals in the open hole. On the second run, the survey was made in conjunction with the Sonic Log.

IV GEOLOGY

1. Summary of Previous Work

(a) Geological

Since the drilling of Port Campbell Nos. 2 and 3 Wells no further surface geological work has been done in the eastern part of the Otway Basin. However, Weegar (4) has carried out photogeological studies of the area to the west of the Flaxmans structure in the east-central part of the basin, and he has recognised certain physiographic units in which drainage and linear patterns are dominant in each, with anomalies inferred to be related to subsurface structure. It is also suggested by Weegar that the Mesozoic and Tertiary subsurface structures are related to pre-established Palaeozoic primary compressional structures, and that these former structures have been highly modified by Mesozoic faults which probably occurred along Palaeozoic shear trends.

(b) Geophysical

Robert H. Ray contract seismic party continued work within the basin shooting westward from Port Campbell to Warrnambool. During this work the Flaxmans structure was delineated. This

structure was further delineated by a marine seismic (gas gun) survey along the coast between Port Campbell and Warrnambool.

This seismic mapping indicated the Curdie Vale trend, a roughly northeast-southwest trending high with good east-west relief cut by numerous faults, the dominant ones at right angles to the trend. The southernmost culmination on land along this trend at Flaxmans Hill had evidence of some north dip into a fault in the deeper horizons, and similar shallower dip on the upper horizons. The marine seismic survey showed south plunge to be present along this axis in the shallow horizons, but unfortunately no reflections were obtained from the deeper horizons. However, as the deeper horizons on land usually conform to the shallow horizons, structural closure on these deeper horizons was inferred out to sea to the south. Thus the amount of closure on the deeper horizons could not be determined, and the structure is possibly further complicated by faulting in these horizons out to sea.

(c) Drilling

Since the drilling of Port Campbell No. 2, Frome drilled a non-subsidised well on the Port Campbell structure without obtaining any commercial production. This well, Port Campbell No. 3, cut a fault in the lower part of the well and bottomed in sediments on the upthrown side of this roughly east-west trending down-to-the-south fault. The section in this well was very similar to that cut in Port Campbell No. 1, with the exception that the Belfast Mudstone appeared a little more sandy and the Waarre Formation was cleaner in No. 3 than in No. 2.

Two further features were apparent from the No. 3 well, viz: there did not appear to be any unconformity between the Otway Group and the Waarre Formation, and Otway Group sediments tested some free petroliferous gas with formation water of a fair salinity. This accumulation of fluids may have been associated with the faulting, but in general upgraded Otway Group possibilities for oil and gas.

The Mines Department of Victoria drilled two water wells at Warrnambool confirming the seismic interpretation of the Warrnambool high in which very little Belfast Mudstone and no Waarre Formation was present above Otway Group sediments.

2. Stratigraphy

The lithology of the section cut in Flaxmans No. 1 well was similar to that of the Port Campbell structure, formation correlations being made without undue difficulty.

The section is generalised as follows:-

Surface to 2008 feet	Heytesbury Group
Surface to 520 feet	Limestone, yellow-tan to light grey, very fossiliferous, fragmentary, porous.
520 to 2008 "	Dominantly medium to blue grey, very fossiliferous, argillaceous, puggy marl, with some glauconite and becoming silty towards base. Sandy limestone marker bed 1685 - 1703 feet and thin sand and limestone members towards base of interval.
2008 to 4833 "	Wangerrip Group Dominantly medium to coarse grained light grey quartz sand and sandstone with interbedded medium to dark grey micaceous siltstones. Some gravels and conglomerates are present and thin stringers of ankerite towards the base. Dark green, soft glauconitic mudstone 2100 to 2213 feet.
4833 to 5570 "	Paaratte Formation Transition zone consisting of medium to dark grey micaceous and carbonaceous siltstones and mudstones interbedded with light grey, fine to coarse grained quartz sandstones. Ankerite concretions present, and some of the siltstones are glauconitic.
5570 to 6490 "	Belfast Mudstone Dark grey, dense, micaceous, glauconitic mudstones, very fossiliferous and also some plant remains. Ankerite concretions and stringers.
6490 to 6876 feet	Flaxmans Beds Limonitic sandstones and chloritic greywackes, brown and greenish-brown with abundant limonitic pellets and chlorite and minor quartz grains. Silty and chloritic matrix. Some pyrite and a little glauconite and carbonaceous material.

6876 to 7330 feet — Waarre Formation

Light grey, fine to very coarse clean, porous quartz sandstones up to conglomerates in places, interbedded with dark grey carbonaceous and micaceous pyritic siltstones and mudstones.
Coal band 7246 to 7270 feet. Sandstone becomes dirtier, with increasing percentage of feldspar and rock fragments and less quartz towards the base.

7330 to 11,528 " — Otway Group

Greenish-grey feldspathic sandstones and sub-greywackes with interbedded grey to dark grey carbonaceous and micaceous mudstones and siltstones. Sandstone generally tight and usually fine grained. Coal fragments present. Distinctive orange zeolite (Heulandite) in sandstone from 7680 to 7850 feet.

A correlation between Port Campbell Nos. 2 and 3 and Flaxmans No. 1 is summarised below. Figures in brackets refer to the depths of the various horizons below sea level. (All depths in feet).

	Flaxmans 1	Pt.Campbell 2	Pt.Campbell 3
Thickness of Heytesbury Group	1993	1214	1519
Top of Wangerrip Group	2008 (-1787)	1230 (-948)	1534 (-1324)
Thickness of Wangerrip Group	2825	3770	2369
Top of Paaratte Formation	4833 (-4612)	5000 (-4718)	3913 (-3703)
Thickness of Paaratte Formation	737	810	317
Top of Belfast Mudstone	5570 (-5349)	5810 (-5528)	4230 (-4020)
Thickness of Belfast Mudstone	920	2100	378
Top of Flaxmans Beds	6490 (-6269)	7910 (-7628)	Not present
Thickness of Flaxmans Beds	386	200	-
Top of Waarre Formation	6876 (-6655)	8110 (-7828	4608 (-4398)
Thickness of Waarre Formation	454	404	202
Top of Otway Group	7330 (-7109)	8514 (-8232)	4810 (-4600)
Thickness of Otway Group	4198 +	332 +	722 +

The limestone section within the Heytesbury Group from surface to 520 feet is equivalent to that from surface to 290 feet in Port Campbell No. 3 and would probably correlate with Baker's (3) Port Campbell limestone member. This unit obviously thickens towards the west from the Port Campbell structure. Sediments down to the Flaxmans Beds are very similar to those occurring in Port Campbell No. 2 except that they are somewhat thinner.

The Flaxmans Beds in Flaxmans No. 1 have been determined by petrologic means as chloritic and very limonitic greywackes and sandstones, and are equivalent to the section from 7910 to 8100 feet (later called Flaxmans Beds) in Port Campbell No. 2. It is suggested that these sediments are more allied to the Belfast Mudstone rather than the Waarre Formation.

It also appears that in Flaxmans No. 1 there are no recognisable unconformities between the Otway Group and intervening formations up into the Belfast Mudstone. As mentioned previously (Port Campbell No. 3) the Waarre sediments grade downwards into typical Otway Group lithology, the top of the Otway being fairly hard to pick, as it is dependent upon the relative proportions of quartz, feldspar and rock fragments in the sediments. The Waarre-Flaxmans contact is picked mainly at the occurrence of the first clean coarse quartz sandstone below the Flaxmans Beds. However, fragments of this sandstone are noted within the Flaxmans Beds and no abrupt change is present in this well. Similarly, the Flaxmans-Belfast contact appears somewhat gradational and on this basis no unconformity has been postulated between the above units in Flaxmans No. 1. Certainly seismic work has shown that equivalents of these sediments are deeper in other areas but it is inferred that the units themselves probably thicken rather than that any new formation is present.

Although Otway Group sediments have not yet definitely been proved to be either of a marine or freshwater nature, it is considered that, if the latter is the case, the Waarre Formation and Flaxmans Beds are indicative of transition into the wholly marine sediments of the Belfast Mudstone. Throughout this interval, dips from cores and dipmeter survey, were generally not at great variance in magnitude and direction and there does not appear to be much angularity between these formations.

Unfortunately, no formation water was obtained from tests within the Otway Group but from the S.P. and Resistivity logs it appears that the connate water is fresher in these sediments than in the Waarre sands, and the nature of the above referred transition is further enhanced.

3. STRUCTURE

As mentioned under Geophysics in the summary "Previous Work", the Flaxmans structure has good east-west relief, north dip into a fault on land, but only inferred south plunge along the axis to the south in the deeper horizons. Consequently closure on these deeper horizons could not be determined.

Dips seen in cores range from 3 to 5 degrees above the Waarre Formation. In Waarre and Otway sections dips of 10° to 20° were common and, although cross bedding was sometimes present, the continued recurrence of similar magnitudes of dips are assumed to be representative of true dip. Recorded dips higher than 20° may be associated with faulting. Three runs were made with the Continuous Dipmeter and dip

values determined from these surveys were nearly always somewhat higher than core dips. Direction of dip determined from these surveys was, with only one exception, towards the north quadrant, i.e. between northwest and northeast. This was further confirmed by the deviation of the hole, which was in all cases towards the southern quadrant. From the above results it appeared that the well was probably situated a little to the north of the crest of the structure, as was evident from the north dip on the seismic sections. Cores within the Otway Group showed evidence of fracturing and some minor faulting and although no large scale fault appeared to be penetrated, it may be that the well was in close proximity to a major fault.

4. RELEVANCE TO OCCURRENCE OF PETROLEUM

Testing in Flaxmans No. 1 showed the Waarre and Paaratte sands to be water saturated with some minor dissolved gas and, although the gas was wet, there was no appreciable production from these zones. One Waarre core (No. 25) exhibited fluorescence and hydrocarbon odour but this was probably associated with the dissolved gas.

Three cores within the Otway Group (Nos. 28, 34 and 43) exhibited fluorescence and gave fairly good cuts with solvents. Core No. 43 had a thin slicken sided calcite surface on the top of the core with oil stained quartz crystals within a vugh on this surface. Similar oil-stained quartz crystals were seen in the cuttings from 10,928 feet and were probably also associated with calcite in vughs. Most of the cores within the Otway Group were tight and had no effective permeability apart from fractures. The strong gas flow noted while drilling at 11,388 feet was assumed to come from fracture porosity. Fractures with calcite in-filling were present in the lower Otway Group sediments and often associated with intervals from which gas was indicated on the gas detector. The fractured nature of this reservoir was substantiated by Core No. 43 as mentioned above.

On test, the lower zone from 10,842 to 11,528 feet, yielded free petroliferous gas with a small amount of 51.2° A.P.I. condensate. Preliminary flow tests indicated a volume of approximately 250 Mcfd of gas. However, flow pressures on this zone decreased to zero during extended flow periods and an accurate estimate of volume was not possible. Surface shut in pressures on this zone in the early stages of testing also decreased from 1425 psi to 900 psi over a period of five days; build up also taking longer towards the end of this period. Unfortunately, no bottom hole pressures were obtained for this test, but the surface pressures and later testing enabled a fair deduction to be made regarding the zone's possibilities. From the tests, it was deduced that the fractures within the interval 10,842 to 11,528 feet were a part of, or in communication with, a reservoir of only very limited size.

Other tests carried out within the Otway Group yielded a slight amount of solution gas, but no appreciable formation water, and confirmed views that sands within the Otway Group in Flaxmans No. 1 were tight and unproductive.

The reason for the Waarre sands (the best reservoir) not producing any hydrocarbons other than solution gas is still not apparent. Possibly

the structure was not closed in these sediments towards the south and the reservoir at Flaxmans was depleted.

5. Porosity and Permeability of Sediments Penetrated

Porosity and permeability were estimated qualitatively at the well-site from cuttings and cores and for electric log analyses were calculated quantitatively from both the Microlog and Sonic Log. Some selected cores were also analysed quantitatively.

In general the Otway sands showed low porosity and no effective permeability as is shown by the following core analyses.

Core No. & Depth.	Effective Porosity %	Permeability (Millidarcies)	Saturation (% porosity) Water	Oil
No. 28 (7473-7493')	15.4	less than 0.2	57	7.5
No. 34 (8470-8486')	16.7	" " 0.2	68	3
No. 39 (10,122-10,134')	11.0	" " 0.1	49	NIL

The tight nature of the Otway sands was further confirmed on testing.

As regards the Waarre sands, they appeared generally to be dirtier than their equivalents in the Port Campbell area and this was confirmed by analyses on Core No. 25 which showed a porosity of 22.1 to 22.9% and permeabilities varying from 126 to 139 millidarcies horizontal and 112 to 250 millidarcies vertical. This is in marked contrast to the 23.6% porosity and 4840 millidarcies permeability evident within the Waarre sands in Port Campbell No. 3. It is probable that the reason for the dirtier nature of the sands at Flaxmans as compared with the Port Campbell area, is that these sands were laid down a little further offshore and under deeper conditions.

The Paaratte Formation and Wangerrip Group contained sands with porosities and permeabilities similar to their equivalents in the Port Campbell area.

6. Contribution to Geological Concepts Resulting from Drilling

Flaxmans No. 1 well added considerably to our knowledge of the geology of the basin as a whole.

Firstly, the Belfast Mudstone and Waarre Formation were found to have a fairly wide areal extent in the eastern part of the basin from Port Campbell to Warrnambool. It is also apparent that the Flaxmans Beds are present in the deeper part of the basin separating the Waarre Formation from the Belfast Mudstone. As mentioned under Stratigraphy, it appears that no major unconformities are present from the Otway Group through the Waarre Formation and Flaxmans Beds up into the Belfast Mudstone in the Flaxmans No. 1 well.

It had been thought from evidence from Port Campbell No. 3 that the

Waarre-Otway contact was transitional and this was further evident in this well. The Waarre Formation is dirtier in the Flaxmans area than in the Port Campbell area. The Flaxmans Beds had a few fragments of the clean light grey Waarre Sandstone within them, and also appeared to become more allied to the Belfast Mudstone in the upper beds. Although the depositional environment of the Otway is still not definitely known it seems that, if it is of a fresh water nature as is generally supposed, the Waarre Formation and the Flaxmans Beds probably represent alternating freshwater and marine conditions up into the wholly marine Belfast Mudstone deposition.

It is apparent that the Otway Group sediments in the deeper part of the basin are not as attractive as reservoirs as where the Otway is relatively high. This feature is substantiated by the tight and dirty nature of the sands at Flaxmans compared to some of the sands in the Otway on the Port Campbell structure and also from bores on the Warrnambool high.

Regarding source rocks within the eastern part of the basin, the Belfast Mudstone still appears to be the best seen so far in this regard. None of the Otway Group sediments in Flaxmans No. 1 appear to be likely source rocks lithologically and if they are also of a freshwater nature their chances as sources are further decreased.

The source of the petroliferous gas, recovered from the bottom part of the hole, is not known. As this gas appeared to be wholly within a fracture reservoir of very limited extent and in rocks of very low permeability it may be evidence of the existence of some larger reservoir, either below the Otway Group at this location or in more favourable conditions laterally in the Otway Group itself. As only minor shows occur in the Otway Group except where fracturing occurs it would appear that the former is the more likely as these fractures are probably related to the known faulting within the deeper sediments of the basin, and obviously this faulting plays a major role in the disposition of petroleum accumulations in the area. The source of these hydrocarbons could also possibly be younger sediments downfaulted to be contiguous to the Otway section.

Melbourne

December, 1961

J. S. Bain

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FLAXMANS - 1

APPENDIX NO. 1.

PALAEONTOLOGICAL REPORTS

by

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Report

on the examination of foraminifera and other fossils from the Port Campbell and Flaxman Hill bores (Victoria)

By M. F. Glaessner

Samples from 46 cores from three bores at Port Campbell and one at Flaxman's were examined. In addition, selected foraminifera from three sets of cuttings from Port Campbell No. 1 and a number of larger fossils were studied.

The specific object of these examinations was the determination of the age of the fossil assemblages found. Early and Late Cretaceous age had been suggested by different investigators. Larger fossils from other bores had been studied by officers of the Victorian Mines Department but were not available.

Questions of zoning and correlation between different bores were not included in the present study.

It must be stated clearly that even with these limited objectives and on the basis of the limited material available, much more work could and should be done to complete the investigation of the foraminiferal fauna. This work should include a full description of the numerous new species and their comparison with known forms, probably involving re-assessment of contentious generic classifications. It would also necessitate sectioning and detailed morphological analysis of many specimens. Owing to limitations of available time none of this work can be carried out at present. It is considered, however, that a reasonable clear answer to the main question can be given on the basis of observations made in the limited available time. The identifications of foraminifera from all samples containing them (though not of all genera or species present) are tabulated in the accompanying chart. General comments on the fauna are given first and more detailed conclusions follow.

The general composition of the fauna is marked by an abundance of arenaceous forms, particularly Haplophragmoides, Dorothia, Textularia and Marssonella. Taylor's observation of an alternation of purely arenaceous and mixed arenaceous-calcareous assemblages has been confirmed. The calcareous element is dominantly benthonic and includes numerous Nodosariidae, a fair number of specimens of a few Bulminid genera and various simple rotalid (discorbid) genera, some Polymorphinidae (which have not been examined in detail) and Miliolidae. The planktonic element is distinctly poor. Because of the relatively small number of specimens available, which makes a proper assessment of variability impossible, these have not been examined in detail. The genus Globotruncana and related forms on which the world-wide zoning of the Upper Cretaceous depends, is definitely absent. The

pelagic fauna consists of small Globigerina, some of which are often described as "Hedbergella" or as "Praeglobotruncana" which I consider as wrong as they are not congeneric with the type species of this genus. Almost planispiral forms of Hastigerinella aspera also occur. It is difficult to decide which species of Globigerina are represented as too many names for overlapping taxonomic concepts have been proposed. Some of the present specimens are identical with G. gautierensis Brönnimann which ranges (including variants) from Cenomanian to Turonian. Other forms resemble species described as Hedbergella ranging from Aptian to Coniacian. It has been made clear in recent publications that these small globigerinids are common in at least part of the Upper Cretaceous. It is, therefore, incorrect to assume that the absence of true Globotruncana, Praeglobotruncana and Rotalipora indicates pre-Cenomanian age. Other evidence shows that it is due to palaeogeographic and ecological conditions.

The absence or rare occurrence of suitable planktonic index foraminifera and the abundance of arenaceous benthonic forms suggests attempts to use these, particularly the very common large Haplophragmoides, for zoning and correlation. This involves the risk of misidentifications as the tests of these foraminifera were soft and are compressed in different directions. Such compressed and collapsed specimens are often figured and named in the literature. Although at least four distinct species of Haplophragmoides have been recognised in the present fauna, no attempt has been made to name them. I do not consider them or other arenaceous species as closely resembling those described from the Lower Cretaceous of the Great Artesian Basin.

The general composition of the fauna is, however, not unlike that of the Aptian - Albian sequence of the Great Artesian Basin, while it differs considerably from that of the West Australian Carnarvon Basin and Northern Australian Bathurst Island Cretaceous. It also resembles recently described faunas from the Cretaceous of Alberta, Alaska, and Northern Japan and some faunas from Northern Europe while it differs from the well-known Gulf Coast and Tethyan faunas. The conclusion is inescapable that we are dealing with a new Cretaceous cold-water fauna.

It is a matter of considerable interest that this fauna includes the previously unknown ancestors of a number of Tertiary foraminifera from Southern Australia, particularly Citharina aff. subplumoides, Buliminella aff. westraliensis, and Alabamina n. sp. These species tend to give the fauna a younger aspect than the age suggested by previously known species. The presence of this endemic faunal element gives no indication of the age of the fauna.

The detailed evidence from the ranges of previously known species indicates (as stated below) a total time range of the foraminiferal faunas examined from Cenomanian or Lower Turonian to Senonian (Santonian - Campanian). There is thus no substantial conflict between the conclusions of the Jersey Production Research report on Pt. Campbell

No. 1 and the results of the present work. However, the evidence for Senonian comes only from Pt. Campbell No. 2 core 1 which is believed to represent the Paaratte Formation. Most of the Belfast Mudstone is here considered as Turonian which in the absence of Globotruncana cannot be divided into standard world-wide zones or divisions.

A number of genera and species of formainifera appear to have been considered by Leffingwell and Hoskins (Rep. Jersey Production Research Co. 7200-G-76, Nov. 1960, GLA 155-60) as suggesting Santonian to Campanian age of Pt. Campbell No. 1, 4866-46 and 5018-5020 ft., and "Late Cretaceous" age generally from 4288-90 to 5400 ft. While no comment is required on species known to occur within the age range suggested in the present report (pre-Santonian at 4756 ft. in this well), some notes concerning species claimed to be restricted to younger ages are given here.

"Gyroidinoides depressa (Alth)". The species found differs from the similar Late Cretaceous European form.

"Globorotalites michelinianus (d'Orbigny)". This species does not occur in the present material. The genus is represented by another species closer to G. subconica (Morrow).

"Marginulina curvisepta Cushman and Goudkoff". The age of this species and its range within the Upper Cretaceous are not known.

"Saracenaria triangularis d'Orbigny". I have identified the species from core 17 as S. jarvisi Brotzen.

"Allomorphina navarroana Cushman". This genus of which the earliest known species are from the Callovian and from the Santonian - Campanian, is here represented by a new species.

"Frondicularia goldfussi Reuss". I have not found this genus or species.

"Valvulineria cf. umbilicata (d'Orbigny)". This is here considered as a Gyroidinoides. Difficulties in the synonymy of these species make stated ranges unreliable.

"Ceratobulimina sp.". This genus occurs from Albian to Recent.

There is no evidence for Campanian (with the possible exception of Pt. Campbell No. 1, core 2) and none for Maestrichtian age of any of the forams examined. This may be of some significance for the question of a marine transition from Cretaceous to Tertiary, which I consider as highly improbable.

Conclusions

No fossils were found in the Otway Formation (Port Campbell No. 2, core 18; Port Campbell No. 3, cores 4, 5).

1. The cores examined from the Waarre Formation (Port Campbell No. 2, cores 6-11, 15-17) contain no foraminifera. They contain either plant remains or coal or are unfossiliferous. The sample from Port Campbell No. 3, core 3, contains only plant remains and unidentified shell fragments. No foraminifera were found in the samples from Flaxman's No. 1 below core 17 (cores 19, 20, 22, 24, 25) although core 20 is glauconitic.

2. Most of the samples designated as Belfast Mudstone i.e. all samples from Port Campbell No. 1, all samples from 5910 ft. (core 3) to 7694 ft. (core 13) in Port Campbell No. 2, with the exception of core 5 (7885-7890 ft.) contain foraminifera. Similar faunas occur in Flaxmans No. 1, cores 8 to 17, and these are thought to represent the same formation. No formainifera were found in samples from cores 5, 7, 11, 12, 14 from this well. Poorer assemblages of arenaceous foraminifera and fish remains occur in cores 3 and 4. Fossiliferous samples not listed in the attached chart are Port Campbell No. 3, core 2, containing one fish scale, one unidentified arenaceous foraminiferal test, plant remains and shell fragments, and Flaxman's No. 1, core 2, with Cassidulina subglobosa, Globigerina and Cibicides (probably Tertiary), and core 15 (1 fragment of Haplophragmoides).

3. One sample (Port Campbell No. 2, core 1) was stated by D. Taylor to represent the base of the Paaratte Formation. The foraminiferal assemblage resembles that of the underlying Belfast Mudstone, with two or three rare additional species. These range from Coniacian or Santonian to Campanian.

4. Omitting from consideration these species, the following are of importance for the determination of the age of the Belfast Mudstone:

Citharina geisendorferi (Franke). Cenomanian - Turonian

Dorothia conula (Reuss). Turonian - Lower Senonian

Dorothia filiformis (Berthelin). Probably about Albian - Turonian

Gavelinella cf. berthelini (Keller). The typical form occurs in Cenomanian - Turonian

Gavelinella moniliformis (Reuss). Turonian

Gavelinopsis cenomanica (Brotzen). U. Albian - L. Turonian Rare but typical.

Gavelinopsis cf. infracretacea Hofker. The typical form occurs in Albian - Cenomanian.

Nodosaria orthopleura Reuss. Albian - Turonian

Pallaimorphina n. sp. The genus ranges from Albian to Turonian

Stensjoina praeexsculpta Keller. Cenomanian - Coniacian
Rare but typical.

Valvulineria lenticula Reuss. Turonian - Santonian

Praebulimina reussi Morrow. Turonian - Campanian

5. While there are big facies fluctuations in the core samples examined from Port Campbell No. 1, a significant faunal change occurs above core 12 in Port Campbell No. 2 (7093 ft.). Cursory examination of the cuttings from the lower part of Port Campbell No. 1 (5450-5480 ft.) suggests the same change there, as expected according to D. Taylor's correlation. The question to be considered here is whether the age of the lower faunal assemblage differs significantly in terms of the standard stratigraphic scale from that of the upper assemblage, i.e. whether it is pre-Turonian. While my first impression was that it could be Albian - Cenomanian, no further restricted Albian or Cenomanian species have been found. No corresponding faunal change was observed in the cores from Flaxman's No. 1 below the top of core 8 (4974 ft.). Textularia sp. 2 which seems to be one of the distinctive species of Taylor's lower 2 faunules, occurs in cores 9 and 17, and Bulimina nannina Tappan (Albian - Cenomanian) in cores 8 and 9. Otherwise, these assemblages do not differ significantly from those in the upper part of the Belfast Mudstone in other bores. Consequently, there is not sufficient evidence to assign any part of it definitely to the Cenomanian (or Albian).

6. There is no evidence for and much against contemporaneity of the Belfast Mudstone with any part of the marine Cretaceous of the Great Artesian Basin (Aptian - Albian). General resemblances in the foraminiferal fauna are due to similar facies and temperature conditions and also to the recently established long range of some small pelagic foraminifera. Marine sediments of the same age occur in Western Australia (part of the Gearle Formation and equivalents). The lithofacies is rather similar but the Gearle fauna appears to have lived in warmer water. Detailed comparisons of the fauna have not yet been made.

7. Non-foraminiferal microfossils have been collected but not yet studied. They include ostracodes and fish teeth and scales in many samples and radiolaria in Pt. Campbell No. 2, core 3 and Flaxman's No. 1, core 16.

8. The molluscan fauna also requires further comprehensive study. Previous investigations (P. R. Kenley, Min. Geol. J. vol. 6, No. 3, 1958-9) on such fossils from the Belfast No. 4 bore suggested Upper Cretaceous age (and the absence of any species known from the Great Artesian Basin). A series of mollusca from the Flaxman's No. 1 bore have been examined. Core 4 (4309-4316 ft.) contains definite Inoceramus of Cretaceous age. Dr. N. H. Ludbrook has informed me of

the occurrence of Inoceramus in a core from 4400 ft. from Port Campbell No. 3. Flaxman's No. 1, core 9 (4983-4993 ft.) contains an unidentifiable ammonite fragment and a fragmentary belemnite which is probably the same species as the fragment found in Heywood No. 10 bore at 5382 ft. It is not a Dimitobelid (this family ranges from Aptian to Cenomanian), nor a Neohibolites, nor does it belong to any of the few known post-Cenomanian belemnite genera. The available material is not yet sufficient for detailed comparative studies and description. Core 16, 5950-5955 and 5958-5961 ft., contains one small and one larger reasonably well preserved ammonite which can be positively identified as Hauericeras cf. augustum Yabe. This species ranges from Coniacian to Campanian. Although Hauericeras has not yet been found below the Coniacian I am not prepared to accept this as incontrovertible evidence of post-Turonian age of the Belfast Mudstone at this depth but only as one species which has to be considered together with all others present (mainly foraminifera) in determining age.

9. While the evidence of known species of foraminifera favours a Turonian age of most of the Belfast Mudstone in the bores which I have examined (see para. 4 above) it must be remembered that the boundaries of the Turonian Series need not be marked here by sharp changes of the foraminiferal fauna. In fact, even in Europe no sharp biostratigraphic boundaries have been established on foraminifera to mark the base and top of the Turonian in its type area and much work remains to be done on its foraminifera (other than Globotruncana). It is therefore possible that more than Turonian is represented in the Belfast Mudstone. It was stated above (para. 5) that there is no definite evidence of Cenomanian being present in its lower part. The possibility of a Coniacian age of at least its upper part cannot be ruled out on present evidence. The faunal evidence is, however, definitely against any Upper Senonian being present.

15th August, 1961 (Signed) M. F. GLAESSNER

Distribution of selected foraminifera in the Belfast Mudstone, Victoria	Port Campbell No. 1				Port Campbell No. 2					Flaxmans No. 1							
	17	18	20	21	1	3	12	4	13	3	4	8	9	10	13	16	17
Globogerina gautierensis	x				x												
Globogerina spp.	x		x		x	x						x			x		
Hastigerinella aspera	x																
Gumbelina sp.	x					x											
Haplophragmoides sp. 1	x	x	x	c	x	x	x	c		x	x	x	x	x		c	x
" sp. 2	x		x	c	x	x	x	c		x	x	x	x	x		c	x
" sp. 3	x		x			x	x	c		x			x	x			
Ammobaculoides sp.	x																
Textularia sp. 1	x				x	x		x				x	x	x		c	x
" sp. 3	x																
Dorothia conula	x												x		x		x
Cornuspira cretacea	x					x	x					x					
" n. sp.	x						x										
Quinqueloculina sp. 1	x																
" sp. 2	x		x		x	x											
Nodosaria aspera	x																
" orthopleura	x											x					x
Lingulina nodosaria	x																
Dentalina sp.	x					x											
Saracenaria jarvisi	x																
Marginulina sp.	x					x										x	x
Astacolus sp.	x																
Lenticulina ovalis	x																
Rectoglandulina sp. 1	x					x											
" cf. mutabilis	x																
Fissurina globosa	x					x	x										
Polymorphinidae indet.	x						x										
Praebulimina reussi	x						x						x		x		
Buliminella aff. westraliensis	c				x							x	x		x		
" sp.	x																
Allomorphina n. sp.	x					?	x					x			x		

Distribution of selected foraminifera in the Belfast Mudstone, Victoria	Port Campbell No. 1				Port Campbell No. 2					Flaxmans No. 1							
	17	18	20	21	1	3	12	4	13	3	4	8	9	10	13	16	17
Conorbina cf. marginata	x											x					
" n. sp.	x				x							x	x				
Stensjoina praeexsculpta	x																
Gyroidinoides nitidus	x		x			x	x	x				x	x		x		
" cf. depressus	x																
Pallaimorphina n. sp.	x						x					x	x				
Valvulinera lenticula	x				x	x						x	x				
Globorotalites sp.	x		x			x											
Alabamina n. sp.	x		x		x	x	x					x	x		x	x	
Hoglindina supracretacea	x					x											
Discorbis ?sp.		x			x		x										
Dorothia filiformis			x	c	x	x	x	x					x	c		x	x
Gavelinella moniliformis			x			x											
Marssonella oxycona				x	x	x	x		x	x				x		c	
Trochammina sp. 1					x	x											
Ammobaculites cf. fragmentarius					x										x		
Pseudouvigerina plummerae					x												
Reussella cf. buliminoides					x												
Reophax ? sp.						x					x						
Marginulinopsis curvisepta						x	x						x				
Bolivina sp.						x											
Gavelinella cf. berthelini						x	x					x	x				
Ceratobulimina sp.						x											
Textularia sp. 2							x	x					x				x
Ammobaculites sp. 1							x					x					
Marginulina inaequalis							x										
Citharina geisendorferi							x										
Dentalina communis							x										
Nodosaria obscura							x										
Lenticulina gaultina							x					x					

Distribution of selected foraminifera in the Belfast Mudstone, Victoria	Port Campbell No. 1				Port Campbell No. 2					Flaxmans No. 1							
	17	18	20	21	1	3	12	4	13	3	4	8	9	10	13	16	17
Conorboides n. sp.							x										
Gavelinopsis cenomanica							x										x
" cf. infracretacea							x										
Gyroidinoides infracretacea							x						x				
Eponides sp.							x										
Hoglundina chapmani							x	x									x
Haplophragmoides sp. 4												x	x				
Dentalina cf. basiplanata												x					
Citharina aff. subplumoides												x	x				
Praebulimina nannina												x	x				
Recurvoides sp.													x			x	
Gavelinella ?sp.													x				
Ammodsicus sp.																	x

FLAXMANS HILL NO. 1 WELL
PALAEONTOLOGICAL REPORT

by

Dr. I.C. Cookson - University of Melbourne

30th June, 1961.

Core number depth in feet	Dinoflagellate Zonation		Microfloral Zonation: Angiosperm pollen	Microfloral Zonation: Spore tetrad	Megaspores	Series	Stage
Core 4	"Odontochitina porifera Zone"	"Nelsoniella aceras Subzone"	+	-	Balmeisporites glenelgensis		probably Campanian
Core 10 5330-5336' 6"			+	-			
Core 12 5376-5396			+	-		Upper Cretaceous	probably Senonian
Core 13 5458		"Deflandrea cretacea Subzone"	+	-			
Core 14 5531-39			+	-			
Core 16 5950			+	-			
Core 17 6375-6391		"Deflandrea acuminata Subzone"	-	+			
6663+	? Zone		-	+			possibly Cenomanian to Lower Turonian

+ "Palaeoperidinium" sp. present, also in Port Campbell No. 1 at 4866-68 - 5705-08 feet (See Report)

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PORT CAMPBELL NO. 1 WELL

Core number depth in feet	Dinoflagellate Zonation		Microfloral Zonation: Angiosperm pollen	Microfloral Zonation: Spore tetrad	Megaspores	Series	Stage
Core 23 5700-5718	"Odontochitina operculata Zone"	"Deflandrea acuminata sub zone"	+	+	-	Upper Cretaceous	possibly Cenomanian Lower Turonian
Core 24 5928-5934		equivalent of "Gonyaulax amplex sub zone" +	-	+	Balmeisporites holodictyus	Lower Cretaceous	probably Albian

\+ Age based mainly on microflora which agrees with that of deposits of probable Albian age in South Australia.

Miss Dettmann, who also examined this deposit, remarks that a similar assemblage occurs in sample 7 from Forrest Bore 1 (Nat. Mus. Vic. No. P16770).

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PORT CAMPBELL NO. 2 WELL

Core number depth in feet	Dinoflagellate Zonation		Microfloral Zonation: Angiosperm pollen	Microfloral Zonation: Spore tetrad	Series	Stage
Core 1 5340-5348	"Odontochitina porifera zone" or its equiv-a lent (Preserv-ation bad)	equivalent of "Deflandrea cretacea sub zone" but D. cretacea itself not seen	+	-	Upper Cretaceous	Probably Senonian
Core 3 5910-5917			+	-		
Core 4 7403-7408			-	+		
Core 6 7904-7913	equivalent of "Deflandrea acuminata sub zone"		-	+		possibly Cenomanian to Lower Turonian
Core 7 7913-7930			-	+		
Core 9 8174-8182			-	+		

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PORT CAMPBELL NO. 3 WELL

Core number depth in feet	Dinoflagellate Zonation		Microfloral Zonation: Angiosperm pollen	Microfloral Zonation: Spore tetrad	Megaspores	Series	Stage
Core 1 4400-4404	"Odontochitina porifera zone"	equivalent of Deflandrea cretacea sub zone"+	+	-	-	Upper Cretaceous	Probably Senonian
Core 4676-4693	equivalent of "Odontochitina operculata zone"	probably the equivalent of the "Gonyaulax amplex sub zone	-	+	Balmeisporites tridictyus	probably Lower Cretaceous	probably Albian
Core 3 4781-4792			-	+	-		

\+ Deflandrea cretacea not seen but assemblage otherwise is completely identical with that of the Belfast No. 4 bore between 4492 and 4499 feet and 4645-4652 ft.

++ Specimens illustrated in the report on Port Campbell No. 1 Well ie G amplex were not well enough preserved for specific designation.

PALEONTOLOGICAL REPORT

by

Dr. I.C. Cookson - University of Melbourne

REPORT ON FLAXMANS HILL BORE NO. 1. 7th August, 1961.

Of the cores that have followed the sample taken at 6663 feet (noted in table previously submitted) no. 27 at 7200 feet and no. 36 at 9136 feet have given the most instructive results.

Core 27 at 7200 feet.

The occurrence of a species of Gonyaulax and sparse fragmentary remains of Odontochitina operculata suggests salt water sedimentation and permits correlation with the sediments in Port Campbell No. 1 bore at 5928-5934 ft. and Port Campbell No. 3 at 4676-4693 ft.

Only a few recognisable spore types have been seen. These include, Cingulatisporites euskirchensoides, Trilobosporites trioreticulatus and Balmeisporites tridictyus all of which occur in deposits which Miss Dettmann and I have suggested are of Albian age.

Core 36 at 9135 feet.

No evidence of microplankton has been seen and it would appear that the deposit at this depth is of lacustrine origin. It contains far less wood and cuticles than in the higher samples examined and a much larger number spores, the preservation of which is reasonably good. The dominant species is Cingulatisporites simplex Cookson and Dettman which has been recorded by Miss Dettman and myself from several Mesozoic deposits in south-eastern Australia, namely the Dergholm No. 1 bore at 532 ft., Birregurra Number One bore at 1089 ft., Barongarook Creek, and Little's Shaft No. 2 Bellarine Peninsula at 38-47 ft. in Victoria and from the Robe Bore at 2360 ft., and Tilcha Bore at 1040 ft. in South Australia. The age suggested by us (1958) for these deposits was "probably Albian".

ISABEL C. COOKSON

		Flaxmans No. 1 7200'	Flaxmans No. 1 7864'	Flaxmans No. 1 9135'	Pt.Campbell No. 1 5928-34'	Pt.Campbell No. 3 4676-4693'	Devils Kitchen	Dergholm No. 1 532'	Birregurra No. 1 1102-1089'	Robe Bore 2360'
Megaspores	Balmeisporites holodictyus	-	+	-	+	-	-	-	+	+
Megaspores	Balmeisporites tridictyus	+	-	-	-	+	-	-	-	-
	Cingulatisporites euskirchensoides	+	-	+	+	+	+	+	+	+
	Cingulatisporites simplex	-	-	+	+	-	-	+	+	+
Microspores	Trilobosporites trioreticulatus	+	-	-	-	+	+	-	+	-
Microspores	Aequitriradites spinulosus	-	-	+	-	-	+	-	+	-
	Spore tetrad	+	-	-	+	+	-	-	-	-
Microplankton	Gonyaulax ? amplus	+	-	-	+	+	-	-	-	-
Microplankton	Odontochitina operculata	+	-	-	+	+	-	-	-	-

I.C. COOKSON.

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PRE:DA

106G/13/74

21st June, 1961.

CHIEF GEOLOGIST

F.B.H. FLAXMAN'S HILL NO. 1 WELL, VICTORIA

1. Samples of cores which have been received so far from the following depths in F.B.H. Flaxman's Hill No. 1 well have been subjected to palynological analysis.

		Suggested Fm. equivalent
Core 8,	4974 - 4983 feet,	Paaratte
" 9,	4983 - 4993 " ,	
" 10,	5330 - 5336 ft.6in.,	
" 11,	5362 feet,	Barren
" 12,	5396 "	"
" 13,	5458 - 5463 feet,	Belfast
" 14,	5531 - 5539 " ,	
" 15,	5543 - 5546 " ,	
" 16,	5958 - 5961 " ,	
" 17,	6375 - 6391 " ,	?—
" 20,	6626 - 6636 " ,	Barren
" 22,	6871 - 6877 " ,	" Waarre
" 25,	6902 - 6913 " ,	

2. Some of the immediately recognizable species which were noted in these samples are listed in the appended table, (Table 1) mainly because they had been noted in Port Campbell Nos. 1 & 2 wells (Evans, 1961a) or had been described recently (Cookson & Eisenack, 1961) from some samples of Belfast No. 4 bore.

3. The first similarity between this section of Flaxman's Hill No. 1 and the Cretaceous of Port Campbell No. 1 is in the order of appearance of Nelsoniella aceras above strata containing Deflandrea cretacea, Amphidiadema denticulata and Gymnodinium nelsonense. Repetition of basically the same sequence at Flaxman's Hill suggests that a zone with N. aceras may distinguish a portion of the Upper Cretaceous in both areas - where it lies within the Paaratte Formation. That is, core 9 (4983 - 4993 feet) Flaxman's Hill No. 1 should be compared with core 18 (4862 - 4864 feet) Port Campbell No. 1. However, the wide limits between fossiliferous samples in both wells does not allow much accuracy in a point correlation of this type, since insufficient data on the complete life ranges of these species are available, so that a comparison of the wells can be demonstrated only with the interval in each bore between samples with this and the next oldest assemblage. On such a basis, the interval below known N. aceras bearing beds, i.e. 4993 - 5330 feet, in Flaxman's Hill No. 1 compares with the interval 4864 - 5020 feet in Port Campbell No. 1.

Nothing yet can be differentiated immediately below this interval in the Upper Cretaceous. G. nelsonense is the only species which

seems to have an appropriately short period of existence, but it is so rare in both wells that observation failure might account for this characteristic. It is pointed out that the species was seen only in the top of the Belfast Mudstone of Port Campbell No. 1 (c.19, 5020 - 5025 feet), while it occurs above the base of the Paaratte Formation in Flaxman's Hill No. 1 as defined by Frome Broken Hill (106G/13/74, 5th June, 1961.)

4. The presence of Odontochitina cribropoda and triporate pollens in core 17 (6375 - 6391 feet) Flaxman's Hill No. 1 suggests that nothing older than the Belfast Mudstone of Port Campbell No. 1 had been penetrated at that level. The top of the equivalent of the Waarre Formation has not yet been identified. Cores 20 - 22 provided no microfossils; core 25 (6902 - 6913 feet) provided a few specimens of Cicatricosisporites australiensis which is typical of Lower Cretaceous deposits in Australia and thus might suggest that by 6902 feet equivalents of the Lower Cretaceous Waarre Formation were being penetrated. However, very rare C. australiensis was found within the Belfast Mudstone of both Port Campbell No. 1 and No. 2 wells so that positive identification of the Waarre equivalent still must be sought. Associate microplankton differ from the more characteristic Belfast forms, but the diagnostic Deflandrea acuminata, Odontochitina operculata assemblage from the top of the Waarre has not yet been observed.

5. Cookson & Eisenack (1961) described species from two samples (4652 feet, 4492 - 4499 feet) from the Belfast No. 4 bore. They included D. cretacea, A. denticulata, O. porifera, H. heteracanthum and Hexagonifera gen.nov. Species of the latter genus may be stratigraphically important since H. vermiculata occurred in both samples and H. glabra only at the lower level. While these forms were not found together in Flaxman's Hill No. 1, H. glabra came below H. vermiculata in the well so that a correlation might be tentatively suggested between Belfast No. 4, 4652 feet and a point in Flaxman's Hill No. 1 between 5546 and 5958 feet. (See Figure 2).

6. At several horizons reworked Permian microspores were seen (Tholosporites egregius, Nuskoisporites gondwanensis, Lunatisporites sp.). This is a widespread feature characterizing the Victorian Cretaceous and Tertiary sediments (Cookson, 1956, Evans, 1961 b). However, the problem arises whether microfossils of an age younger than Permian also have been reworked. The presence of e.g. one specimen of Cingulatisporites euskirchenoides, a species more characteristic of Lower Cretaceous sediments in association with Nelsoniella aceras in core 9 (4983 - 4993 feet) might be an indication of the reworking of Lower Cretaceous sediments in Upper Cretaceous times. A specimen of Ischyosporites cf. scaberis in core 13 furnishes another example. While the reworking hypothesis might be invoked too readily and erroneously to explain what in fact represented an extension to the known life-range of the species, the unconformity between Lower Cretaceous and Tertiary sediments in outcrop towards Otway shows that reworking is feasible from a tectonic point of view.

P.R. EVANS.

23/6/61.

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TABLE 1

SPECIES	CORES (depths listed on p.1)
	8 9 10 11 12 13 14 15 16 17 20 22 25
Nelsoniella aceras	?--+
Hystrichosphaeridium heterocanthum	+--+--+--+--+--+--+--+
Odontochitina porifera	+--+--+--+--+
Deflandrea cretacea	cf--+--+--+--+
Hexagonifera vermiculata	?--+--+
Deflandrea belfastensis	+
Hystrichoshaeridium spp.	+--+
aff. Deflandrea thomasii	+
Gymnodinium nelscnense	+
Amphidiadema denticulata	+
Odontochitina cribropoda	+--+
Hexagonifera glabra	+
Baltisphaeridium sp.	+
Hystrichosphaera cf. furcata	+
Gonyaulacidae sp.	+
Cyclonephelium sp.	+
Cyathidites australis (incl. f. rimalis)	+--+--+
C. cf. minor	+
Triporate pollens undiff.	+--+--+--+--+--+
Lycopodiumsporites sp.	+
Araucariacites australis	+
Microcachryidites antarcticus	+--+
Cingulatisporites euskirchenoides	+
Pilosisporites sp.	+
Ishyosporites cf. scaberis	+
aff. Dictyotosporites complex	+
Appendicisporites sp.	+
Cicatricosisporites australiensis	+
Nuskoisporites gondwanensis	+--+
Tholosporites egregius	+
Lunatisporites sp.	+

P.R. EVANS

23rd June, 1961.

APPENDIX NO. 2

ANALYSES OF FLUID SAMPLES

by

Standard Vacuum Refinery Pty. Ltd.

Vacuum Oil Company Pty. Ltd.

State Laboratories.

GAS ANALYSES

	D.S.T. No. 2 5356-5396 ft. Paaratte Formation %	D.S.T. No. 3 6891-6913 ft. Waarre Formation %	Gas from Mudstream Bottom Hole depth 11,388 ft. Otway Group %	D.S.T. No. 6 10842-11528 ft. Otway Group %	D.S.T. No.14 8518-8528 ft. 8462-8480 ft. Otway Group %	D.S.T.No.16 6875-6881 ft. Waarre Formation %
Air	3.9	-	-	-	-	-
Carbon dioxide	1.7	1.7	-	-	-	-
Hydrogen	0.5	-	-	-	-	-
Nitrogen and oxygen	3.9	2.5	-	-	-	-
Methane	91.3	88.7	88.1	76.9	95.9	83.7
Ethane	2.3	3.4	6.3	13.2	3.3	10.4
Propane	0.3	0.8	4.0	6.9	0.8	4.5
Propylene	0.1	-	-	-	-	-
Isobutane	-	-	0.4	1.5	-	0.7
Normal butane	-	-	0.8	0.7	-	0.7
Isopentane	-	-	0.2	-	-	-
Normal pentane	-	-	0.2	-	-	-
Water vapour	-	-	-	0.8	-	-
Analysis by:	State Laboratories Melbourne	State Laboratories Melbourne	Standard Vacuum Refinery, Altona	Standard Vacuum Refinery, Altona S.G. of gas 0.729 (Air = 1.0) Site determination	Standard Vacuum Refinery, Altona.	Standard Vacuum Refinery, Altona.

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CONDENSATE ANALYSIS

by

Standard Vacuum Refinery

Production Test No. 1	10,842 to 11,528 feet	Otway Group
Initial Boiling Point:	176°F	
Cuts: 10%	224 "	
20%	236 "	
30%	246 "	
40%	256 "	
50%	271 "	
60%	292 "	
70%	316 "	
80%	358 "	
90%	444 "	
Final	577 "	
Residue: 3% wax		
Loss: 2% (Methane-Ethane)		

Liquid is aromatic (Toluol) rather than paraffinic base

WATER ANALYSES

by

Standard Vacuum Refinery

	D.S.T. No. 2 5356-5396 ft. Parratte Formation	D.S.T. No. 3 6891-6913 ft. Waarre Formation	D.S.T. No.16 6875-6881 ft. Waarre Formation
Steam distillable oil	Nil	Nil	Trace (0.05%)
Hexane extract	Nil	Trace	Trace (0.05%)
Explosive gases	Nil	Trace	Present
Chloride as Cl gms/litre	11.1	8.4	12.8
Chloride as NaCl gms/litre	18.3	13.7	21.0

WATER ANALYSES

by

State Laboratories, Melbourne

		D.S.T. No. 2 5356 to 5396 feet Paaratte Formation Parts per Million	D.S.T. No. 3 6891 to 6913 feet Waarre Formation Parts per Million
Total solids in solution		21,258	21,390
Chloride	(Cl)	11,610	12,440
Carbonate	(CO_3)	Nil	Nil
Bicarbonate	(HCO_3)	1,380	534
Sulphate	(SO_4)	206	86
Nitrate	(NO_3)	3	Nil
Calcium	(Ca)	258	1,255
Magnesium	(Mg)	62	60
Iron - Total	(Fe)	520	85
Iron - Soluble	(Fe)	0.2	5
Silica - Soluble	(SiO_2)	13	20
Total Hardness as $CaCO_3$		901	3,379
pH		7.5	7.0
Hypothetical combination is as below.			
Calcium Bicarbonate	- $Ca(HCO_3)_2$	1,045	694
Magnesium Bicarbonate	- $Mg(HCO_3)_2$	373	-
Ferrous Bicarbonate	- $Fe(HCO_3)_2$	1	16
Sodium Bicarbonate	- $NaHCO_3$	388	-
Calcium Sulphate	- $CaSO_4$	-	122
Calcium Chloride	- $CaCl_2$	-	2,908
Magnesium Sulphate	- $MgSO_4$	-	-
Magnesium Chloride	- $MgCl_2$	-	235
Sodium Carbonate	- Na_2CO_3	-	-
Sodium Sulphate	- Na_2SO_4	305	-
Sodium Nitrate	- $NaNO_3$	4	-
Sodium Chloride	- NaCl	19,130	17,147

ANALYSIS OF SOLID MATTER

by

Vacuum Oil Company

Well cuttings from 5531 to 5535 feet.

A sample of greyish-black material submitted for analysis has been examined with the following results:-

Water Content	12.3%
Soluble in Hexane	Trace (less than .1%)
Soluble in Toluene	6.1%
Organic Material	10.8%
Ash Content	70.8%
	100.0%

The material soluble in Toluene had a greyish waxy appearance with softening point 95 to 100°F and specific gravity 0.98. Only a few milligrams of this material were obtained from the whole sample submitted.

The material remaining after toluene extraction had a greyish appearance and after burning off organic matter left a reddish brown ash containing dirt and sand.

APPENDIX NO. 3

CORE DESCRIPTIONS

APPENDIX NO. 3

CORE DESCRIPTIONS

Core No. 1 3288 to 3308 feet. Recovery 3 feet

Sandy siltstone to silty sandstone, dark brown to greyish greenish brown. Sand is light brown to brown, mainly iron stained, with clear, white and yellow quartz grains. Fine to coarse grained, but mainly medium, fairly well sorted. Grains subangular to rounded. The quartz and some limonite grains are set in a greyish-green to greyish-brown to grey silty clay matrix. Core is light, soft, calcareous, without any apparent bedding. Approximately 50% sand, 50% matrix. No fossils, no oil or gas, no fluorescence.

Core No. 2 3561 to 3573 feet. Recovery 12 feet.

Sand to sandstone, light grey speckled, extremely friable. Recovered material mainly loose sand with less than 5% poorly cemented sandstone. The rock consists of 95% quartz sand, predominantly clear, only few yellow stained grains. Poorly sorted, fine to mainly medium grained. Angular to subrounded grains. 5% dark minerals probably glauconite and limonitised glauconite. Fe-Mg minerals are greenish-brown to medium green, soft, subrounded to rounded. Micas occur as books and flakes and are coloured golden brown to dark reddish brown. Few grains of carbonaceous material present. Rare streaks of white-grey to bluish-black puggy clay. Indication of current bedding in one part of core. No oil or gas and no fluorescence.

Core No. 3 4126 to 4134 feet. Recovery 8 feet.

0 - 2.5' Siltstone, sandy, grey to dark grey, glauconitic, micaceous with fine crystalline pryite nodules. Small fragments of carbonaceous material and small lenses and streaks of light grey very fine cross bedded sandstones are in core.

2.5 to 8 feet, Siltstone, dark grey, micaceous with pyrite nodules, carbonaceous material and fossil fragments, very fine chlorite grains. Small lenses of very fine, light grey sand. Core is very slightly calcareous and breaks up into small pieces under pressure. No fluorescence. Density: 2.4

Core No. 4 4309 to 4316 feet. Recovery 7 feet.

Siltstone to very fine sandstone, dark grey with abundant plant remains, partly carbonaceous, partly pyritised. Glauconitic, micaceous with large flakes of biotite and muscovite. Pyrite nodules and streaks, and fossils are partly replaced by pyrite. Light brown resin. Small lenses of lighter grey, very fine sandstone. Non-calcareous. No oil or gas, no fluorescence. Apparent dip 10°. Density: 2.4.

Core No. 5 4479 to 4496 feet. Recovery 12 feet

0 to 0.5 ft. Sandstone, light grey to buff, fine grained, angular to subangular quartz grains, speckled with dark minerals, green glauconite, brown and colourless micas, carbonaceous material. Soft, white, interstitial material may be decomposed feldspar. Weakly cemented.

0.5 to 4 ft. Sandstone, very fine grained, similar to above with very fine dark laminations, due to concentrations of fine carbonaceous material on bedding planes, cross-bedded.

4 to 7.25 ft. Sandstone, fine grained, light grey to buff angular quartz with glauconite, mica and carbonaceous material. Several bands of light brown colour, slightly dolomitic.

7.25 to 7.5 ft. Intraformational conglomerate, medium to dark grey. Silty matrix with random quartz grains and granules, rounded patches of the above sandstone and pyrite nodules.

Core No. 6 4687 to 4695 feet. Recovery 4 inches.

2" sand, light grey, medium-well sorted, angular. Consisting of quartz, dark rock fragments, chlorite, carbonaceous material, mica. Non-calcareous.
2" Sandstone, grey to dark grey, fine to coarse grained unsorted, subrounded grains. Consisting of quartz, dark rock fragments, chlorite, dolomite cemented in parts. No fluorescence. Acetone test negative.

Core No. 7 4695 to 4714 feet. Recovery 7 feet.

Interbedded light grey sandstone and dark grey siltstone. Sandstone approximately 60%, siltstone approximately 40%. Sandstone forms beds 6" to 1 foot thick and also occurs as thin lenticular laminae in dark siltstone. Sandstone consists of 95% quartz, colourless, with few yellow grains. Fine to coarse with few granules but mainly medium grained, poorly sorted, subangular to subrounded. Rounded grains of green glauconite, fragments of carbonaceous material, few micas, mainly colourless. Beds thinly laminated. Fine crossbedding occurs in sandstone.
Siltstone, dark grey, dirty, very micaceous and carbonaceous, pyritic and contains few granules and pebbles of quartz. One fragment of fossil wood partly replaced by pyrite and silica. Acetone: Negative. Soxhlet: No cut. Density: 2.3

Core No. 8 4974 to 4983 feet. Recovery 1.5 feet

Dark grey silty mudstone with abundant carbonaceous material partly replaced by pyrite. Golden-yellow to light brown resin. Few fine to medium quartz grains and

Core No. 8 (Cont'd)

abundant fine grained micas. Bottom inch brown sandy dolomite, very glauconitic and with large shell impression.

Dip: $4\frac{1}{2}^{o}$ to 5^{o}. Density: 2.4 Acetone and Ultra Violet: Negative.

Core No. 9

4983 to 4993 feet. Recovery 9 feet.

Top inch fine grained brown dolomite, dense, compact with abundant carbonaceous material and few micas. Rest of core is medium to dark grey mudstone grading into silty mudstone, very carbonaceous and micaceous. Pyrite replacing wood and plant remains. Some resin. Thin lenses of very fine grained light grey cross bedded sandstone with a few doubtful fossil fragments. Indication of intra-formational conglomerate in parts. Bottom 6 inches is light grey, dirty, silty sandstone, medium grained, very micaceous and glauconitic.

Dip: 5^{o}. Density: 2.42. Acetone and Ultra Violet: Negative.

Core No. 10

5330 to 5336 .5 feet. Recovery 6.5 feet

Dark grey to greenish grey sandy siltstone to silty sandstone and mudstone. Micaceous, carbonaceous, glauconitic with thin lenses of light grey fine sandstone. Pyritic. Glauconitic sandy ankerite concretions.

Dip: 3^{o}. Density: 2.4. Acetone and Ultra Violet: Negative.

Core No.11

5358 to 5376 feet. Recovery 11 feet.

Light grey, fine to coarse, mainly medium grained, glauconitic sandstone. Quartz grains, clear and some light brown well sorted, angular to subrounded and approx-imately 30% to 40% of rock is glauconite and ?chlorite. Few brown, hard very glauconitic ankerite and ankeritic sandstone concretions, and some patches of grey brown micaceous siltstone.
No apparent bedding.

Density: 2.14. Acetone and Ultra Violet: Negative.

Core No. 12

5376 to 5397 feet Recovery 20.5 feet

Light grey to greenish grey quartz sandstone with thin lenses of dark grey carbonaceous and micaceous siltstone in the bottom eight feet. Sandstone is friable and quartz is clear and light grey, subangular to subrounded, fairly well sorted. Plant remains partly replaced by pyrite and carbonaceous matter. Some fine sandstone lenses are harder and have a slightly calcareous matrix. Sandstone is fairly porous. Cross bedding present.

Density: 2.3 Acetone solution: Slightly yellow and Ultra Violet on this solution is bluish white.

Core No. 13 5458 to 5463 feet Recovery 5 feet.

Medium to dark grey micaceous and carbonaceous lenticular sandy siltstone. Few grains of glauconite and trace of pyrite. Fine to granule sized angular grains present and thin lenses and patches of light grey, very fine to fine grained micaceous glauconitic and carbonaceous sandstone. Core has few doubtful fossil fragments.

Dip: 3°. Density: 2.43. Acetone and Ultra Violet: Negative.

Core No. 14 5531 to 5539 feet. Recovery 8 feet

Light grey silty quartz sandstone, very fine to coarse grained poorly sorted, angular to subrounded grains. Glauconite and ?chlorite present. Friable, slightly calcareous cement in parts. Trace of pyrite. No dip evident.

Density: 2.4 Acetone very slightly positive, with Ultra Violet on this solution showing light bluish white fluorescence. Few gas bubbles in mud sheath.

Core No. 15 5543 to 5546 feet Recovery 3 feet.

Top 2 feet mottled light and medium dark grey, intraformational conglomerate consisting of rounded lenticular patches of very fine to fine grained light grey sandstone with mica and glauconite and soft white noncalcareous interstitial cement set in a medium to dark grey matrix of sandy siltstone. Matrix is carbonaceous and micaceous. Rock uniform with matrix predominant over sandstone fragmments.

Density: 2.39
Bottom foot. Dark grey to black sooty puggy clay with disseminated sand and sandstone grains and fragments in it. Possibly not true core, but ground up core and mud cake. Weak positive reaction with acetone and strong blue white Ultra Violet fluorescence.

Core No. 16 5950 to 5970 feet Recovery 11 feet

Dark grey slightly brownish dense glauconitic and micaceous mudstone. Fossiliferous with plant remains partly replaced by pyrite. Ankerite nodules.
Density: 2.4. No apparent bedding.

Core No. 17 6375 to 6391 feet. Recovery 16 feet.

Dark grey silty mudstone and mudstone, very glauconitic, micaceous, dense, fossiliferous. Core is fractured and slickensided and breaks up into small pieces. No dip or hydrocarbon evidence. Density: 2.49.

Core No. 18 6606 to 6616 feet. Recovery 3 inches

Weathered brown limonitic pellets closely packed in a green and brown chloritic matrix. Few subangular to subrounded quartz granules.

Core No. 19 6616 to 6626 feet. Recovery 5 feet.

Brown sandstone made up of limonitic pellets and iron stained quartz grains set in a green chloritic matrix and brown red limonitic matrix. Sand is mostly clear and iron stained, fine to granule sized grains, very poorly sorted, subangular to rounded. Whole core is dirty and has low porosity. Few gas bubbles in mud sheath.
Density: 2.86. Acetone solution has slight bluish fluorescence.

Core No. 20 6626 to 6636 feet. Recovery 10 feet

Six feet of brown limonitic sandstone as for Core No. 19, four feet of green (chlorite) limonitic sandstone, the same as for the top 6 feet except that the matrix is green chlorite. Core uniform and dirty. Density: 2.77. Few gas bubbles in mud sheath. Acetone cut has slight bluish fluorescence.

Core No. 21 6832 to 6838 feet. Recovery nil.

Core No. 22 6871 to 6877 feet. Recovery 2 feet.

Dirty grey silty sandstone, made up of very poorly sorted fine to granule, subangular to rounded, light grey quartz grains set in a grey-brown and brown silty matrix (in parts very slightly calcareous) and ?dolomitic matrix in parts. Whole core is tight fairly hard and very glauconitic and chloritic. Fossil wood and carbonaceous matter present. Density: 2.7
Acetone and Ultra Violet : Negative.

Core No. 23 6877 to 6881 feet. Recovery nil.

Core No. 24 6882 to 6902 feet. Recovery 2 feet.

Light grey clean sandstone made up of clear, fine to coarse (mainly medium) subangular to subrounded quartz grains. Sandstone is very porous and permeable and friable. Coal and carbonaceous fragments present. Small amount of siliceous matrix in parts. Trace of green mineral (?chlorite). Density: 2.26
Acetone and Ultra Violet: Negative.

Core No. 25 6902 to 6913 feet. Recovery 9 feet.

Mainly clean light grey porous sandstone grading into dirty, silty, pebbly sandstone in places. Sandstone is the same as that for Core No. 24 with some white soft, interstitial grains present, probably weathered feldspar, and trace of chlorite. The pebbly sandstone had a dark grey micaceous and carbonaceous silty matrix and pyrite and chlorite are also present. Pebbles are angular to subrounded quartz and the rock is dirty, tight.
1.5' section of clean sandstone in middle of core had hydrocarbon smell, fluoresced and yielded a positive acetone cut. Soxhlet extraction on this section gave a residue of brown wax with yellow fluorescence.
No apparent dip in core. Density of clean sandstone 2.36 and pebbly silty sandstone 2.77

Core Analysis	Effective Porosity	Permeability (Millidarcies)	Saturation (% of Porosity)
6904 feet	22.9%	(139 Horiz. (250 Vert.	89.8 Water 1.3 Oil
6906 feet	22.1%	(126 Horiz. (112 Vert.	59 Water 3.5 Oil

Core No. 26 6982 to 7000 feet. Recovery 14 feet

Light grey to grey quartz sandstone made up of clear to light grey coarse to granule size angular to subrounded quartz grains with thin lenses and patches of dark grey pyritic carbonaceous and coaly siltstone and mudstone. Core is laminated in parts and shows evidence of crossbedding with dip up to 25°. Density: 2.33
No fluorescence on core, acetone cut slightly positive with light blue fluorescence.

Core No. 27 7200 to 7220 feet. Recovery 9 feet.

Interbedded light to dark grey sandstones made up of fine mainly medium angular to subangular quartz, few soft, white decomposed feldspar grains, green chlorite and carbonaceous material and some calcareous cement, interbedded and laminated with dark grey micaceous and carbonaceous siltstone. Evidence of small scale cross bedding and lenticular structures. Resin common.
No fluorescence in core. Acetone cut slightly positive with pale bluish fluorescence. Dip: 15°.
Density: Sandstone 2.48. Siltstone 2.55.

Core No. 28 7473 to 7493 feet. Recovery 18 feet.

Light blue-grey mottled sandstone with two foot pebble conglomerate band in ninth and tenth feet. Sandstone well sorted composed of fine to coarse (mainly medium)

Core No. 28 (Cont'd)

fairly angular to subround grains of which 30 to 40% are quartz. Remainder are dark rock fragments and feldspar. Core is calcareous in two three-foot sections and has trace of chlorite and pyrite. Abundant carbonaceous matter in places. Conglomerate is made up of rounded to well rounded pebbles of the same sandstone, dark grey siltstone, quartz; igneous fragments (?jasper) and clay balls. Third foot has strong hydrocarbon smell and has positive acetone cut with blueish fluorescence. Soxhlet on this section yielded yellow greasy cut with yellow fluorescence. Density: 2.45. Dip: 20 to 23°.

Analysis on third foot

Effective Porosity 15.4% Saturation (% of porosity)
Permeability less than 0.2md. Water 57%
Oil 7.5%

Core No. 29

7648 to 7660 feet. Recovery 17 feet.

Light to medium grey-green feldspathic subgreywacke with one foot band of fine grained dense, compact, brown, siliceous and cherty mudstone in the centre. Greywacke made up of 60% grey-green, chlorite, talcose-sericitic material (altered feldspar) about 20% clear yellow and red subrounded quartz grains, dark rock fragments, mica flakes and chlorite. Coarse grained at the top and grading into fine to medium grained at the bottom. Some slickensiding in the core and dip varies from 35° in the top of the core to 12° to 17° in the bottom. Density: 2.44 to 2.58. Few gas bubbles on surface of core. Acetone and Ultra Violet: Negative.

Core No. 30

7864 to 7870 feet. Recovery 6 feet.

Greenish grey mudstone with thin streaks and patches of siltstone and one very fine sandstone lense through it. Biotite dominant mineral with carbonaceous material, feldspar and trace of pyrite in mudstone. Sandstone has feldspar, minor quartz, chlorite, dark and red rock fragments. Core is hard, tight, noncalcareous, slickensided, fractured, and shows microfaulting with displacement up to 1 inch. Dip of 15°. Density: 2.58 No fluorescence in core.

Core No. 31

7966 to 7978 feet. Recovery 11 feet.

Light to medium green grey, feldspathic sandstone greywacke, uniform, medium grain size. Feldspar predominant as very angular to subangular grey green and clear grains and some white altered grains. Abundant subrounded to wellrounded dark rock fragments and less than 10% quartz. Coarse, clear golden and black mica flakes and green fine grained chloritic rock also present. Few fragments carbonaceous material.

Core No. 31 (Cont'd) Slightly calcareous cement in places. Rare orange-red grains (?zeolites). Matrix subordinate and rock is dense, hard and tight. Dip varies from 30° in top to 20° at bottom. Density: 2.49. No apparent oil or gas in core apart from a few weak bubbles in mud sheath.

Core No. 32 8139 to 8150 feet. Recovery 11 feet.

Interbedded light to medium grey and light green-grey very fine to fine sandstone (greywacke) and medium to dark grey micaceous and carbonaceous siltstone and mudstone. Sandstone is made up of feldspar, micas, dark rock fragments, carbonaceous clay and minor (less than 10%) quartz. Core is compact, hard and tight, slickensided and laminated, and cross bedding is present. It is noncalcareous. Dip varies from 10° to 20° through core but is generally 15°. Density: 2.6. Ultra Violet and acetone: Negative.

Core No. 33 8150 to 8161 feet. Recovery 11 feet.

Interbedded sandstone, siltstone and mudstone as for Core No. 32 except that the sandstone is more predominant and a little coarser than in Core No. 32. Crossbedding is present and also a high angle normal microfault at right angles to the bedding and angle of 75° to axis of core. Dip varies from 10° to 20° through core. Density: 2.5. No evidence of any oil or gas. Ultra Violet and acetone tests negative.

Core No. 34 8470 to 8486 feet. Recovery 13 feet.

Light grey feldspathic sandstone (greywacke), fine to coarse but mainly medium grained with feldspar, mainly dark rock fragments, and approximately 20% quartz. Micaceous and carbonaceous and few red ?chert fragments and chlorite. Grains mainly angular but some up to subrounded, uniform, fairly hard, dense and tight. Trace of dark grey, very carbonaceous mudstone lenses in places, and thin intraformational conglomerate in eleventh foot, with dark grey mudstone pebbles within the sandstone. Dip approximately 15° through core and core is very slightly calcareous in parts. Fluorescence, and hydrocarbon smell through core. Toluene cut is not visibly positive but fluoresces. Acetone positive. Soxhlet extraction gives good yellow waxy cut with strong yellow fluorescence. Density: 2.40

Core Analysis Effective porosity - 16.7% Permeability - less than 0.2 md. Saturation 68% water, 3% oil.

Core No. 35 8884 to 8896 feet. Recovery 10 feet.

Light grey feldspathic sandstone (greywacke) very fine to medium, mainly fine with white grey and clear feldspar predominant, with quartz up to 10%. Abundant golden-brown to black micas, dark rock fragments and green chlorite.

1.5 feet of medium to dark brown-grey dense carbonaceous mudstone-siltstone through core. Crystalline calcite is present in one section which has a vertical joint. Large poorly preserved carbonaceous plant remains in bottom 6 inches. Dip: 10° to 15°, although bedding is poor. No oil or gas. Density: 2.55.

Core No. 36 9123 to 9135 feet. Recovery 9 feet.

Interbedded light grey, very fine to fine grained feldspathic sandstone (greywacke) and medium to dark grey siltstones and mudstones. Sandstones are made up of feldspar, dark rock fragments, mica and minor quartz, and are calcareous in parts. Siltstones and mudstones are very carbonaceous and micaceous. Core is laminated, with dips of 12° to 15° and is uniformly tight. Density: 2.46 for sandstone, 2.63 for mudstone. No oil or gas.

Core No. 37 9499 to 9520 feet. Recovery 21 feet.

Light grey speckled feldspathic sandstone (greywacke), medium grained made up of colourless and grey-white angular tightly packed feldspars, and subrounded to rounded dark rock fragments and less than 10% quartz. Coarse mica flakes and few rounded grains green chlorite. Concentration of brown-black carbonaceous matter and larger fragmental plant remains. Top foot has higher percentage of quartz grains (30 to 40%) and two sections show bedding due to orientation of carbonaceous matter. Core uniformly tight, is very slightly calcareous, and has average dip of 15°. Density: 2.5. Slight positive cut with acetone on quartz rich section.

Core No. 38 9772 to 9785 feet. Recovery 3 feet.

Uniform grey-green feldspathic sandstone (greywacke) made up of feldspar, dark rock fragments, chlorite, mica flakes and minor quartz. Grains are fine to medium, angular to rounded. Core is noncalcareous and tight with a few thin carbonaceous and micaceous bands. Dip 20°. Density: 2.60. No oil or gas.

Core No. 39 10,122 to 10,134 feet. Recovery 12 feet.

Interbedded green-grey feldspathic sandstones, (greywacke), and medium to dark grey micaceous and carbonaceous siltstones and mudstones. Sandstone is usually very fine to fine grained, uniform and made up of feldspar, dark rock fragments, chlorite, mica and minor quartz, and is very slightly calcareous in places, with abundant carbonaceous plant remains in bottom section. One section of conglomerate containing mudstone, siltstone, quartzite, ?phyllite and andesite also present. Dip 15°. No apparent oil or gas. Density sandstone: 2.57, mudstone 2.67.

Core Analysis Porosity 11.0% Permeability - less than 0.1 md
Saturation 49% water
Nil Oil

Core No. 40 10,492 to 10,502 feet. Recovery 9 feet.

Medium to dark grey feldspathic, very fine grained sandstone grading into dominant dark grey, micaceous and carbonaceous siltstone and mudstones light and dense. Sandstones have feldspar, dark rock fragments, mica, minor quartz and rare chlorite and are slightly calcareous in parts. Whole core has fair bedding with dip of 15° and is slickensided in places. No apparent oil or gas. Density: 2.63 to 2.65.

Core No. 41 10,801 to 10,817 feet. Recovery 16 feet.

Mainly dark grey to brown grey, feldspathic, micaceous and carbonaceous siltstone and mudstone with thin light grey fine grained feldspathic sandstone (greywacke). bands with constituents as before, and very slightly calcareous in parts. Core is cross bedded and has calcite filling in some of the joints. Dip of 17° to 25°. Density sandstone 2.33, mudstone 2.63. No apparent oil or gas.

Core No. 42 11,087 to 11,092 feet. Recovery 4 feet.

Grey to medium grey, very fine grained sandstone grading into siltstone and mudstone in places. Hard, very dense, non-calcareous and tight. Sandstone made up of feldspar, dark rock fragments, mica, quartz, little carbonaceous matter and few plant fragments. Matrix indeterminate. Few laminated streaks at base with some evidence of cross bedding. Dip 10° to 12°. Density: 2.61. No apparent oil or gas.

Core No. 43 11,225 to 11,235 feet. Recovery 6 feet.

Medium to dark grey, very dense, hard, micaceous mudstone, interlaminated with light grey siltstone, containing feldspar, dark fragments, quartz, mica and carbonaceous matter. Core is cross bedded and fractured, with calcite veins. On top of core is slickensided calcite surface within which is a vugh with oil stained, well developed quartz crystals. Dip 10^{o} to 12^{o}. Density: 2.64. No other evidence of oil or gas.

Core No. 44 11,517 to 11,528 feet. Recovery 11 feet.

Medium to dark grey mudstone and siltstone, feldspathic and micaceous, very dense, hard with thin light grey very fine grained felspathic sandstone which is very slightly calcareous. Core shows vertical fracture with calcite veining in the mudstone, is cross bedded and has carbonaceous plant remains. Dip 12^{o} to 15^{o}. Density sandstone 2.64, mudstone 2.68. Sandstone has slight hydrocarbon smell when broken and has slight Toluene cut.

APPENDIX NO. 4

FORMATION TESTING

Placement

65/86

FORMATION TESTING

OPEN HOLE TESTING

D.S.T. No. 1 5347 to 5396 feet — Paaratte Formation

Bottom choke ½". Set packer at 5347 feet. Slight blow until packer seat failed after 1 minute. Test failed. No fluid recovery - ball on retaining valve did not seat.

I.H.P. 2460 psi F.H.P. 2320 psi

D.S.T. No. 2 5356 to 5396 feet — Paaratte Formation

Bottom choke ½". Set two packers; top at 5349 feet, bottom at 5356 feet. Open for 16 minutes. Fair blow remaining steady throughout flow period until seat failed. Recovered 655 feet of gas cut mud and 920 feet of gas-cut muddy water = 12 bbls. approximate total of 1575 feet of fluid. Salinity of water 12,600 ppm. chlorides. Resistivity 0.33 ohms @ 65°F.

I.H.P. 2410 psi F.H.P. 2310 psi
I.F.P. 1030 " F.F.P. 1030 " steady

D.S.T. No. 3 6891 to 6913 feet — Waarre Formation

Bottom choke ⅜". Set two packers; top at 6882 feet, bottom at 6891 feet. Open for 50 minutes. Shut in for 3 minutes. Good blow remaining steady throughout flowing period. Gas to surface 22 minutes. 100% explosive mixture on gas detector. Collected gas samples. On pulling up on string for shut in pressure packer pulled loose. Recovered 240 feet of gas-cut mud, 1350 feet of gas-cut muddy water, 4564 feet of gas-cut water and 100 feet of gas-cut mud. Total fluid recovered 6254 feet approximately 87.5 bbls. Salinity of water 12,500 ppm chlorides. Temperature 106°F. Resistivity 0.33 ohms @ 66°F (0.16 @ 159°F).

I.H.P. 3600 psi F.H.P. 2275 psi
I.F.P. 2375 " F.F.P. 2750 "

Two bombs run in tailpipe - one loose in perforated pipe. Appears shut in did not work.

D.S.T. No. 4 8103 to 8139 feet — Otway Group

Bottom choke ⅜". Set packer at 8103 feet. Open for 33 minutes. Shut in for 61 minutes. Weak blow, decreasing to very weak. No gas. Recovered 120 feet of drilling mud - very slightly gas-cut. Resistivity of mud = 1.62 ohms @ 57°F. Salinity of filtrate = 3000 ppm.

I.H.P. 4010 psi F.H.P. 4020 psi
I.F.P. Nil F.F.P. 50 "
I.S.I.P. 300 psi F.S.I.P. 480 "

Flow pressures were erratic. During flow period pressure rose to 400 psi, then fell back to zero. A lot of pebbles of cement were found on top of tester with disc breaker, probably from empty pipe. Packer element badly torn.

D.S.T. No. 5 10,898 to 10,974 feet Otway Group

Bottom choke $\frac{3}{8}$". Set packer at 10,898 feet. Tool opened after the third bar was dropped. The packer unseated, the tool was shut, and the packer was re-seated, after opening the tool the packer failed to hold second time. Test unsuccessful.

Recovered 2000 feet of cushion water slightly gas cut and 1300 feet of gas cut mud.

I.H.P. 5750 psi F.H.P. 5550 psi
I.F.P. 2300 "

TESTS THROUGH CASING PERFORATIONS

D.S.T. No. 6 10,842 to 11,528 feet Otway Group

Bottom choke $\frac{5}{8}$". Set packer at 10,797 feet. Open for 368 minutes including swabbing time. Slight immediate blow of air, had to re-seat the packer twice. Blow increased for approximately 10 minutes, then died off until only very faint bubbling before swabbing started after approximately 3 hours. No gas to surface during this time. Swabbed approximately 10 bbls mud with 2 swabs. On attempting third swab, fluid came to surface. Connected tubing head to flare line and cleaned out mud and flared gas. Adjustable choke on wellhead with initial setting of $\frac{3}{4}$" to clean out mud. Flow pressure 500 to 600 psi for approximately 10 minutes. Flow pressure dropped to nil apparently due to well loading up with mud. Altered adjustable choke to various settings without any noticeable flow pressure being recorded. A mud leak was noticed in the annulus and the packer pulled loose. One chart was completely unreadable - and the second chart showed running in until STOP on chart. No flow or swab pressures and only part of coming out was registered. Packer rubbers were all gone when packer brought to surface. Also the retaining ring for these rubbers was jammed over the threads. This possibly happened when having trouble getting into the top of the $5\frac{1}{2}$" liner.

Production Test No. 1 10,842 to 11,528 feet Otway Group

Perforations at 10,842 to 10,844 feet; 10,949 to 10,951 feet; 11,349 to 11,351 feet.

Displaced the tubing with 42 barrels of water and set Guiberson KV 30 production packer at 10,780 feet. Immediate slight flow of water out of tubing. The well was swabbed in at 8.00 pm on October 3, 1961. During the swabbing one of the swab cups was lost in the tubing.

A Gray adjustable choke was fitted to the well head and the well flowed petroliferous gas on a $\frac{3}{4}$" setting on this for its first flow period until 9.52 pm. Flow pressure decreased to 75 psi. (Note: All pressure readings in this report are gauge readings - not absolute). Well making quite a lot of mud and water.

Well shut in from 9.52 pm until 10.32 pm. Shut in pressure built up to 1300 psi. Well flowed 10.32 pm to 10.56 pm on $\frac{3}{4}$" adjustable choke - flow pressure 75 psi. Well shut in 10.56 pm to 11.36 pm. Shut in pressure build up to 1200 psi. Flowed from 11.36 pm to 12.07 am. (Oct. 4, 1961) with 75 psi flow pressure on $\frac{3}{4}$" choke. During this flow period there was evidence that the well was making condensate. A small quantity collected in the separator had a greenish-brown colour and a gravity of 51.2°A.P.I. at 60°F (S.G. = 0.773). Apart from the mud being brought up there was no evidence of any other formation fluid.

Well shut in from 12.07 am to 1.07 am - shut in pressure 1300 psi. Flowed well from 1.07 am to 2.45 am on different settings on the adjustable choke. Flow pressures were as follows for the different sizes:

$\frac{3}{4}$"	-	Flow pressure	75 psi
$\frac{1}{2}$"	-	" "	120 - 200 psi
5/16"	-	" "	200 - 225 psi
$\frac{1}{4}$"	-	" "	225 - 275 psi

Well was still cleaning out mud and a small (not measurable) quantity of condensate was produced. Shut in from 2.45 am to 3.45 am - build up to 1250 psi. Well flowed from 3.45 am to 5.00 am. Flow pressure 25 psi on $\frac{3}{4}$" adjustable choke.

Well shut in from 5.00am to 8.20 am and during this period the shut-in pressure built up to 1425 psi at 6.00 am and then dropped to 900 psi at 8.20 am when the well was again opened. The implications of this drop in shut in pressure are discussed later in this report.

Well flowed from 8.20 am to 10.05 am on $\frac{1}{2}$" setting on adjustable choke at flow pressure of 60 psi. As the well appeared to be still cleaning out mud it was decided to keep flowing and shutting it in until it was cleaned and had stabilised before trying to obtain any volume readings and the following times and readings were obtained:

Shut in from 10.05 to 11.38 am - S.I.P. 1200 psi
Flowed " 11.38 to 1.34 pm - F.P. 200 psi on $\frac{1}{4}$" choke (adjustable)
Shut in " 1.34 to 4.30 pm - S.I.P. 1450 psi

During this last shut in time the adjustable choke on the well head was changed to a National positive choke housing and a $\frac{1}{2}$" positive choke inserted. Also, the meter run was installed downstream of the separator. This consisted of a 4" meter run with a Kent Dri-Flow meter with 2500 psi static element and 100 inches of water full scale differential reading. At the start a $1\frac{1}{2}$" orifice plate (O.D. - 7 inches) was put in the meter run.

Well flowed from 4.30 to 6.30 pm on $\frac{1}{2}$" positive choke - no flow pressures. taken while checking meter. Shut in from 6.30 pm to 8.35 pm S.I.P. 1125 psi. Flowed from 8.35 to 10.10 pm without any positive choke and it was obvious that the well was still cleaning out mud with a small amount of condensate. Still no evidence of any water being produced.

It was decided to let the shut in build up to 800 psi and then blow it down again to help clean out the well.

Well shut in 10.10 pm to 11.30 pm - S.I.P. 800 psi
" flowed 11.30 pm to 1.00 am (Oct.5,1961) F.P. 25 psi on $\frac{3}{4}$" choke
" shut in 1.00am to 4.00 am - S.I.P. 800 psi
" flowed 4.00 am to 5.30 am - F.P. 25 psi on $\frac{3}{4}$" choke
" shut in 5.30 am to 7.30 am - S.I.P. 800 psi
" flowed 7.30 am to 9.00 am - F.P. 25 psi on $\frac{3}{4}$" choke
" shut in 9.00 am to 12.15 pm - S.I.P. 1025 psi

The latter shut in was let go higher to see if the well would clean up quicker on a higher build up of pressure.

Flowed well from 12.15 pm to 1.35 pm Oct. 5,1961 on $\frac{3}{4}$" positive choke with flow pressure dropping to 25 psi and still obtaining some mud. Shut in from 1.35 pm to 4.30 pm - S.I.P. 925 psi. Flowed from 4.30 pm to 7.00 am (Oct.6.1961) with flow pressure of 25 psi without well head choke at all and during this time small amount of muddy water and condensate was evident. On filtering this muddy water it was obvious that it was mud filtrate due to its dark red colour (Myrtan) and a salinity of 2700 ppm chlorides - the same as the mud. The amount of mud, mud filtrate and condensate produced was still hard to gauge, being a small amount measureable in gallons rather than bbls, but appeared to be in the ratio of 2/3 mud and filtrate to 1/3 condensate.

During this flow period a rough approximation of the flow was obtained through the meter run using a 1" orifice plate. This was the smallest orifice plate we had and with a well head flow pressure of only 25 psi a readable downstream pressure on the meter run was hard to obtain - even by pinching back a downstream valve to back pressure the system. Also, downstream pressures on the chart were hard to determine as the static element in the meter has a full scale range up to 2500 psi. An approximation of the flow during this time was 250 Mcfd.

Well then shut in from 7.00 am to 12.35 pm with shut in build up to 950 psi. Flowed again from 12.35 pm to 5.20 p.m. on $\frac{1}{2}$" choke with 25 psi flow pressure. Considerable amount of mud obtained during the flow period and it was obvious that the well was still not clean. It appeared that a long draw down followed by a fairly long shut in seemed to clear the well better. Shut in from 5.20 pm to 8.45 pm - S.I.P. of 700 psi and then flowed from 8.45 pm to 7.00 am (7.10.61) with a flow pressure of 25 psi on $\frac{1}{2}$" choke. During this time an approximation of the flow was 200 Mcf/24 hours with about 10 gals. of condensate produced during this flow period and not very much mud at all.

Well then shut in from 7.00 am to 4.30 p.m with S.I.P. of 1000 psi and flowed on $\frac{1}{2}$" choke from 4.30 p.m. to 12 midnight (Oct.7) with a flow pressure of 15 to 20 psi. During this flow period, there was still evidence of mud and it was obvious that the well was still not clean. Shut in well from 12 midnight to 10.10 am (Oct.8, 1961) with build up to 900 psi and flowed well from 10.10. am on $\frac{3}{4}$" well head choke until

pressure down to 15 to 20 psi and then decided to rig up swab to see where fluid level was and if we could increase the flow pressures, etc.

Ran sinker bars without swab cups and bars were held up at 7560 feet. A $\frac{1}{2}$" stinger run on the end of the bars was also held up at this point. Due to this obstruction it was felt necessary to pull the packer loose so as to be able to find the obstruction and re-test the zone. Consequently the packer was pulled loose at 7.45 pm on 8.10.61 after first filling the tubing and space below the packer with approximately 82 bbls of mud.

After pulling the test, two disc breaker bars (as used for the Johnston tester but which have not been used in tubing in this hole) plus rubber from the rubber elements lost off the Johnston tester on D.S.T. No. 6 were found to be causing the obstruction. The rubber element on the Guiberson K.V. 30 production packer was also found to be lost when the tool was pulled out.

Due to the time that it took the well to clean up it was first thought that the cement between this test zone and the next one higher (9,750 to 10,100 feet) may have broken down and that we were draining both zones of mud. However, on the amount of mud pumped back into the tubing before the packer was pulled loose, this does not seem a possibility, the amount being similar to our calculations for the mud in this bottom zone plus the tubing. It was also felt that the breakdown in shut in pressure on October 4, might have been indicative of this cement bond breaking down. The reason for this decrease in shut in pressure is not apparent but may be allied in some way to the obstruction in the pipe.

Graphs were made of selected shut in pressure build-ups on successive days and it was obvious that the trend was for falling pressure with increase in time (see attached Figure 1). The break down in pressure on October 4 was particularly noticeable. From later testing it appeared that the flow rate of 250 Mcfd through 2" tubing was the highest rate at which the well would produce on an extended flow test.

Production Test No. 2 - 10,842 to 11,528 feet

Guiberson KV 30 production packer set at 10,744 feet. Open for $7\frac{1}{2}$ hours. Perforations at 10,842 to 10,844 feet, 10,949 to 10,951 feet, 11,349 to 11,351 feet. Before setting packer displaced tubing with 43 bbls water. Swabbed tubing to 9500 feet without noticeable fluid rise when sandline broke and dropped swab and sinker bars in tubing. Pulled test.

Production Test No. 3 - 10,842 to 11,528 feet

Guiberson KV 30 production packer set at 11,196 feet. Open for $6\frac{3}{4}$ hours. Perforations at 10,842 to 10,844 feet; 10,949 to 10,959 feet; 11,341 to 11,351 feet (4 shots per foot). Displaced tubing with water before setting packer and set packer in between bottom two perforations. Swabbed tubing to 7700 feet (approximately 21 bbls water). No notice-

able fluid rise. Test pulled.

Production Test No. 4 - 10,842 to 11,528 feet

Guiberson KV 30 production packer set at 10,775 feet. Open for 6 hours. Perforations at 10,842 to 10,844 feet; 10,949 to 10,959 feet; 11,341 to 11,351 feet (4 shots per foot). Displaced tubing with water before setting packer. Swabbed tubing to 7425 feet (approximately 26 bbls water). No noticeable fluid rise or evidence of gas. Pulled test.

Production Test No. 5 - 10,842 to 11,528 feet

Guiberson KV 30 production packer set at 10,744 feet. Open for 1½ hours. Perforations at 10,842 to 10,844 feet; 10,922 to 10,928 feet; 10,949 to 10,959 feet; 11,090 to 11,096 feet; 11,178 to 11,184 feet; 11,219 to 11,225 feet; 11,230 to 11,236 feet; 11,341 to 11,351 feet. Displaced tubing with water before setting packer. Swabbed tubing to 10,725 feet. No noticeable fluid rise. Pulled test.

Production Test No. 6 - 10,837 to 11,528 feet

Halliburton R.T.T.S. Set packer at 10,734 feet. Swabbed 62 bbls of water. Packer was not holding. Pulled test.

Production Test No. 7 - 10,837 to 11,528 feet

Halliburton R.T.T.S. Set packer at 10,781 feet. Swabbed 11.5 bbls water before water level dropped in casing. Pulled test.

Production Test No. 8 - 10,837 to 11,528 feet

Halliburton R.T.T.S. Set packer at 10, 724 feet. Pulled one swab 14 bbls of water before water level dropped in casing. Pulled test.

D.S.T. No. 7 - 10,837 to 11,528 feet.

Bottom choke $\frac{5}{8}$". Set packer at 10,724 feet. Bar did not rupture disc. Tubing full of water. Ran swab, water dropped in casing. Pulled test.

D.S.T. No. 8. - 10,837 to 11,528 feet

Bottom choke $\frac{5}{8}$". Set packer at 10,724 feet. Weak blow increased to fair then dead after 80 minutes. Swabbed 7 bbls gas-cut water with small amount of free gas; 1.5 bbls gas-cut water and 1.0 bbls water, before sandline parted when swabbing from the depth of the tester. Pulled test.

Production Test No. 9 - 10,837 to 11,528 feet

Halliburton R.T.T.S. Set packer at 10,644 feet. Twenty-seven bbls of water were swabbed to as far as 9400 feet. On a run to 10,000 feet the sandline parted. No gas was noticed. Pulled test.

D.S.T. No. 9 - 9720 to 10,130 feet

Bottom choke $\frac{5}{8}$". Set packer at 9625 feet. Open for 35 minutes. The tool opened with very violent shaking. No blow was observed at the surface. Recovered 3000 feet of very gas cut mud. Weight: 8.3 lb.gal. Salinity of filtrate 14,200 ppm. Pulled test.

I.H.P. 4750 psi	F.H.P. 4400 psi
I.F.P. 1000 "	F.F.P. 1525 " (up)

Production Test No. 10 - 9720 to 10,130 feet

Halliburton R.T.T.S. Set packer at 9655 feet. After washing out perforated zones packer was set for swabbing. Ran 2 swabs to 1100 feet, pulled 4.5 bbls. Packer failed to hold. Pulled test.

D.S.T. No. 10 - 9720 to 10,130 feet

Bottom choke $\frac{5}{8}$". Set packer at 9655 feet. Open for 85 minutes. Very weak blow appeared after 27 minutes, dead after 5 minutes. Dry test. 5800 feet of water was recovered from tubing. Water entry into tubing due to main valve opening during trip.

I.H.P. 4400 psi	F.H.P. 4300 psi
I.F.P. 4000 "	F.F.P. 4000 "

D.S.T. No. 11 - 9240 to 9258 feet

Bottom choke $\frac{5}{8}$". Set packer at 9197 feet. Very weak bubbling for 13 minutes, 4 minutes after dropping bar. Disc did not rupture, bubbles and 641 feet recovered water were from tubing leaks.

I.H.P. 4000 psi	F.H.P. 4000 psi
I.F.P. 4000 "	F.F.P. 4000 "

D.S.T. No. 12 - 9240 to 9258 feet

Bottom choke $\frac{5}{8}$". Set packer at 9197 feet. Open for 5 hours. Weak immediate blow which was dead after 30 minutes. Ran swab to 4500 feet, recovered no fluid but lost fluid from casing. Filled tubing with 21.5 bbls of water and pumped soft line to mark leak with 17 bbls. Pumping pressure of 1000 psi jumped to 2100 psi. Tubing leaked. Pulled test.

I.H.P. 4200 psi	F.H.P. 4200 psi
I.F.P. 350 "	F.F.P. 1650 "

D.S.T. No. 13 - 9240 to 9258 feet

Bottom choke $\frac{5}{8}$". Set packer at 9197 feet. Open for 142 minutes. Immediate good blow, opened valve after 20 minutes for pressure bleed-off and no further pressure build up. Ran swab to 7500 feet, no fluid found. 950 feet of slightly gas-cut water was recovered. Salinity 26,500 ppm.

I.H.P. 4250 psi	F.H.P. 4200 psi
I.F.P. 325 "	F.F.P. 475 "

D.S.T. No. 14 - 8518 to 8528 feet, 8462 to 8480 feet

Bottom choke $\frac{5}{8}$". Set packer at 8433 feet. Open for 96 minutes. Good blow was received two minutes after the tool was opened. After 13 minutes the pressure was released periodically by a 2" valve. Gas came to the surface 50 minutes after the tool was opened and a small flame was lit 18 minutes later. After 15 minutes fluid was lost from casing. Re-set packer but packer did not hold and was pulled loose 13 minutes later. Recovered 3650 feet gas cut water, salinity 25,600 ppm. The tailpipe contained mud from which about 10 ccm light green petroleum jelly-like substance (bluish white fluorescence) was washed out. This was later found to be a refined product.

I.H.P.	3700 psi	F.H.P.	3900 psi
I.F.P.	350 "		

D.S.T. No. 15 - 8518 to 8528 feet, 8462 to 8480 feet

Bottom choke $\frac{5}{8}$". Set packer at 8435 feet. Open for 4 hours and 32 minutes. Shut in for 168 minutes. Received a fair blow immediately after dropping bar, which increased to good. Gas appeared at surface 3 hours, 20 minutes later. Gas burned with small yellow smoky flame. The well was shut in on the surface for 168 minutes and the pressure increased from 3 to 14 psi. Pulled 3 swabs from 7560 feet from which the first and third were dry. The second recovered 1 bbl of water. 1465 feet of water was recovered from the tubing. Salinity from top of fluid 24,700 ppm, bottom of fluid 19,600 ppm.

I.H.P.	3800 psi	F.H.P.	3800 psi
I.F.P.	475 "	F.F.P.	675 "
I.S.I.P.	700 "	F.S.I.P.	825 "

D.S.T. No. 16 - 6875 to 6881 feet

Bottom choke $\frac{1}{2}$". Set packer at 6861 feet. Open for 174 minutes. Shut in for 90 minutes. Immediate weak blow increasing to very good. Gas at surface after 54 minutes and small flame lit 4 minutes later. Flow pressure on surface approximately 3 psi. Shut in pressure 3 psi, 65 minutes later 10 psi and after 25 more minutes 7 psi. Recovered full string of fluid. 1109 feet of mixed formation and casing water, 5490 feet of formation water, 182 feet of mixed formation and casing water. A total of 6781 feet of gas-cut water. Salinity 13,300 ppm. Rw 0.335 ohms at 62°F.

I.H.P.	3200 psi	F.H.P.	3200 psi
I.F.P.	500 "	F.F.P.	2800 "
I.S.I.P.	2900 "	F.S.I.P.	2900 "

APPENDIX NO. 5

DETAILED LITHOLOGICAL DESCRIPTION

APPENDIX 5

DETAILED LITHOLOGICAL DESCRIPTION

Heytesbury Group

Surface to 520 feet	Limestone, yellow-tan to light grey, very fossiliferous, fragmentary, very porous.
520 to 1685 "	Marl, medium grey to blue grey, soft, puggy, very fossiliferous with few glauconite pellets.
1685 to 1703 "	Limestone, pink to yellow, very fossiliferous with sand grains and limonite.
1703 to 1918 "	Marl, medium grey to blue grey, soft, puggy, very fossiliferous with few glauconite pellets.
1918 to 1921 "	Limestone, buff to light tan, very fossiliferous.
1921 to 1923 "	Sand, mainly fine to medium grained, clear quartz.
1923 to 1925 "	Limestone, buff to light tan, very fossiliferous.
1925 to 1927 "	Sand, mainly fine to medium grained, clear quartz.
1927 to 1938 "	Limestone, buff to light tan, very fossiliferous.
1938 to 1942 "	Sand, mainly fine to medium grained, clear quartz with limonite pellets.
1942 to 2008 "	Marl, medium grey to blue-grey, soft, puggy, very fossiliferous, silty in parts with few glauconite pellets.

Wangerrip Group

2008 to 2015 "	Limestone, sandy, buff to light tan, fossiliferous.
2015 to 2039 "	Sand, loose, clear brown, medium to coarse grained, subrounded to rounded polished grains.
2039 to 2041 "	Limestone, sandy, buff to light tan, fossiliferous.
2041 to 2056 "	Sand, loose, clear brown, medium to coarse grained, subrounded to rounded polished grains.
2056 to 2057 "	Limestone, sandy, buff to light tan, fossiliferous.
2057 to 2069 "	Sand, loose, clear, brown, medium to coarse grained, subrounded to rounded polished grains.

Wangerrip Group (Cont'd)

2069 to 2071	feet	Limestone, sandy, buff to light tan, fossiliferous.
2071 to 2100	"	Sand, loose, clear, brown, red, medium to coarse grained subrounded to rounded, polished grains. Trace of pyrite.
2100 to 2213	"	Mudstone, dark green, soft, glauconitic, vugular with calcite fillings.
2213 to 2232	"	Sand, loose, clear, light brown, iron stained, red, medium to very coarse grained, mainly coarse, subrounded to wellrounded, fairly well sorted, grains polished. Traces of pyrite.
2232 to 2235	"	Siltstone, brown, soft, micaceous.
2235 to 2247	"	Sand, loose, clear, light brown, iron stained, red, medium to very coarse grained, mainly coarse, subrounded to wellrounded, fairly well sorted, grains polished. Traces of pyrite.
2247 to 2249	"	Siltstone, brown, soft, micaceous.
2249 to 2355	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to wellrounded, fairly well sorted, grains polished. Traces of pyrite.
2355 to 2365	"	Siltstone, brown, soft, micaceous. ? not
2365 to 2395	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to wellrounded, fairly well sorted, grains polished. Traces of pyrite.
2395 to 2403	"	Siltstone, brown, soft, micaceous.
2403 to 2420	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded.
2420 to 2441	"	Sand, loose, clear, light brown, iron-stained, very coarse to granule.
2441 to 2451	"	Siltstone, brown, soft, micaceous.
2451 to 2471	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted, grains polished. Traces of pyrite.

Wangerrip Group (Cont'd)

2471 to 2495	feet	Siltstone, brown, soft, micaceous.
2495 to 2634	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted, some polished grains. Traces of pyrite.
2634 to 2655	"	Siltstone, brown, soft, micaceous.
2655 to 2702	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted, some polished grains. Traces of pyrite.
2702 to 2705	"	Siltstone, brown, soft, micaceous.
2705 to 2743	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted, some polished grains. Traces of pyrite.
2743 to 2748	"	Siltstone, brown, soft, micaceous.
2748 to 2758	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted. Some polished grains. Traces of pyrite.
2758 to 2760	"	Siltstone, reddish brown to brown, soft, compact.
2760 to 2860	"	Sand, loose, clear, light brown, iron-stained, red, medium to very coarse grained, mainly coarse, subrounded to well rounded, fairly well sorted, grains polished. Traces of pyrite.
2860 to 2880	"	Sand to gravel, white, clear quartz to dirty medium to very coarse grained, mainly medium. Subangular to rounded, some polished grains. Traces of pyrite.
2880 to 2890	"	Sand, white, clear quartz, medium to coarse, subrounded to rounded.
2890 to 2900	"	Sand to gravel, white, clear, quartz to dirty medium to very coarse grained, mainly medium, Subangular to rounded, some polished grains. Traces of pyrite.
2900 to 2950	"	Sand, white, clear quartz, medium to coarse, subrounded to rounded.

Wangerrip Group (Cont'd)

2950 to 2980	feet	Siltstone, dark grey-brown to greenish-brown, soft, tight, micaceous, dirty.
2980 to 2995	"	Sand, light brown, iron-stained, clear quartz, fine to coarse, mainly medium grained.
2995 to 3003	"	Siltstone, dark grey-brown to greenish-brown, soft, tight, micaceous, dirty.
3003 to 3060	"	Sand, light brown, clear to iron-stained, quartz, fine to coarse, mainly medium grained, angular to subrounded, poorly sorted. Pyrite.
3060 to 3200	"	Sandy siltstone to silty sandstone, dark brown to greyish brown to greenish brown.
3200 to 3220	"	Sand, light brown, clear to iron-stained, quartz, fine to coarse, mainly medium grained, angular to subrounded, poorly sorted.
3220 to 3260	"	Sandy siltstone, dark brown to greyish brown to greenish-brown.
3260 to 3270	"	Sand, light brown, clear to iron-stained quartz, fine to coarse, mainly medium grained, angular to subrounded, poorly sorted.
3270 to 3283	"	Sandy siltstone, dark brown to greyish-brown to greenish-brown.
3283 to 3308	"	Sand, light brown to clear, white, fine to coarse grained, mainly medium, subangular to rounded with limonite grains.
3308 to 3311	"	Sandy siltstone, dark brown to greyish brown to greenish brown.
3311 to 3380	"	Sand, light brown to clear, white, fine to coarse, mainly medium grained, subangular to rounded with limonite grains.
3380 to 3390	"	Sand, gravel, red to brown, very dirty, medium to granule, poorly sorted.
3390 to 3603	"	Sand to sandstone, clear to light brown, dirty, fine to coarse grained, angular to subrounded, pyritic.
3603 to 3607	"	Dolomite to sandy dolomite, light brown.
3607 to 3615	"	Siltstone, dark grey, compact.

Wangerrip Group (Cont'd)

3615 to 3706	feet	Sand to sandstone, clear to light brown, dirty, fine to granule, mainly medium grained, angular to subrounded, pyritic.
3706 to 3711	"	Siltstone, dark grey, compact.
3711 to 3713	"	Sandy dolomite, light brown.
3713 to 3722	"	Siltstone, dark grey, compact.
3722 to 3739	"	Sand, clear to light brown, dirty, medium to coarse grained.
3739 to 3740	"	Siltstone, dark grey, compact.
3740 to 3780	"	Sand, clear to light brown, dirty, medium to coarse.
3780 to 3782	"	Siltstone, dark grey, compact.
3782 to 3821	"	Sand, clear to light brown, dirty, medium to coarse grained.
3821 to 3827	"	Siltstone, dark grey.
3827 to 3849	"	Sand, clear to light brown, dirty, medium to coarse grained.
3849 to 3861	"	Siltstone, dark grey.
3861 to 3870	"	Sand, clear to light brown, dirty, medium to coarse grained.
3870 to 3891	"	Siltstone, dark grey.
3891 to 4000	"	Sand, white quartz, fine to very coarse grained.
4000 to 4015	"	Siltstone, green to greenish-grey, glauconitic.
4015 to 4035	"	Sand, white, fine to coarse grained.
4035 to 4040	"	Siltstone, green to greenish-grey, glauconitic.
4040 to 4042	"	Sand, white, fine to coarse grained.
4042 to 4050	"	Siltstone, green to greenish-grey, glauconitic.
4050 to 4072	"	Sand, white to coarse grained.
4072 to 4132	"	Siltstone, medium grey to greenish-grey, glauconitic with some pyrite and mica, fossiliferous.

Wangerrip Group (Cont'd)

4132 to 4170	feet	Sand, clear to white to yellow quartz, angular to subrounded, fine to coarse grained.
4170 to 4172	"	Coal.
4172 to 4190	"	Sand, clear to white to yellow quartz, angular to subrounded, fine to coarse grained.
4190 to 4220	"	Sand to granules, grey to white to yellow, very coarse grained, angular.
4220 to 4235	"	Sand, quartz, grey-white-yellow, medium to coarse grained, angular.
4235 to 4240	"	Dolomite to dolomitic sandstone, light to dark grey, fine grained, dense.
4240 to 4250	"	Sandstone, light grey to buff, very fine to fine grained, well cemented with dolomitic cement.
4250 to 4282	"	Siltstone, medium to dark grey, compact with pyrite and carbonaceous material.
4282 to 4287	"	Dolomitic to calcareous sandstone.
4287 to 4300	"	Sandstone, light grey to white, dense, very fine to fine grained.
4300 to 4310	"	Siltstone, medium to dark grey, plant remains.
4310 to 4315	"	Sandstone, light grey, very fine grained.
4315 to 4330	"	Siltstone, dark grey, mica, glauconite, plant remains.
4330 to 4345	"	Sandstone, light grey, very fine grained.
4345 to 4349	"	Dolomitic sandstone, light brown, hard, dense, glauconitic.
4349 to 4363	"	Sand, light brown to red, loose, medium to coarse grained, angular to subangular.
4363 to 4470	"	Siltstone, medium to dark grey, tight, compact, glauconitic, sandy in places with a few white, very fine to fine sandstone bands. Slightly dolomitic at base.
4470 to 4550	"	Sandstone, light grey to buff, fine grained, angular to subangular. Glauconite, dark minerals, carbonaceous matter. Interbedded with thin intra-formational conglomerate of quartz and sandstone in siltstone matrix.

Wangerrip Group (Cont'd)

4550 to 4833 feet		Sandstone, light to dark grey, very fine to coarse grained, angular to subangular, fairly tight. Dolomite cemented bands. Interbedded with siltstone, medium to dark grey, glauconitic pyritic.

Paaratte Formation

4833 to 5070	"	Siltstone to silty mudstone, dark brownish-grey, glauconitic, micaceous, with carbonaceous material, fossils and resin. Interbedded with few bands of sandstone, dolomitic in parts.
5070 to 5115	"	Sand, clear, white, very fine to coarse grained, poorly sorted, subangular to rounded.
5115 to 5265	"	Siltstone-mudstone, dark grey, micaceous with carbonaceous material, sandy in parts. Ankerite concretions.
5265 to 5275	"	Sandstone, light grey to buff, fine grained, dirty.
5275 to 5282	"	Siltstone-mudstone, dark grey, micaceous with carbonaceous material.
5282 to 5300	"	Sandstone, light grey to buff, fine.
5300 to 5350	"	Silty mudstone to silty sandstone, dark to greenish-grey, micaceous, glauconitic with ankerite concretions.
5350 to 5423	"	Quartz sandstone, greenish-grey, clear to white, fine to coarse grained, mainly medium, subangular to subrounded, glauconitic, with dark minerals and carbonaceous material.
5423 to 5527	"	Siltstones to sandy siltstone, lenticular, medium to dark grey, micaceous, glauconitic, with carbonaceous material and traces of pyrite and resin. Interbedded with thin lenses of sandstone, white to light grey, very fine to fine grained. Cemented in places with dolomite. Ankerite bands and concretions present.
5527 to 5540	"	Sand to sandstone, light grey, silty, very fine to coarse grained, unsorted, angular to subrounded, glauconitic, chloritic with carbonaceous material.
5540 to 5570	"	Siltstones to sandy siltstone, medium to dark grey micaceous, glauconitic with carbonaceous material. Ankerite band.

Belfast Mudstone

5570 to 6490 feet	Mudstone, dark to brownish-grey, compact, glauconitic, micaceous, with fossils and plant remains. Interbedded with thin streaks and concretions of ankerite.

Flaxmans Beds

6490 to 6876 "	Limonitic sandstone and chloritic greywacke, brown to greenish-brown, compact with limonite pellets, carbonaceous material, pyrite. Green (chloritic) silty matrix. Quartz grains subordinate. Some mica and rock fragments.

Waarre Formation

6876 to 7003 "	Sandstone, fine to pebbly, clear to dark grey, clear quartz grains to dirty sand bedded in dark silt material. Grains are subangular to subrounded, unsorted. Interbedded with dark grey carbonaceous pyritic mudstones.
7003 to 7012 "	Siltstone, dark grey, carbonaceous material.
7012 to 7090 "	Sandstone, fine grained to pebbly, angular to subrounded, unsorted with thin beds of vitreous coal.
7090 to 7178 "	Siltstone-mudstone, dark grey, fine, micaceous.
7178 to 7210 "	Sandstone, light grey mottled fine to medium grained. Clear quartz with some decomposed feldspar, green chlorite and carbonaceous material.
7210 to 7228 "	Siltstone, dark grey, dense, compact, with carbonaceous material and resin.
7228 to 7246 "	Sandstone, light grey, fine to medium grained, feldspathic.
7246 to 7270 "	Coal, vitreous, fractured with dark brown to black clay.
7270 to 7330 "	Sandstone, clear to white, fine to coarse grained.

Otway Group

7330 to 7680 feet	Sandstone to subgreywacke, greenish-grey, mottled, fine to coarse grained, mainly medium, well sorted, consisting of quartz, feldspar, chlorite, dark rock fragments, with traces of red grains, alternating with dark grey siltstones. Thin bands of carbonaceous mudstone to coal.

Otway Group (Cont'd)

7680 to 7767	feet	Sandstone, feldspathic to subgreywacke, greenish-grey mottled, fine to coarse with distinctive orange red coloured zeolite (Heulandite) alternating with dark grey siltstone and light grey to brown hard, dense mudstone.
7767 to 7845	"	Subgreywacke, greenish grey, medium to coarse grained, made up of feldspar, dark rock fragments, chlorite, quartz and orange coloured mineral, slightly calcareous.
7845 to 8175	"	Subgreywacke, greenish-grey, alternating with grey slightly greenish-grey micaceous greywacke with thin pockets of siltstone.
8175 to 8222	"	Mudstone, grey to greenish-grey micaceous.
8222 to 8230	"	Subgreywacke, greenish-grey.
8230 to 8342	"	Mudstone, light grey to grey, dense, siliceous.
8342 to 8352	"	Subgreywacke, greenish-grey.
8352 to 8390	"	Mudstone, light to medium grey, dense, siliceous.
8390 to 8730	"	Subgreywacke, greenish-grey, alternating with siltstone dark grey, micaceous with carbonaceous material and mudstone, light to medium grey, compact, siliceous.
8730 to 8782	"	Siltstone to very fine feldspathic sandstone, grey with large flakes of mica and carbonaceous material.
8782 to 8800	"	Mudstone, grey to greenish-grey, hard, siliceous.
8800 to 8872	"	Siltstone to very fine feldspathic sandstone, grey, micaceous.
8872 to 8970	"	Siltstone, light to medium to dark grey, micaceous, with carbonaceous material, alternating with greenish grey subgreywacke and light to greenish grey mudstone.
8970 to 9037	"	Mudstone. Light to medium to greenish grey, hard, dense.
9037 to 9235	"	Siltstone to very fine sandstone, light to greenish grey, micaceous with carbonaceous material, interbedded with mudstone, light to greenish to brownish-grey.

Otway Group (Cont'd)

9235 to 9277 feet	Sandstone to subgreywacke, cream to buff to light grey medium, calcareous, tight, containing quartz, feldspar, calcite, mica, chlorite, dark rock fragments.
9277 to 9297 "	Siltstone, light to grey to brownish grey, micaceous with very fine texture.
9297 to 9338 "	Sandstone to subgreywacke, light grey, very fine to fine grained, light, angular to subrounded grains.
9338 to 9500 "	Mudstone, medium to greenish-brownish grey, hard, dense, alternating with siltstone, light grey to grey micaceous, and sandstone, greenish-grey, feldspathic.
9500 to 9565 "	Subgreywacke, light to greenish-grey, speckled, tight consisting of feldspar, quartz, dark rock fragments, coarse flakes of mica and chlorite.
9565 to 9665 "	Siltstone, medium to dark grey, micaceous, alternating with mudstone, grey to dark grey, hard, siliceous, with bands of subgreywacke and dark brown to black shiny coal.
9665 to 9795 "	Subgreywacke, greyish green to dark green, consisting of feldspar, dark rock fragments, chlorite, mica and quartz, with a band of mudstone.
9795 to 10,195 "	Subgreywacke, greenish-grey, interbedded with mudstone medium to dark grey, and siltstone, grey to brownish-grey.
10,195 to 10,393 "	Subgreywacke, greenish to brownish grey, fine to medium grained.
10,393 to 11,528 "	Alternating greenish-grey subgreywacke with medium to dark grey mudstones and light to brownish grey, micaceous siltstones with carbonaceous material. Oil stained quartz crystals 10,928 feet.

APPENDIX No. 6

HOLE DEVIATION

by

Totco & Schlumberger Methods.

DEVIATION SURVEYS

Totco Readings

Depth (feet)	Deviation (degrees)	Depth (feet)	Deviation (degrees)
280	1/8	6912	1 7/8
610	1/2	7385	3 1/4
1045	1	7591	2 1/2
1305	1/4	7768	2
2210	1/4	7966	1 1/2
2312	1	8139	2
2800	1	8321	1 1/2
3275	1/4	8882	3 1/2
3540	1	8974	3 1/2
4126	2	9120	3 1/2
4309	2	9300	3
4479	1	9943	3
4687	2 1/4	10,122	3
4970	2	10,340	3 1/4
5155	2	10,697	5 1/4
5683	2 1/2	10,801	6
5940	2 3/4	10,932	7
6179	2 1/2	11,081	7
6335	2 3/4	11,528	5 1/2
6755	2 1/2		

Schlumberger Readings

Depth (Feet)	Deviation (degrees)	Azimuth (Rel. to T.N.)
3616) 3622)	1	181
3658	0.30	181
4751) 4753)	2.15	221
4808	2.15	211
4895	1.45	206
5360	2.30	201
5397	1.45	188
5477	145	176
5540	2.15	196
7054	2	161
7238) 7240)	3.15	166
7268	3	166
7302) 7305)	3.15	156
7392) 7420)	3	161
7452) 7462)	2.45	151
7472	2.45	156
7523) 7532)	2.45	156
7592	2.30	156
7725	2.15	161
7845	1.45	146
7882) 7884)	1.30	151
7910) 7920)	1.30	151
8050	1.15	161
8228	1.30	191
8268	1.45	191
8380) 8398)	1.30	186
8440) 8446)	1.15	161
8478) 8490)	1.30	161
8517) 8522)	1.15	171
8562	1.45	156
8574	1.30	166
8599	1.45	161
8748	2	171
8818) 8828)	3.15	166
8866	3.30	161
8912	3.15	171
8952) 8962)	3.30	161
9116) 9126)	3.15	151
9148) 9152)	3.15	156
9347	3.15	191
9471	3.15	161
9650	3	186
9800	3	201
9950	3	201
10,135	3	201
10,300	4	196
10,450	4	181
10,600	4.45	171

ILLUSTRATIONS:

PE904020

This is an enclosure indicator page.
The enclosure PE904020 is enclosed within the container PE905764 at this location in this document.

The enclosure PE904020 has the following characteristics:

ITEM_BARCODE	= PE904020
CONTAINER_BARCODE	= PE905764
NAME	= Stratigraphic Column
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= STRAT_COLUMN
DESCRIPTION	= Stratigraphic Column Prior to Drilling (enclosure from WCR) for Flaxmans-1
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)

PE905763

This is an enclosure indicator page.
The enclosure PE905763 is enclosed within the container PE905764 at this location in this document.

The enclosure PE905763 has the following characteristics:

ITEM_BARCODE	= PE905763
CONTAINER_BARCODE	= PE905764
NAME	= Locality Map for Flaxmans-1
BASIN	= OTWAY
PERMIT	= PEP/5
TYPE	= WELL
SUBTYPE	= MAP
DESCRIPTION	= Locality Map (illustration, plate-1 from WCR) for Flaxmans-1
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= FLAXMANS-1
CONTRACTOR	=
CLIENT_OP_CO	= FROME-BROKEN HILL CO. PTY. LTD.

(Inserted by DNRE - Vic Govt Mines Dept)

PE904021

This is an enclosure indicator page.
The enclosure PE904021 is enclosed within the container PE905764 at this location in this document.

The enclosure PE904021 has the following characteristics:

ITEM_BARCODE	= PE904021
CONTAINER_BARCODE	= PE905764
NAME	= Stratigraphic Column
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= STRAT_COLUMN
DESCRIPTION	= Stratigraphic Column After Drilling (enclosure from WCR) for Flaxmans-1
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)

PE904022

This is an enclosure indicator page.
The enclosure PE904022 is enclosed within the container PE905764 at this location in this document.

The enclosure PE904022 has the following characteristics:

ITEM_BARCODE	= PE904022
CONTAINER_BARCODE	= PE905764
NAME	= Geological Cross Section
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= CROSS_SECTION
DESCRIPTION	= Geological Cross Section b/w Port Campbell no 3 & proposed Flaxmans no. 1 Plate 3 (enclosure from WCR) for Flaxmans-1'
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)

PE904024

This is an enclosure indicator page.
The enclosure PE904024 is enclosed within the container PE905764 at this location in this document.

The enclosure PE904024 has the following characteristics:

ITEM_BARCODE	= PE904024
CONTAINER_BARCODE	= PE905764
NAME	= Geological Cross Section
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= CROSS_SECTION
DESCRIPTION	= Geological Cross Section b/w Port Campbell no 2 & Flaxmans No 1 Plate 6 (enclosure from WCR) for Flaxmans-1
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)

PE904023

This is an enclosure indicator page.
The enclosure PE904023 is enclosed within the container PE905764 at this location in this document.

The enclosure PE904023 has the following characteristics:

ITEM_BARCODE	= PE904023
CONTAINER_BARCODE	= PE905764
NAME	= Geological Cross Section
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= CROSS_SECTION
DESCRIPTION	= Geological Cross Section b/w Port Campbell no 3 & Flaxmans No 1 Plate 5 (enclosure from WCR) for Flaxmans-1
REMARKS	=
DATE_CREATED	= 31/12/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)

PE602065

This is an enclosure indicator page.
The enclosure PE602065 is enclosed within the container PE905764 at this location in this document.

The enclosure PE602065 has the following characteristics:

ITEM_BARCODE	= PE602065
CONTAINER_BARCODE	= PE905764
NAME	= Composite Well Log
BASIN	= OTWAY
PERMIT	= PEP 5
TYPE	= WELL
SUBTYPE	= COMPOSITE_LOG
DESCRIPTION	= Composite Well log (enclosure from WCR) for Flaxmans No 1
REMARKS	=
DATE_CREATED	= 8/11/61
DATE_RECEIVED	=
W_NO	= W466
WELL_NAME	= Flaxmans-1
CONTRACTOR	= Frome-Broken Hill Co P/L
CLIENT_OP_CO	= Frome-Broken Hill Co P/L

(Inserted by DNRE - Vic Govt Mines Dept)