FROME-BROKEN HILL COMPANY PTY. LTD.

WELL COMPLETION REPORT - FERGUSONS HILL NO. 1

SOUTHWEST VICTORIA

by

J. S. Bain

Melbourne
July, 1964

74 Pages
4 Plates

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3. Geological Cross Sections Before and After Drilling.

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I SUMMARY

The Fergusons Hill No. 1 well was drilled to a total depth of 11,633 feet within the southeastern part of the Otway Basin.

The well penetrated the Tertiary succession, the Upper Cretaceous sediments, and the whole of the Lower Cretaceous Otway Group section at this location, bottoming in quartz-mica schist considered to be of Cambro-Ordovician age.

The Otway Group was found to have an overall thickness of nearly 9,000 feet, and from results in this well it appears that a two-fold division of the Otway Group can be made, based primarily on lithology and palynology. It is also possible that an hiatus may be present between these two units of the Otway Group. The presence of an Otway Group basal sand section immediately overlying metamorphic basement was apparent from this well.

The well further confirmed the nature of the pinchout zone which was a principal exploration objective of the Sherbrook No. 1 well. The marine Cretaceous section penetrated in Fergusons Hill No. 1 was thinner than that in Sherbrook No. 1, confirming that the well was situated near the extreme eastern edge of the pinchout zone. Whether an unconformity is present between the Waarre Formation and the Otway Group, and whether a re-worked Otway Group zone occurs as suggested for Sherbrook No. 1 well is hard to determine on present information. The marine Cretaceous section in this well, as was the case in Sherbrook No. 1, could not be subdivided into well defined formations, and it is probable that an unconformity exists between this section and the underlying Waarre Formation.

The only hydrocarbon produced from the well was a slight show of free gas from an Otway Group sandstone. The Waarre Formation was found to contain fresh water, as was the case at Sherbrook No. 1, suggesting that flushing of the formation has taken place in this area.

II INTRODUCTION

Fergusons Hill 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 sited primarily from seismic results to drill through to the previously unpenetrated Otway Group sediments which were thought to be in a favourable position at this location. Of secondary consideration was the testing of the extreme eastern edge of the Cretaceous pinchout zone confirmed by the previous Sherbrook No. 1 well.

The Commonwealth Government agreed to share the cost of drilling Fergusons Hill No. 1 on a test well basis to 2,520 feet, and thereafter on the basis of stratigraphic drilling.

III WELL HISTORY

(1) General Data

(a) Well Name and Number:

Fergusons Hill No. 1

(b) Location:

Parish of Latrobe, Shire of Otway, County of Heytesbury.
State Aerial Survey Vic. Princetown A-99, Zone B, Ref. 058366.
Latitude: 38° 37' 20" south; Longitude: 143° 09' 41" east.

(c) Name and Address of Tenement Holder:

Frome-Broken Hill Company Pty. Ltd.,
95 Collins Street,
Melbourne, C.1.

(d) Details of Petroleum Tenement:

Petroleum Exploration Permit No. 6, issued by the State of Victoria.

(e) District:

Southwest Victoria.

(f) Total Depth:

11,633 feet.

(g) Date Drilling Commenced:

December 24, 1963.

(h) Date Drilling Completed:

May 6, 1964.

(i) Date Well Abandoned:

June 3, 1964.

(j) Date Rig Released:

June 3, 1964.

(k) Drilling Time in Days to Total Depth:

135 days.

(l) Elevation:

Ground: 638 feet
Rotary Table: 651 feet

(m) Status:

Abandoned. $5\frac{1}{2}$" casing cut at 9,000 feet and recovered.
Plugs set in the $9\frac{5}{8}$" casing as follows:

Cement plug 5,807 to 5,858 feet.
Cement plug 5,600 to 5,700 feet.
Cement plug 2,510 to 2,610 feet.
Cement plug 2,050 to 2,148 feet.
Cement plug at surface with 10 sacks.

(n) Cost:

£266,627, as at September 10, 1964.

(2) Drilling Data:

(a) Name and Address of Drilling Contractor:

Drilling Contractors (Australia) Pty. Ltd.,
383 George Street,
Sydney, N.S.W.

(b) Drilling Plant:

Make:	National
Type:	Ideal 80-B
Rated Capacity with $4\frac{1}{2}$" drill pipe:	12,000 feet

Motors:

Make:	Waukesha
Type:	Model LRDBSU
B.H.P.	526
Number:	3

(c) Mast/Derrick:

Make:	Lee C. Moore
Type:	136 feet
Rated Capacity:	700,000 lbs.

(d) Pumps:

Make:	Emsco	National
Type:	D850	G700
Size:	$8\frac{1}{4}$" x 18"	8" x 14"

(e) Blowout Preventor Equipment:

Make:	Cameron	Hydril	Hydril
Type:	SS	GK	Accumulator
Size:	12"	12" flanged	
Series:	900	900	

(f) Hole Sizes and Depths:

(1) 20" conductor pipe set at 26 feet by hand.

(2) (i) Drilled $12\frac{1}{4}$" hole to 1,050 feet.
(ii) Reamed $12\frac{1}{4}$" hole to $17\frac{1}{2}$" hole to 1,050 feet.
(iii) Set $13\frac{3}{8}$" casing at 1,049 feet.

(3) (i) Drilled $8\frac{3}{4}$" hole to 7,345 feet.
(ii) Reamed $8\frac{3}{4}$" hole to $12\frac{1}{4}$" hole to 5,860 feet.
(iii) Set $9\frac{5}{8}$" casing at 5,825 feet.

(4) (i) Drilled $8\frac{1}{2}$" hole from 7,345 to 11,633 feet, T.D.
(ii) Set $5\frac{1}{2}$" casing at 11,580 feet.

(g) Casing Details:

Size:	13⅜"	9⅝"	5½"
Weight:	48 lbs.	36 & 40 lbs.	17 & 20 lbs.
Grade:	H.40	J.55 & N.80	N.80
Range:	2	2	2
Setting Depth:	1,049 feet	5,825 feet	11,580 feet

(h) Casing Cementing Details:

Size:	13⅜"
Setting Depth:	1,049 feet.
Quantity Cement Used:	1,057 sacks.
Cemented to:	Surface.
Method Used:	Single stage cementing, with plugs, by Halliburton cementing truck.

Size:	9⅝"
Setting Depth:	5,825 feet.
Quantity Cement Used:	Total 370 sacks. 200 sacks in 1st stage, 170 sacks in 2nd stage.
Cemented to:	1st stage: 4,000 to 5,310 feet. 2nd Stage: 1,700 to 2,500 feet.
Method Used:	Two stage continuous cementing with Baker Type J cementing collar at 2,501 feet using Halliburton cementing truck.

Size:	5½"
Setting Depth:	11,580 feet.
Quantity Cement Used:	500 sacks.
Cemented to:	10,575 feet (estimated)
Method Used:	Single stage cementing, with plugs, using Halliburton cementing truck.

(i) Drilling Fluid:

The mud employed in Fergusons Hill No. 1 was a spersene-bentonite-caustic soda system, with XP.20 being used in addition below 9,800 feet.

Details of additions and properties are covered in Appendix 8.

(j) Water Supply:

Water was carted for the well from the nearby Gellibrand River. Salinity of this water averaged 2,200 ppm total solids. A water well was drilled on site, but was unproductive.

(k) Perforation and Shooting Record:

All perforating was done with Schlumberger shaped charge equipment with 4" guns, at a density of 4 shots per foot.

The following intervals were perforated for testing purposes:

11,490 to 11,514 feet)	
11,380 to 11,416 ")	$5\frac{1}{2}$" casing
5,660 to 5,690 feet)	
5,436 to 5,464 ")	$9\frac{5}{8}$" casing
2,096 to 2,106 ")	

The following intervals were perforated for isolation squeeze cementing purposes:

5,600 to 5,601 feet)	
5,410 to 5,411 ")	$9\frac{5}{8}$" casing

(l) Plugging Back and Squeeze Cementation Jobs (see Plate No. 4)

(a) 50 sacks bradenhead squeeze around shoe of $9\frac{5}{8}$" casing. First stage cement was overdisplaced while cementing $9\frac{5}{8}$" casing.

(b) Halliburton DH bridge plug set at 11,443 feet.

(c) Spotted 60 sack plug from 5,807 to 5,858 feet.

(d) Squeezed 95 sacks through perforations 5,600 to 5,601 feet to 2000 psi.

(e) Spotted 50 sack plug from 5,600 to 5,700 feet.

(f) Squeezed 95 sacks through perforations 5,410 to 5,411 feet to 2000 psi.

(g) Spotted 40 sack plug from 2,510 to 2,610 feet.

(h) Spotted 50 sack plug from 2,050 to 2,148 feet.

(i) Spotted 10 sack plug at surface.

(m) Fishing Operations:

At bottom hole depth of 6,440 feet:

On pulling string after running D.S.T. No. 7, the testing string became stuck at 4,300 feet at top of drill collars. Broke circulation through pump out sub below drill collars and spotted 63 barrels of diesel fuel. Fish worked loose and all recovered. Drilled ahead without further trouble.

(3) Logging and Testing

(a) Ditch Cuttings:

Cuttings were taken over a normal shale shaker. Interval sampled was every 10 feet to 6,530 feet and thence every five feet to total depth, with bottom hole samples circulated at various depths. When sampling at five foot intervals, samples were retained only for every ten feet, this being a representative cut of both the five feet sample intervals described.

(b) Coring: (See Appendix 4 for Core Description)

The original coring program specified cores to be taken on the occurrence of hydrocarbons shows, indications of prospective reservoirs, at formation changes and drilling breaks, and at fossiliferous marker beds. In addition, Commonwealth Government subsidy agreement stipulated routine cores to be taken at 300 foot intervals, these intervals being extended to 500 feet for drilling within a section of uniform lithology.

Thirty-four cores were cut for a total footage of 492 feet. Recovery was 382 feet, or 78%.

All cores were cut with a Reed Kor-King barrel with soft and hard formation coreheads. Core diameters were $3\frac{1}{2}$".

(c) Sidewall Sampling: (See Appendix No. 4)

Sidewall cores were taken of various intervals using Schlumberger C.S.T. equipment. Ninety cores were attempted and fifty-seven cores were recovered. Hard formation heads were found to be the most satisfactory.

(d) Electrical and Other Logging:

Logging was carried out by Schlumberger Seaco Inc., the engineer being J. A. W. White in the early stages and I. Strecker for the remainder of the well.

Logs were run as follows:

Electrical Log	Microlog	Sonic-Gamma Ray Log
68 to 1,050 feet	1,050 to 3,054 feet	70 to 1,042 feet
1,049 to 3,082 "	2,884 to 5,941 "	1,050 to 3,074 "
2,882 to 5,937 "	5,830 to 7,347 "	3,074 to 5,925 "
5,830 to 7,346 "	7,147 to 8,931 "	5,830 to 7,330 "
7,146 to 8,674 "	8,731 to 10,356 "	7,130 to 8,912 "
8,474 to 10,396 "	10,293 to 11,488 "	8,712 to 10,389 "
10,196 to 11,626 "	9,500 to 11,606 "	8,700 to 11,596 "

Laterolog	Sonic Amplitude in Open Hole
5,830 to 6,700 feet	9,000 to 10,000 feet
8,450 to 8,931 "	10,600 to 11,600 "
10,500 to 11,641 "	

Cement Bond Log	Continuous Dipmeter
1,400 to 2,600 feet	1,050 to 3,074 feet
3,740 to 5,840 "	3,100 to 5,925 "
	5,925 to 6,650 "
	5,830 to 10,200 "

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

(e) Drilling Time and Gas Log:

A Geolograph continuous time-depth recorder was used during the drilling of Fergusons Hill No. 1, which recorded the time taken for each foot penetrated. A drilling time log was drawn up from the Geolograph records and is included in the Composite Log.

An Atlas continuous gas detector monitored the mud throughout the drilling and the gas log obtained from this instrument is included in the composite graphic well log.

(f) Formation Testing:

Testing was carried out by Halliburton Limited, the engineer being Mr. B. O. Martin. Eleven open hole drill stem tests were carried out, using a 5" Hydrospring tester with associated 5 position T.C. valve and $7\frac{3}{4}$" and $7\frac{1}{2}$" packers. Eleven production tests were carried out inside casing, seven inside $5\frac{1}{2}$" casing and four inside $9\frac{5}{8}$" casing. A $3\frac{7}{8}$" Hydrospring tester and a $5\frac{1}{2}$" R.T.T.S. tool with associated valves were used inside the $5\frac{1}{2}$" casing, and $9\frac{5}{8}$" R.T.T.S. packer and 5" Hydrospring were used for testing in the $9\frac{5}{8}$" casing.

Details of these tests are shown in Appendix 6 and brief results are as follows:

D.S.T. No. 1 - 2,050 to 2,092 feet.
No formation fluids recovered due to loose sand plugging the tool.

D.S.T. No. 2 & 2a - 3,074 to 3,105 feet.
Misrun - packer seat failed.

D.S.T. No. 3 - 3,090 to 3,111 feet.
Misrun - packer seat failed.

D.S.T. No. 4 - 3,043 to 3,111 feet.
Misrun - packer seat failed.

D.S.T. No. 5 - 4,308 to 4,350 feet.
Misrun - packer seat failed.

D.S.T. No. 6 - 4,293 to 4,350 feet.
Recovered 90 feet rathole drilling mud. No hydrocarbons.

D.S.T. No. 7 - 6,414 to 6,440 feet.
No fluids recovered due to string becoming stuck. Any fluids present reversed out.

D.S.T. No. 8 - 6,528 to 6,570 feet.
Recovered 20 feet of rathole drilling mud. No hydrocarbons.

D.S.T. No. 9 - 7,288 to 7,330 feet.
Recovered 30 feet of rathole drilling mud. No hydrocarbons.

D.S.T. No. 10 - 11,364 to 11,432 feet.
Misrun - packer seat failed.

D.S.T. No. 11 - 11,376 to 11,467 feet.
Misrun - packer seat failed.

Production Test No. 1 - 11,490 to 11,514 feet
Misrun - C.I.P. valve washed out.

Production Test No. 2 - 11,490 to 11,514 feet.
Misrun - sub washed out.

Production Test No. 3 - 11,490 to 11,514 feet.
Recovered water cushion and 10 feet rathole drilling mud. No hydrocarbons.

Production Test No. 4 - 11,380 to 11,416 feet.
Misrun - T.C. valve did not open completely.

Production Test No. 5 - 11,380 to 11,416 feet.
Recovered water cushion. 130 feet gas-cut water and 200 feet gas-cut rathole mud.

Production Test No. 6 - 11,380 to 11,416 feet.
Misrun - T.C. valve washed out.

Production Test No. 7 - 11,380 to 11,416 feet.
Recovered water cushion and 150 feet gas-cut rathole mud.

Production Test No. 8 - 5,660 to 5,690 feet.
Recovered 1,818 feet of gas-cut mud.

Production Test No. 9 - 5,436 to 5,464 feet.
Recovered very slight gas flow (unmeasurable). No formation water recovered.

Production Test No. 10 - 2,096 to 2,106 feet.
Misrun - swab line stuck.

Production Test No. 11 - 2,096 to 2,106 feet.
Formation water standing at 537 feet below surface. Salinity 225 ppm Cl. No hydrocarbons.

(g) Deviation Surveys:

Deviation surveys were carried out with the Totco instrument and in conjunction with the Schlumberger Continuous Dipmeter. In general, deviation was lower than 2^{o} to 4,000 feet. Between 4,000 and 8,000 feet, deviation varied between 2^{o} and $6\frac{1}{2}^{o}$ to around 2^{o} at T.D. Some minor trouble with crooked hole was experienced in the 4,000 to 8,000 feet section, but setting of the intermediate $9\frac{5}{8}$" casing helped alleviate these problems.

(h) Other Well Surveys:

A well geophone velocity survey was run to total depth in the well in conjunction with United Geophysical Corporation Inc.

Check shots were taken at selected intervals and compared to data already obtained from the Sonic Log.

IV GEOLOGY

(1) Summary of Previous Work

(a) Geological:

No surface geological studies have been made since the drilling of Sherbrook No. 1, and previous surface work has been reported in earlier subsidy reports. As mentioned in Klaric's report (4), the Fergusons Hill structure was evident as a surface high in Tertiary sediments.

(b) Geophysical:

The Fergusons Hill No. 1 location was selected on the basis of results of a land seismic survey carried out by Ray Geophysics (Australia) Pty. Ltd., and partly from the results of geological work by Klaric, mentioned above.

Due to surface conditions, no mappable seismic reflections occurred below 3,000 feet at the Fergusons Hill location, but it was felt that the Otway Group section could be penetrated at this location. The location was selected in a position to penetrate the extreme up-dip edge of the pinchout zone mapped from seismic, and which was the objective of the Sherbrook No. 1 well.

(c) Drilling

Sherbrook No. 1 had been abandoned at 5,434 feet just prior to the drilling of Fergusons Hill No. 1. This well had tested the pinchout zone approximately 3 miles to the west of Fergusons Hill No. 1 without production of hydrocarbons.

The Mines Department of Victoria also completed their Latrobe No. 1 well close to the Tertiary outcrop section near Princetown at about the same time as Sherbrook No. 1 was abandoned.

(2) Summary of Regional Geology

Surface geology in the Port Campbell Embayment does not provide much information about possible subsurface units and conditions. The surface is principally covered by Quaternary alluvium and extensive areas of Tertiary and Quaternary basalts and other volcanic rocks.

In the east the Otway Group sediments crop out extensively through the Otway Ranges and these sediments are unconformably overlain by Tertiary sediments at their western limit of outcrop. These Tertiary sediments are seen chiefly in the cliff sections extending along the coast between Princetown and Warrnambool.

The section encountered in previous wells in the Port Campbell Embayment is described briefly below from the lowermost beds, the Otway Group, up to the Heytesbury Group.

The Otway Group consists of sandstones of a subgreywacke type, siltstones and mudstones, with coal bands at intervals throughout the section. None of the previous wells in the Port Campbell Embayment has drilled through the Otway section, the maximum thickness penetrated being 3,898 feet in the Flaxmans No. 1 well. These Otway Group sediments are recognised on spore content to be of Lower Cretaceous age, at least to the depth drilled in Flaxmans No. 1, and it is thought that they underlie most of the younger Cretaceous and Tertiary sediments of the Otway Basin. The Otway Group sediments have been regarded as being of non-marine origin but whether this is so has not yet been proved conclusively and it is certainly possible that they may be marine in part.

Overlying the Otway Group in the Port Campbell Embayment is a section of sandstone, including some very clean sandstone, interbedded with minor siltstones, mudstones and coal bands. This section is the Waarre Formation which contains the gas reservoir tapped in the Port Campbell No. 1 well. This formation contains rare foraminifera and plant microfossils which are considered to represent alternating marine and freshwater conditions of deposition. The age of the Waarre Formation is generally regarded as Lower Cretaceous (Albian). Maximum drilled thickness of Waarre is 752 feet in Flaxmans No. 1. The Waarre unconformably underlies the Belfast Mudstone in places, but appears to be conformable with the overlying Flaxmans Beds where the latter have been penetrated.

The Flaxmans Beds are regarded as transitional between the Waarre Formation and the Belfast Mudstone, and in age appear to straddle the Lower to Upper Cretaceous boundary. These beds consist of brown to green sandy siltstones and chloritic greywackes, very limonitic in part. The maximum drilled thickness occurs in Port Campbell No. 2 where 510 feet is present.

The Belfast Mudstone, which consists of medium to dark grey, dense, glauconitic mudstone and siltstone, is of marine origin and attains a maximum thickness of 1,873 feet in Port Campbell No. 2 well. This unit is fossiliferous and its age has been determined as early Upper Cretaceous. The Belfast Mudstone underlies the Paaratte Formation with apparent conformity.

The Paaratte Formation is regarded as representing a transition from the Belfast Mudstone to the arenaceous Wangerrip Group. It consists of fine to coarse grained quartz sandstone interbedded with grey to dark grey micaceous and carbonaceous siltstones and mudstones. The maximum thickness drilled in the Port Campbell Embayment is 1,490 feet in the Flaxmans No. 1 well, and the age of this unit is regarded as Upper Cretaceous. This unit is predominantly of marine origin and underlies a presently unnamed section (see Stratigraphy).

The Paaratte Formation, Belfast Mudstone, Flaxmans Beds and Waarre Formation are not known to crop out in the Otway Basin.

The unnamed section above the Paaratte Formation has previously been included in the Wangerrip Group, but it appears that it is a separate unit between the base of the Wangerrip Group, Baker's Pebble Point Formation, and the Paaratte Formation. This section is composed dominantly of quartz sand with minor interbeds of micaceous and carbonaceous siltstones and mudstones, with coal and pyrite commonly present. It is usually devoid of fossils although from Port Campbell No. 1 it has been suggested to be Cretaceous in age, while in the Mines Department Latrobe well Tertiary fossils have been found. Thickness drilled is 1,700 feet in Port Campbell No. 2 well. On seismic evidence it appears that the overlying Pebble Point Formation rests unconformably upon the unnamed section.

The Wangerrip Group comprises interbedded sand, sandstone, siltstone and mudstone, and coal bands. The sand units are the principal aquifers throughout the Otway Basin and the maximum drilled thickness of this group is 1,870 feet in Port Campbell No. 2 well. The basal section, the Pebble Point Formation, rests unconformably on the unnamed section. Rocks of this group crop out on the western flanks of the Otway Ranges.

Above the Wangerrip Group is the Heytesbury Group, a section of marl and limestone of Tertiary age, ranging in thickness from about 800 to 2,000 feet.

(3) Stratigraphic Table - Fergusons Hill No. 1

Unit	Age	Subsurface Top (feet)	Thickness (feet)
Wangerrip Group	Eocene-Palaeocene	Surface	836
Unnamed interval	Palaeocene-?Upper Cretaceous	849 (-198)	477
Paaratte-Belfast-Flaxmans interval	Upper Cretaceous	1326 (-675)	720
Waarre Formation	Lower Cretaceous	2046 (-1395)	468
Otway Group - Upper Beds	Lower Cretaceous	2514 (-1863)	4104
Lower Beds	Lower Cretaceous	6618 (-5967)	4895
Basement	Cambro-Ordovician	11,513 (-10,862)	120 +

Note: Figures in brackets refer to depth below sea level of the various horizons. The Paaratte Formation, Belfast Mudstone and Flaxmans Beds have not been differentiated in this well due to difficulties in correlating their specific lithologies from other wells to a specific interval in Fergusons Hill No. 1.

(4) Stratigraphy

General descriptions of the lithologies cut in Fergusons Hill No. 1 are as follows:

Surface to 849 feet — Wangerrip Group

Surface to 670 feet.
Sand, siltstone and sandstone, dominantly medium to coarse grained, clean with some iron-stained quartz sand interbedded with medium to dark grey and brown-grey micaceous and carbonaceous siltstones. Dolomite (?ankerite) bands in places.

670 to 849 feet.
Conglomerate up to pebble size made up of quartz, igneous and metamorphic fragments, and sand, as for surface to 670 feet. ≡ Pebble Point Formation.

849 to 1,326 feet — Unnamed Interval

Dominantly sand and sandstone with minor interbedded carbonaceous and micaceous siltstone. Pyrite and coal common constituents.

1,326 to 2,046 feet — Paaratte-Belfast-Flaxmans Interval

Glauconitic and chloritic sandstones, siltstones, mudstones and clays. Dominantly green and grey. Sandstones are dirty and have low porosity. Some dolomite, (?ankerite), pyrite, and minor coal.

2,046 to 2,514 feet — Waarre Formation

Sand and sandstone, dominantly, with minor interbedded carbonaceous siltstones, mudstones, clay and coal. Sand is made up of clean, clear, medium to very coarse grained quartz, with very little matrix, and is very porous.

2,514 to 11,513 feet — Otway Group

2514 to 6,618 feet - Upper Beds.
Interbedded sandstones, siltstones and mudstones. Sandstone is dominant and is light green-grey to medium grey, micaceous, chloritic, feldspathic, tight, very fine to medium grained, and calcareous in part. Siltstones and mudstones are light to medium grey, dense, carbonaceous and micaceous. Minor dolomite and siderite lenses and concretions.

6,618 to 11,513 feet - Lower Beds.
Dominantly medium to dark grey and greyish black micaceous and carbonaceous siltstones and mudstones with minor interbeds of very fine to medium grained light to medium grey, feldspathic, and in parts calcareous, sandstones. Dolomite and siderite and coal lenses and bands present. Sand and sandstone, generally medium grain size, increases from 11,385 to 11,513 feet, and is a basal sand section.

11,513 to 11,633 feet — Basement

Quartz mica schist.

The well was spudded in the Wangerrip Group which consists of the typical coarse quartz sands interbedded with brown-grey, micaceous and carbonaceous siltstones. From 670 to 849 feet conglomerates up to pebble size, and made up of quartz and quartzite pebbles, igneous and metamorphic fragments, equivalent to Baker's Pebble Point Formation (2) were intersected.

Below 849 feet a section of dominantly sandstone with interbedded siltstones and with pyrite and coal as important constituents was cut until the top of the Paaratte Formation was recognised at 1,326 feet. Previously, this section has been placed within the Wangerrip Group but, on later correlations of the conglomerate section above, and the occurrence of a seismic reflection throughout the Port Campbell Embayment which is correlatable to the Pebble Point Formation, it has been decided to separate this unit from the Wangerrip Group. On the seismic sections this reflection is at the base of the Pebble Point Formation and appears to represent an unconformity surface. Fossils are usually absent in this zone below Pebble Point, but in Port Campbell No. 1, it appeared that some of this unnamed section, previously included in the Wangerrip Group, was probably Upper Cretaceous in age on microfossil evidence. However, a section correlated to this interval in the Mines Department of Victoria's Latrobe No. 1 well

yielded Tertiary foraminifera and the age of this unit is still indefinite. As yet, no name has been proposed for this interval, but it is possible that it is equivalent to the Eastern View Coal Measures mentioned by Raggatt and Crespin (5).

Between 1,326 and 2,046 feet, sediments equivalent to the undifferentiated Paaratte-Belfast-Flaxmans interval, as mentioned in Sherbrook No. 1 well completion report, were drilled. Again, as in Sherbrook No. 1, it was found that this section could not be subdivided and was barren of obvious macrofossils. This interval is thought to represent a marginal marine environment of deposition at this locality.(Taylor, 1964)

At 2,046 feet the typical, very porous clean quartz sand and sandstones of the Waarre Formation were cut. Minor siltstones, clays and coals are present in the section. Fresh formation water (salinity 225 ppm Cl.) was recovered from tests in the Waarre Formation without any evidence of hydrocarbons.

Below 2,514 feet Otway Group sediments were identified. As is mentioned above, it is felt that it is possible to subdivide the Otway Group into two separate units which are generally lithologically distinctive. The "upper beds" are generally dominantly light coloured sandstones with minor interbedded medium grey siltstones and mudstones while the "lower beds" are dominantly the finer grained siltstones, usually darker in colour than the "upper beds". It is also apparent that the sandstones in the "lower beds" are usually finer in grain size than the sandstones in the "upper beds". Palynological work on the Otway Group indicates a variation in microflora at approximately the same level. The upper section has been found to have the "Paradoxa Assemblage" while the lower section has the "Speciosus Assemblage" of Dettmann (3). There also appears to be a break on the Continuous Dipmeter Log at this level, suggesting a possible hiatus between the two units. Between 11,385 and 11,513 feet, where basement was first intersected, sandstones constitute a higher proportion of the samples, and immediately above this basement is evidence of a basal Otway Group sand.

From 11,513 to T.D. 11,633 feet, quartz mica schist, grey to greenish grey in colour, was drilled. Chlorite, reef quartz and tourmaline are present, and the rock is foliated with original bedding evident in places. The rock has dispersed through it numerous white pin head sized bodies which are composed of a fine aggregate of carbonate minerals. The presence of the tourmaline and carbonate are indicative of a phase of contact metamorphism superimposed on an earlier cycle of regional metamorphism, when low grade schists were formed. The age of the schist is considered to be Cambro-Ordovician.

(5) Structure

As mentioned under Geophysics, there were no mappable seismic reflections below 3,000 feet at the Fergusons Hill No. 1 location so that below this depth the structure was unknown. Above 3,000 feet the test was of a stratigraphic nature, being situated on the extreme up-dip edge of the pinchout zone which was the objective of Sherbrook No. 1. Core dips were generally of the order of 10° to 5,900 feet, increased to about 15° to 30° in the interval 5,900 to 7,300 feet, and then decreased to generally 10° to 15° to T.D. Cross-bedding was present in a number of the cores making regional dip hard to ascertain, but results of the Dipmeter Survey generally confirm the core dips. As mentioned under Stratigraphy, dipmeter results indicate that there is some possibility of an hiatus being present between the upper and lower beds of the Otway Group at about 6,600 feet. Whether unconformities are present between the Waarre Formation and the Otway Group and whether there is a section of re-worked Otway Group sediments is not clear in this well. Dipmeter results through these zones show that the dips are very disturbed and certainly unconformities would be expected to be present.

(6) Relevance to Occurrence of Petroleum

Indications of petroleum were noted in a number of places in the Otway Group during the drilling of Fergusons Hill No. 1. These shows usually consisted of some fluorescence in the cuttings or cores, and/or higher than average gas readings on the gas detector.

Hydrocarbon fluorescence was present in Core No. 9 as well as in cuttings in various intervals of the hole as shown on the composite log. In Core No. 9, the fluorescence was confined only to the bedding planes within the core, and did not occur disseminated through the sandstone. There were also indications of hydrocarbons at 11,400 feet which appeared to be emanating from fracture porosity, but in all cases where successful tests were obtained on intervals containing these slight shows, no free hydrocarbons were recovered, confirming the tight nature of the sediments.

Production testing was carried out on a number of reservoirs not adequately tested in open hole, but apart from a very slight flow of gas from the interval 5,436 to 5,464 feet in the Otway Group, no other indications of free hydrocarbons were noted. The very porous Waarre Formation, which in previous wells had shown the presence of hydrocarbons, yielded fresh formation water on test.

(7) Porosity and Permeability of Sediments Penetrated

Porosity and permeability were estimated qualitatively at the wellsite from cores and cuttings, and quantitatively from log and core analysis.

Sands within the Otway Group all appeared to have very low to nil permeability and probably low porosity. Testing confirmed the tightness of these sediments.

The Waarre Formation consisted largely of unconsolidated sand and no cores were recovered from this interval. However, it is obvious that this zone has extremely high porosities and permeabilities.

The sands in the Wangerrip Group have the usual high porosities and permeabilities associated with them throughout the basin and retain their potential as freshwater aquifers.

(8) Contribution to Geological Concepts Resulting from Drilling

Fergusons Hill No. 1 well was the first well in the Port Campbell area to penetrate the Otway Group and enter basement. The well proved the existence of nearly 9,000 feet of Otway Group sediments in this area, and this is the maximum thickness of these sediments drilled to date within the Otway Basin.

The basement in this well consisted of quartz mica schist which is probably Cambro-Ordovician in age.

The marine Cretaceous section was found to be thinner at Fergusons Hill No. 1 than in Sherbrook No. 1, confirming that the well was situated on the extreme edge of the zone of marine Cretaceous pinchout. It is also evident that this section, like Sherbrook No. 1, is of a much more sandy nature than in equivalent sections in the deeper parts of the basin.

It was also noted that a two-fold division could be made of the Otway Group section on the basis of lithology, palynology and possibly dipmeter survey results. The upper beds are characterised by dominantly lighter coloured rocks, principally medium grained sandstones, while the lower beds are darker in colour and made up mainly of siltstones and mudstones with subordinate finer grained sandstones. Whether an unconformity is present between these two units is not known but from dip information from the Dipmeter Survey, it is possible that an hiatus is present between these two intervals.

This well also showed the presence of a basal Otway Group sand unit overlying basement.

Melbourne,
July, 1964.

J. S. BAIN

V REFERENCES

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APPENDIX 1

PETROLOGICAL REPORTS

PETROLOGICAL REPORT FROME-BROKEN HILL FERGUSONS HILL NO. 1

Core No.	32	33	34
Depth	11,519-11,534 ft.	11,582-11,593 ft.	11,616-11,622 ft.
Recovery	5 feet	2 feet	3 feet
Rock Type	quartz-mica-schist.		

MACROSCOPIC EXAMINATION

The above three cores are essentially the same rock type being a grey to greenish quartz rich foliated rock, in places characterised by the presence of numerous white pin head sized spots, which show slight effervescence with hot HCl. Chlorite is frequently present in fracture planes and reef quartz occurs in cores 32 and 34. Original bedding can be detected particularly in core 32.

MICROSCOPIC EXAMINATION

Core 32

The rock consists of moderate to strongly orientated muscovite flakes and quartz with minor amounts of biotite and rare strongly pleochroic brown tourmaline crystals. The spots are scattered throughout the rock and do not show any preferred orientation. They are generally turbid in appearance and composed of a fine aggregate of carbonate minerals.

Cores 33 and 34

Were not examined microscopically, but are similar to core 32, except that spotting is less pronounced.

REMARKS

The spotting and tourmaline crystals have almost certainly been produced by contact metamorphism, and it is considered probable that this contact metamorphism has been superimposed on an earlier regional metamorphism during which low grade schists were formed.

The rock is considered to be of Cambro-Ordovician in age.

K. BOWEN
Geologist

THE AUSTRALIAN MINERAL DEVELOPMENT LABORATORIES

FROME-BROKEN HILL CORES
FERGUSONS HILL NO. 1 BORE

Core No. 2 - 1,767 to 1,787 feet

This is a very unusual sandstone, especially as regards the cementing material.

Subrounded to rounded grains of quartz, of medium-sand grade (0.25-1.0 mm) are the principal constituent. There are also oolitic grains of chamosite; these consist of a central, irregular, brown (probably oxidised) core, surrounded by concentric layers of greenish material, presumably chamosite.

The cementing material between these quartz grains is also greenish, most probably chamosite or greenalite, showing marked shrinkage-cracks. Carbonate (possibly siderite) also occurs in the interstices.

There is no correlation between this core and any other sample examined. On the basis of the description, the rock may be termed a chamositic sandstone. It should be emphasised however, that the identification of chamosite and similar minerals can only be done with certainty by means of X-ray diffraction.

Core No. 7 - 2,741 to 2,760 feet

This is a medium grained, lithic and vitric tuff.

The grains, ranging in diameter from 0.25 mm to 0.65 mm, are mostly subrounded and consist of greenish vitric material (in parts devitrified) containing microlites, and of rocks of an extrusive igneous nature, apparently of trachytic to andesitic origin. Fragments and crystals of quartz and plagioclase (andesine) are common. A few fragments of more "acid" material are also present, but on the whole this tuff had its origin in an"intermediate" igneous province.

Core No. 11 - 3,732 to 3,752 feet

This rock is generally similar to Core No. 7, though with less vitric and devitrified material. It may be termed a tuff.

The fragments constituting the rock are of an intermediate to acid extrusive igneous nature; fragments of quartz, sodic plagioclase and perthite are also present. Occasional grains of a metamorphic rock, a quartz-muscovite schist, also occur.

The grains are cemented by carbonate, probably calcite.

Core No. 14 - 5,077 to 5,097 feet

This sample is petrologically very similar to Port Campbell No. 3 Core 3 described in an earlier report. It is also related to cores 7 and 11 above; there is a progressive lightening in colour and constituents from Cores 7 to 14.

The core consists of fine-grained subangular, usually elongate, grains of quartz, quartzite, chert, trachyte, sericite-quartzite, sodic plagioclase, mica-schist, and kaolin. Accessory minerals are very scarce. The cementing material is a carbonate, probably calcite.

The rock may be termed a subgreywacke.

Core No. 16 - 5,934 to 5,950 feet

This sample is similar to Core 14, and is also classified as a subgreywacke. It is slightly coarser-grained but still in the fine-sand grade.

The constituents are essentially the same as those of Core 14. The interstitial carbonate is granular and euhedral in part.

The rock is petrologically similar to Eumeralla No. 1, Core 8.

Core No. 17 - 6,403 to 6,423 feet

This rock is a fine- to medium-grained subgreywacke, consisting of subangular to subrounded grains of quartz, plagioclase, microline, sercite-schist, trachyte, chert and quartzite. Two generations of carbonate, one granular and the other interstitial, are conspicuous between the detrital grains.

The sample is very similar to Cores 14 and 16, and correlatable with Eumeralla No. 1 Core 8.

H. W. FANDER
25/3/1964

APPENDIX 2

PALAEONTOLOGICAL REPORTS

PALYNOLOGICAL REPORT ON F.B.H. FERGUSONS HILL NO. 1 AND F.B.H. SHERBROOK NO. 1 WELLS

Cores retrieved from F.B.H. Fergusons Hill No. 1 well between 1554 feet and 11,432 feet and from F.B.H. Sherbrook No. 1 well between 3365 feet and 5424 feet yielded microfloras of Lower and Upper Cretaceous age. These microfloras provide a means by which the two bore sequences may be correlated, both with each other and with Cretaceous sequences at other localities in the Otway Basin.

The Fergusons Hill No. 1 well core samples provided fair or good concentrations of plant microfossils, with the exception of cores 2, 4, 7, 8 and 28-31 which are either barren or yielded extremely sparse microfloras. Microfossils extracted from the lower part of the well (core 22 and below) are poorly preserved, especially in the lowest cores (27-31) in which strongly compressed and often broken spore walls are present. The Sherbrook microfloras are not in general as well preserved or as varied as those from corresponding depths in Fergusons Hill No. 1 well. Moreover, cores 14, 19 and 20 from the former well yielded extremely low concentrations of microfossils.

The microfloral succession in the Fergusons Hill and Sherbrook wells is conformable with that recorded previously from other sequences in the Upper Mesozoic of the Otway Basin. The assemblages identified in the present investigation include, from oldest to youngest, the Speciosus (older and younger categories) and Paradoxa Assemblages of Dettmann (1963a) and Assemblages II and III first recognised in the Port Campbell wells (Dettmann 1964a). The presence of the older category of the Speciosus Assemblage in the lower horizons of Fergusons Hill No. 1 well indicates that these sediments are older (Valanginian-Aptian) than those of Upper Mesozoic age that have been investigated palynologically from the eastern portion of the Otway Basin. Further comments on the occurrences of the Cretaceous microfloral assemblages are documented below, and their distribution in Fergusons Hill No. 1 and Sherbrook No. 1 wells is tabulated in Tables 1 and 2.

The Speciosus Assemblage

(a) The older (Valanginian-Aptian) category, diagnosed by Cyclosporites hughesi (Cookson & Dettmann) together with Dictyotosporites speciosus Cookson & Dettmann, of the Speciosus Assemblage is recorded from between 7818 and 11,432 feet in Fergusons Hill No. 1 well. Thus, on microfloral evidence, these horizons are older than those Upper Mesozoic sediments previously investigated from the eastern portion of the Otway Basin. However, they are younger than the lowermost Cretaceous (Valanginian or older, on the basis of the Stylosus Assemblage) sediments that occur in Penola No. 1 well at 4766-76 feet, in the western portion of the basin. At least part of the succeeding Penola No. 1 sequence (3363-4618 feet) that contained D. speciosus in association with C. hughesi and equivalents of this sequence (Eumeralla No. 1, 7225-10,308 feet, etc. - see Dettmann 1963b) are probable correlatives of sediments in Fergusons Hill No. 1 well between 7818 and 11,432 feet. Within this interval in Fergusons Hill No. 1 well, cores 25 and 26 yielded Cooksonites variabilis Pocock, a spore species that possesses restricted vertical distribution in eastern Australia and western Canada. Its presence suggests correlation of cores 25 and 26 (9195-9631 feet) in Fergusons Hill No. 1 well with the following horizons in the western portion of the basin: Eumeralla No. 1 between 8459 and 8924 feet; Pretty Hill No. 1 between 5935 and 5947 feet; Penola No. 1 between 3715 and 3721 feet; and Robe No. 1 at 3860 feet.

(b) Microfloras that conform with the younger (Aptian) category of the Speciosus Assemblage in containing Dictyotosporites speciosus and Crybelosporites striatus (Cookson & Dettmann) occur in cores 20 and 21 of Fergusons Hill No. 1 well. Equivalent microfloras are known (Dettmann 1963a, 1964b) from Flaxmans No. 1 well between 10,801 and 11,528 feet and in an outcrop sample from the Barrabool Hills in the eastern portion of the basin. These horizons have already been correlated on microfloral evidence with numerous deposits in the western portion of the basin (Dettmann 1964b).

Paradoxa Assemblage

Core 18 in Fergusons Hill No. 1 well contained the diagnostic species, D. speciosus and Coptospora paradoxa (Cookson & Dettmann), of both the Speciosus and Paradoxa Assemblages together with Dictyotosporites filosus Dettmann. A similar occurrence of these three species is in Penola No. 1 well at 2790-98 feet. On the basis of D. filosus core 18 in Fergusons Hill No. 1 well is correlated also with Flaxmans No. 1 at 10,492-502, Robe No. 1 at 3150 feet, Beachport No. 1 at 3946 feet, and Eumeralla No. 1 at 6242-52 feet.

Coptospora paradoxa was encountered in succeeding cores (9-17) in Fergusons Hill No. 1 well. Horizons represented by cores 7 and 8 in the same well contain impoverished microfloras not certainly identifiable with either the Paradoxa Assemblage or Assemblage II. In Sherbrook No. 1 well the Paradoxa Assemblage occurs in horizons between cores 13 and 25. Core 26 in this well is not certainly identifiable with either the Speciosus or Paradoxa Assemblages. However, the presence of Laevigatosporites ovatus Wilson & Webster which is known hitherto only from horizons containing the Paradoxa or younger assemblages suggests conformity with the Paradoxa Assemblage.

Thus, sediments between 4049 and 5424 feet in Sherbrook No. 1 well may be correlated with horizons between 3105 and 6423 feet in Fergusons Hill No. 1 well, between 7473 and 9135 feet in Flaxmans No. 1 well, and with equivalents of the latter sequence (Dettmann 1964b, c). The suggested age of these deposits is Aptian-Albian.

Assemblage II

Diagnostic components of this assemblage first appear in core 6 and continue into core 3 in Fergusons Hill No. 1 well. Microplankton also make their first appearance in core 6 and include Gonyaulax edwardsi Cookson & Eisenack and Odontochitina operculata Deflandre both of which range from the Albian to the Lower Turonian (Cookson and Eisenack 1958). Core 3 yielded Cyclonophelium clathromarginatum Cookson & Eisenack 1962 (?Upper Albian-Cenomanian) and Chlamydophorella nyei Cookson & Eisenack 1958 (?Aptian-Lower Turonian).

Core 11 in Sherbrook No. 1 well contains an impoverished microflora referable to Assemblage II. Microplankton make their first appearance at this level and include the Upper Cretaceous and Lower Tertiary species Hystrichosphaeridium heteracanthum Deflandre & Cookson (see Cookson and Eisenack 1961). Other strata containing the Upper Albian-Cenomanian/Turonian Assemblage II have been recorded from the Port Campbell, Flaxmans, and Timboon sequences (see Dettmann 1964c).

Assemblage III

The presence of cf. Gleicheniidites sp. indicates that Assemblage III is represented in core 1 of Fergusons Hill No. 1 well and cores 9 and 10 of Sherbrook No. 1 well. Associated microplankton obtained from the Sherbrook samples include Odontochitina cribropoda Deflandre & Cookson, Deflandrea cretacea Cookson, and Hexagonifera glabra Cookson & Eisenack indicating a Turonian-Senonian age. This microplankton suite may be compared with those occurring in Flaxmans No. 1 well at 5950-70 feet, Port Campbell No. 1 well at 5223-33 feet, Port Campbell No. 2 well at 7403-09 feet, and Port Campbell No. 3 well at 4400-10 feet. Horizons containing this microplankton suite either are absent or were not sampled in Fergusons Hill No. 1 well. However, Odontochitina porifera Cookson was identified in core 1; this species indicates an Upper Turonian-Senonian age (Cookson and Eisenack 1960).

REMANIÉ FOSSILS

Spores and pollen grains of Permian and Triassic age were observed in the following samples: Fergusons Hill No. 1 well, cores 1, 3, 5, 6, 9, 10, 15, 17, 18 and 22; Sherbrook No. 1 well, cores 11, 24, 25 and 26. Reworked specimens of lowermost Cretaceous (Aptian and older) microspore species were recovered from several samples (cores 1, 3, 6 and 9) in Fergusons Hill No. 1 well. These occurrences may indicate that lowermost Cretaceous strata provided some of the source material for horizons in the upper part of Fergusons Hill No. 1 well.

3rd June, 1964.

Mary E. Dettmann
Department of Geology,
University of Queensland,
St. Lucia, Queensland.

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PALYNOLOGICAL REPORT ON SIDEWALL CORES FROM F.B.H. FERGUSONS HILL NO. 1 WELL

Spores obtained from sidewall cores between 11,438 and 11,495 feet in Fergusons Hill No. 1 well have revealed that strata in this interval are Lower Cretaceous in age. All of the six samples yielded carbonaceous material including spore and pollen fragments, the vast majority of which are too carbonised to enable identification, even at generic level. However, several species have been recognised in the uppermost (11,438 feet) and lowermost (11,495 feet) samples.

(a) The sample from 11,495 feet contains fragmentary carbonaceous material as well as sparse numbers of poorly preserved, whole specimens of spores. The only stratigraphically significant species present is Cicatricosisporites australiensis (Cookson) which demonstrates a Cretaceous age. Since this horizon underlies deposits of Valanginian-Aptian age (see below) it is considered to be Lower Cretaceous in age.

(b) The deposit from 11,438 feet yielded Dictyotosporites speciosus Cookson & Dettmann which illustrates that the Valanginian-Aptian Speciosus Assemblage is represented at this level. No other stratigraphically significant species has been observed.

Mary Dettmann
Department of Geology,
University of Queensland,
St. Lucia, Queensland.

12th June, 1964.

THE FAUNA IN FERGUSONS HILL NO. 1 WELL

A detailed examination has been made on all cores and rotary cuttings in the interval 200 feet to 4,000 feet from Frome-Broken Hill's Fergusons Hill No. 1 well. In addition, 6 sidewall cores from the interval 1,831 to 2,430 feet were examined.

200 - 1,554 feet

Very few foraminifera were isolated. The species present are all common species in the Palaeocene faunas of the Wangerrip Group of both the coastal section and the Latrobe No. 1 drilled section. No foraminifera diagnostic of particular horizons were isolated.

1,554 - 2,048 feet

Core 1 (1,554 to 1,574 feet) contained a sparse fauna of Ammobaculites goodlandensis, Haplophragmoides sp A. and H. sp. B. Such a fauna is typical of the top of the Upper Cretaceous foraminiferal sequence in the Port Campbell area (see Taylor, 1964).

Core 3 (2,020 to 2,031 feet) contained a richer arenaceous fauna including the above species as well as Ammobaculites cf. fragmentaria, A. subcretacea, Bathysiphon sp., Haplophragmoides sp. C. and Reophax ? sp. Such a fauna is typical of the Paaratte Formation as well as the upper portion of the Belfast Mudstone where the foraminiferal fauna is apparently affected by restricted water circulation. This fauna is within Taylor's (loc. cit.) Zonule A.

Sidewall core at 2,032 feet is of particular interest as it contains a fauna similar to the above, but includes a relatively large Textularia which has affinites to both T. semicomplanata and T. trilobita (a new species by Taylor, 1964). The disappearance of T. trilobita and the appearance of T. semicomplanata is one of the features that marks the boundary between Zonule B and Zonule A. However, it has been noticed that there is a transitional form at the base of Zonule A. Taylor regarded this transitional form as a morphotype of T. semicomplanata although its initial chambers are similar to T. trilobita. As the transitional form is present at 2,032 feet, this horizon can be correlated with the basal horizon of the upper part of the Belfast Mudstone in the Port Campbell area. Such correlations are as follows:- Port Campbell No. 1 from 5,230 to 5,350 feet; Port Campbell No. 2 from 6,800 to 7,000 feet; Flaxmans No. 1 from 6,200 to 6,300 feet.

No older Cretaceous faunas (i.e. Zonule B faunas) were found in the section as the Waarre Formation was entered at 2,048 feet.

Therefore the equivalent of the Paaratte Formation and upper part of the Belfast Mudstone is present in correlating this section with the Port Campbell No. 2 section. The lower part of the Belfast Mudstone is missing, which is not unusual when it is realised that this lower portion is present only in Port Campbell No. 1 and No. 2, and Flaxmans.

Paragraph here in Original Report but omitted from this Report.

The Upper Cretaceous sequence in Fergusons Hill No. 1 is of the order of 500 feet thick, whilst that in Latrobe No. 1 is less than 280 feet thick. From the foraminifera present it is assumed that Upper Cretaceous sedimentation commenced in Fergusons Hill before it did in Latrobe No. 1. This is not surprising considering the close proximity of the Latrobe well to the Wangerrip Group - Otway Group contact at Point Margaret, which is $2\frac{3}{4}$ miles to the east. Taylor (loc. cit.) has already shown that the Upper Cretaceous sediments are progressively onlapping the Otway Group. This proximity to the margin also accounts for the condensed sequence in Fergusons Hill. The same sequence in Port Campbell No. 2 occupies 1,700 feet.

Paragraph here in Original Report but omitted from this.

D. J. TAYLOR
Department of Mines of Victoria
2.3.1964

Reference:-

Taylor, D. J. 1964 Foraminifera and the stratigraphy of the Western Victorian Cretaceous sediments. Proc. Roy. Soc. Vict., 77 (2).

APPENDIX 3

GAS AND WATER ANALYSES

STATE LABORATORIES

Melbourne

An. G & F/29/7 3rd August, 1964

Report on Sample No. 847/64

Sample : Bore-hole gas
Locality : Port Campbell
Sender : The Manager,
Frome-Broken Hill Co. Pty. Ltd.,
95 Collins Street,
MELBOURNE.

Fergusons Hill No. 1

A sample of bore-hole gas was received for analysis. The gas was obtained during testing of the oil well, situated about eight miles east of Port Campbell.

Particulars of Sample.

Drilling Company	Frome-Broken Hill
Name of Well	Fergusons Hill No. 1
Depth (feet)	5436 - 5464
Date	25th May, 1964

Condition of Sample.

The sample was received in a low pressure air cylinder and was under slight positive pressure.

Results:

The gas sample contained a fairly large percentage of air, considerably more than there was in another sample of gas from another, later, well (Port Campbell No. 4, sampled 28.7.64).

As a matter of interest, the Fergusons Hill sample was re-calculated on the basis of the same amount of air found in the Port Campbell No. 4 gas.

The lefthand column below gives the analysis of gas as received, the middle column shows the results re-calculated to the basis of the same air content as the Port Campbell No. 4 gas and the righthand column shows, for comparison, the analysis of the gas obtained from the Port Campbell No. 4 well.

	847/64 As received	847/64 Same air basis as Port Campbell No. 4	848/64 Port Campbell No. 4
	% v/v	% v/v	% v/v
Methane	74.1	83.3	82.2
Ethane	6.0	6.7	6.6
Propane	2.2	2.5	3.6
Isobutane	0.74	0.83	1.07
n-Butane	0.51	0.57	1.22
Neopentane	0.015	0.017	0.018
Isopentane	0.32	0.36	0.49
n-Pentane	0.19	0.21	0.40
C_6 and higher	0.73	0.82	1.47
Oxygen	2.8		0.7
Nitrogen	12.4		2.2

Comment

The gas from Fergusons Hill No. 1 is a petroliferous gas and is very similar to the gas obtained from a later well (Port Campbell No. 4).

JOHN C. KENNEDY

Senior Chemist
Mines Department

PETROLEUM REFINERIES (AUST) PTY. LTD.

ANALYSIS OF GAS

Production Test No. 9 - 5,436 to 5,464 feet.

Carbon Dioxide	Nil
Air	11.5 %
Methane	76.6 %
Ethane	8.51 %
Propane	2.07 %
Isobutane	0.65 %
n-Butane	0.35 %
Iso-Pentane	0.13 %
n-Pentane	0.06 %
C_6 and higher	0.07 %

June, 1964.

NOTES ON WATER ANALYSIS

1. Analysis results are given for the solutions which may contain colloidal matter but which are free from any other suspensions.

2. The sum of ions expressed in p.p.m. and m.e./l., are arithmetic totals and are not related to an overall analytical error. Uncertain concentrations of ions are excluded from the sums.

3. Soluble and insoluble solids (at given temperatures) have been determined on the oven dry basis.

4. Concentrations in m.e./l. are not given for constituents which:

   A. Have variable and/or indefinite ionic characteristics.

   B. Have concentrations, in p.p.m., below the limit of analytical methods used.

5. Solutions have been analysed only for ions shown.

APPENDIX 4

CORE DESCRIPTIONS AND ANALYSIS

<u>FERGUSONS HILL NO. 1</u>

WATER ANALYSIS

by

Bureau of Mineral Resources, Geology and Geophysics

D.S.T. No. 11 - 2,096 to 2,106 feet		
Concentrations	ppm	me/1
$CO_3^{=}$	Nil	Nil
HCO_3^-	690	11.3
Cl^-	240	6.8
$SO_4^{=}$	Nil	Nil
SiO_2	40	-
Total Anions	970	18.1
Na^+	345	15
K^+	16.5	0.42
Ca^{++}	Nil	Nil
Mg^{++}	27	2.2
Fe (ferric)	< 8	Nil
Fe (ferrous)	Nil	Nil
Total Cations	388.5	17.62
Total Ions	1,358.5	-
Soluble Solids at 20°-25°C	1,180	-
Insoluble Solids at 20°-25°C	0.18% $^w/_w$	
pH at 24°C	8.2	
Conductivity at 24°C	0.00225 mhos/cm	

from original Report
Analysis by [illegible]

CORE DESCRIPTIONS FERGUSONS HILL - 1.

Core No. 1 — 1,554 to 1,574 feet. Recovered 20 feet

19 feet SILTSTONE; mainly siltstone, but grades to very fine to medium SANDSTONE in a few places. Medium to dark grey and green-grey, poorly cemented, micaceous, glauconitic, carbonaceous and pyritic, dense, tight. A few brown glauconitic dolomite (?ankerite)fragments.

1 foot SILTSTONE as for top 19 feet but with approximately 10% medium to coarse sand.

No evidence of hydrocarbons. No dip.

Core No. 2 — 1,767 to 1,787 feet. Recovered 20 feet.

SANDSTONE; silty, green, contains clear, white fine to very coarse, poorly sorted, subangular to subround quartz set in dark green, very glauconitic matrix. Tight, dense. A little altered to limonite.

No evidence of hydrocarbons. No apparent dip.

Core No. 3 — 2,020 to 2,031 feet. Recovered 11 feet.

SILTSTONE-MUDSTONE; medium to dark grey, micaceous, glauconitic and pyritic, tight, soft in parts. Scattered coarse sand grains throughout core. Top part is less glauconitic than bottom. Pyrite usually as pyritised plant remains.

No hydrocarbons. No apparent dip.

Core No. 4 — 2,092 to 2,110 feet. Recovered 6 inches.

SAND-SANDSTONE; loose, light grey to white, fine to small pebble, poorly sorted, angular to subround, friable, very porous, trace carbonaceous matter, hardly any matrix.

No evidence of hydrocarbons. No dip.

Core No. 5 — 2,427 to 2,437 feet. Recovered 5 feet.

Top 4 feet SAND; loose, clear, milky, very fine to coarse, mainly fine to medium, friable, angular to subround with a slightly silty matrix. Minor carbonaceous matter, pyrite and a few dolomitic sandstone chips. This may be fill on bottom.

Bottom 1 foot MUDSTONE; medium grey, tight, soft, carbonaceous, slickensided in places. Few pieces of amber-resin in the mudstone.

No hydrocarbons. No dip.

Core No. 6 — 2,437 to 2,449 feet. Recovered 12 feet.
Top 3 feet SILTSTONE; medium to dark grey, very carbonaceous, micaceous, dense, tight, pyritic with carbonaceous matter very abundant along a few of the bedding planes. Pyrite in stringers.

1 foot COAL; black with patches of amber-resin.

5 feet SILTSTONE-MUDSTONE; as for top of core.

1 foot COAL; as above.

2 feet SILTSTONE-MUDSTONE as for top of core.

No evidence of hydrocarbons. Apparent dip on coal bands: 10°.

Core No. 7 — 2,741 to 2,760 feet. Recovered 19 feet.
SANDSTONE; light frey, blue and green-grey, whitish colour in parts due to white, clayey matrix, soft, with abundant carbonaceous matter occurring along bedding planes. Sandstone is approximately 60% dark rock fragments and some dark grey mudstone-siltstone, 30% feldspar and 10% quartz, fine to coarse, mainly medium, and in general fairly well sorted. Angular to subround, uniform, some micaceous. Rest is noncalcareous and probably chloritic. Core is tight.

No hydrocarbons. Apparent dip on coal bands: 15°.

Core No. 8 — 3,085 to 3,105 feet. Recovered 12 feet.
SANDSTONE; light grey, green and bluish grey, made up of approximately 50% rock fragments (dark grey to black, green, pink, violet and brown), 40% feldspar, usually dull grey, greenish and quartz about 10%. Fine to coarse, mainly medium, angular to round, fairly well sorted, chloritic and tight. Abundant carbonaceous matter along bedding planes and associated resin patches. Evidence of light yellowish fluorescence and slight cut on some of the bedding planes in the bottom foot of the core. Not very strong fluorescence. No odour.
Apparent dip: 15°.
Cuttings throughout interval showed mainly SANDSTONE as for core.

Core No. 9 — 3,105 to 3,111 feet. Recovered 4 feet.
MUDSTONE; medium to dark grey, tight, dense with carbonaceous plant fragments. Core is darker in colour towards the bottom and falls apart on washing.

No evidence of hydrocarbons. No apparent dip. Density: 2.4.

Core No. 10 — 3,419 to 3,431 feet. Recovered 6 feet.
MUDSTONE; medium to dark grey, in places grades to SILTSTONE. Dense, tight, with a few thin laminations of very fine SANDSTONE, light to medium grey with high percentage of feldspar and only about 20% rock fragments, noncalcareous, tight. Core is broken and slickensided with calcite on slickensided surface.

No hydrocarbons. Apparent dip on thin sandstone laminae: 30°.

Core No. 11 — 3,732 to 3,752 feet. Recovered 19 feet.
Top 8 feet MUDSTONE-SILTSTONE; medium grey, micaceous, carbonaceous, very slightly fissile, dense, compact, tight, containing lenses of sandstone with brecciated mudstones.

11 feet SANDSTONE; light grey mottled, containing 40% rock fragments, 40% feldspar, 20% quartz, fine to coarse, mainly medium, angular to subround. Matrix, white, calcareous. Some granules and pebbles of round re-worked mudstone in sandstone. Carbonaceous plant remains. Tight.

No hydrocarbons. Apparent dip: 10°.
Density: 2.4 - sandstone; 2.5 - mudstone.

Core No. 12 — 4,092 to 4,112 feet. Recovered 20 feet.
2 feet SILTSTONE to very fine SANDSTONE; light to medium grey, carbonaceous, micaceous, compact, calcareous in part in sandstone.

2 feet MUDSTONE; dark grey, carbonaceous, tight, dense, micaceous, slickensided and broken. Slightly laminated.

3 feet SILTSTONE as for top 2 feet.

4 feet MUDSTONE; slickensided as for mudstone above.

7 feet SILTSTONE to very fine SANDSTONE as for top of core with some interbedded, tight, fine, light grey calcareous sandstone.

1 foot MUDSTONE as above.

1 foot COAL.

No hydrocarbons. Apparent dip: 10°.
Density mudstone - 2.5. Density siltstone - 2.6.

Core No. 13 — 4,514 to 4,534 feet. Recovered 6 feet.
SILTSTONE-MUDSTONE; medium to dark grey, dense, carbonaceous, dolomitic and in a few places grades into very fine sandstone which is tight. Made up mainly of angular to subround feldspar and dolomite fragments and minor rock fragments. Few

Core No. 13 (Cont'd)

dolomitic concretions in core up to 1 inch across and some very thin carbonaceous stringers. Core is broken up and slickensided with calcite on slickensided surface.

No hydrocarbons. Apparent dip: 10°.

Core No. 14

5,077 to 5,097 feet. Recovered 20 feet.
9 feet MUDSTONE; medium to dark grey, carbomaceous, dense with some intraformational breccia and fine dolomite specks.

2½ feet SILTSTONE; laminated, medium to light and dark grey laminae and fair amount of mica and carbonaceous matter, clay bedding planes, trace of resin and dolomite.

8½ feet SANDSTONE; light grey, very fine to medium, angular to subround, dark rock fragments, feldspar and quartz in white, calcareous, argillaceous matrix (approx. 30%), tight, well sorted. Dolomite lenses between 5,088½ and 5,090 feet.

No hydrocarbons. Apparent dip 12° on mudstone; 25° to 32° in laminated siltstone.

Core No. 15

5,554 to 5,569 feet. Recovered 14 feet.
Top 4 feet SANDSTONE; very light to light grey to medium grey in places, very fine to medium, mainly medium, angular to subround, tight, calcareous, matrix made up of approx. 40% feldspar, 30% dark rock fragments, 20% light brown dolomite fragments, remainder quartz. Calcite veining present. Very carbonaceous in parts and dolomite in spots. Very little mica.

5 feet mainly very fine SANDSTONE-SILTSTONE; laminated, dense, tight. Same constituents as above, but more micaceous. Very dolomitic including 3" of dolomite. In places grades into very carbonaceous medium to dark grey MUDSTONE with carbonaceous plant fragments on bedding planes.

6 feet mainly medium to dark grey MUDSTONE-SILTSTONE as above, some of which is slickensided with calcite on surface.

No hydrocarbons. Apparent dip 10° to 15° throughout core.

Core No. 16

5,934 to 5,950 feet. Recovered 16 feet.
Top 4 feet SANDSTONE; light grey mottled, with dark rock fragments, fine to coarse, mainly medium, angular to subround, well sorted, tight, slightly calcareous. 40% to 50% feldspar, 30% to 40% dark rock fragments, remainder brown dolomite (?siderite) fragments, matrix and quartz. Trace mica and carbonaceous plant fragments.

Core No. 16 (Cont'd)

12 feet Mainly medium to dark grey and brown-grey MUDSTONE grading into SILTSTONE in a few places, and with one or two thinly laminated very fine SANDSTONE stringers. All is dense and tight, and in the bottom 2 feet very dolomitic including a six-inch section of brown dolomite with calcite veining. All this 12 foot section is very carbonaceous.

No hydrocarbons. Apparent dip 15° to 20°, mainly 15°.

Core No. 17

6,403 to 6,423 feet. Recovered 20 feet.
Top 8 feet 6 inches SILTSTONE to very fine SANDSTONE; laminated, light and dark grey, dark grey laminae usually finer grained. Carbonaceous and micaceous along bedding planes, tight, dense. Minor microfaulting parallel to axis of core. Some dolomite grains - appear to be primary.

11 feet 6 inches SANDSTONE; light grey, fine to coarse, mainly medium, angular to subround, well sorted, made up of feldspar 70%, dark rock fragments, matrix, etc. Calcareous matrix, tight, with bottom 3 feet slightly coarser, mainly medium to coarse.

Whitish yellow fluorescence and light yellow cut on bottom foot of sandstone in core. Slight hydrocarbon odour in this part, but no staining visible. Fluorescence scattered through the sandstone in this foot. Light yellow soxhlet cut.

Apparent dip in core 25° to 30°.

Core No. 18

6,555 to 6,570 feet. Recovered 12 feet.
Top 4 feet SANDSTONE; light grey to medium grey, very dense, tight, compact, hard, very fine to fine, well sorted, calcareous matrix made up mainly of feldspar (approx. 70%). Rest is dark rock fragments, micaceous, matrix and quartz, dolomite fragments. Carbonaceous matter is predominant on bedding planes. Towards bottom some laminated light grey, very fine SANDSTONE with dark grey MUDSTONE and about 3" very dolomitic sandstone grading into dolomite.

8 feet interbedded, laminated, very fine SANDSTONE-SILTSTONE-MUDSTONE; light to dark grey - the finer the grain size the darker the colour in general. Very dolomitic in places and with calcite veining. Core is slickensided.

No evidence of hydrocarbons. Apparent dip 20°.

Core No. 19

7,037 to 7,047 feet. Recovered 9 feet.
MUDSTONE; dark grey, carbonaceous, dense, interbedded SILTSTONE and few very fine SANDSTONE beds. Siderite or dolomite up to 2" thick, most probably as lenses. Coalified plant remains throughout core. SANDSTONE-SILTSTONE laminae or bands are micaceous, particularly on bedding planes.

No fluorescence or indications of hydrocarbons. Apparent dip 20° to 30°.

Core No. 20 — 7,220 to 7,237 feet. Recovered 14 feet.
4 feet SILTSTONE; medium to dark to brown-grey, laminated with carbonaceous material, fissile, coalified plants and mica accumulated on bedding planes. Odd greasy brownish specks with golden yellow fluorescence.

10 feet SANDSTONE; light grey, slightly carbonaceous and micaceous, very fine to medium, mainly fine, angular to sub-round, well sorted. 60% to 70% feldspar, 20% to 30% rock fragments, 10% quartz. Few chlorite grains. Tight, well cemented with siliceous, argillaceous and calcareous matter.

No hydrocarbons. No fluorescence. Apparent dip: 30° in siltstone; up to 45° in sandstone.

Core No. 21 — 7,330 to 7,345 feet. Recovered 15 feet.
1 foot SANDSTONE; light grey, very fine, very tight, 85% feldspar, 5% quartz, 10% dark fragments including rock and carbonaceous fragments, mainly carbonaceous material. Angular to subrounded, fairly well sorted.

4 inches SILTSTONE to very fine SANDSTONE, light grey, same as above.

13 feet 8 inches SILTSTONE; medium to dark grey, very tight, carbonaceous material.
Fine to very fine dolomite nodules and large nodules up to 1 to 2½ inches thick.

No hydrocarbons or fluorescence. Dip: 12° to 18°.

Core No. 22 — 7,818 to 7,832 feet. Recovered 14 feet.
SILTSTONE-MUDSTONE; medium to dark grey, carbonaceous, micaceous, slickensided in places, dense and laminated, fissile (shale). The mudstone is usually the darker colour (dark grey). Abundant plant remains.

No hydrocarbons. Apparent dip 10° to 15°.

Core No. 23 — 8,247 to 8,262 feet. Recovered 13 feet.
Top 8 feet medium to dark grey, dense, carbonaceous SILTSTONE-MUDSTONE, calcareous in places and slightly brown and harder, due to siderite, in spots. Laminated slightly in a few places with carbonaceous lenses of plant remains.

Bottom 5 feet SANDSTONE; light to medium grey, very fine to fine, well sorted, very calcareous, angular to subround grains, a lot of which are brown (?siderite), carbonaceous, tight.

Bright yellow fluorescence throughout sandstone, due to mineral, probably some impurity with calcite. No cut, no odour. Acetone negative. Soxhlet: small greasy cut. Apparent dip 15° to 20°. Note: Sandstone fragments after soxhlet still fluoresced.

Core No. 24 — 8,758 to 8,774 feet. Recovered 15 feet.
SILTSTONE-MUDSTONE; medium to dark grey, dense, compact, slightly calcareous in some of the siltstone. Laminated in part with thin bands of carbonaceous material, and some bands of slightly coarser silt size, usually lighter in colour. Few fragments of brown, hard dolomite (siderite) and trace calcite. Cross-bedded.

No hydrocarbons. Apparent dip 10°.

Core No. 25 — 9,195 to 9,211 feet. Recovered 16 feet.
SILTSTONE-MUDSTONE; medium to dark grey, very carbonaceous, micaceous, fissile, lenticular, laminated with laminae of light to dark grey and of from clay to mudstone to very fine sandstone. Two feet from top a 6 inch band of SANDSTONE; light grey, very fine, laminated to massive, fluorescent, with a faint, greasy, yellowish cut.

Apparent dip 3° to 10°. Cross-bedded parts up to 25°.
Soxhlet: Brown, waxy residue.

Core No. 26 — 9,626 to 9,631 feet. Recovered 5 feet.
1 foot SANDSTONE; light grey, angular, very fine, poorly sorted, 90% feldspar, white to clear; 10% dark fragments, including muscovite, biotite, carbonaceous material. Calcareous, fairly tight, cross bedding with laminated carbonaceous matter. Yellow fluorescence as in Core No. 23.

4 feet SILTSTONE-MUDSTONE; very dark grey to black, tight, micaceous, feldspar, carbonaceous matter. Non-calcareous. Very fractured and slickensided with calcite fracture filling. Some very dull, brown fluorescence with fairly good cut. No apparent dip can be measured. Dip range would be fairly low - 10° or less. Soxhlet: Brown residue with dark golden yellow fluorescence.

Core No. 27 — 10,092 to 10,101 feet. Recovered 4 feet.
Top 2 inches light grey CLAY-MUDSTONE; soft, interbedded with crystalline calcite.

Rest of core SILTSTONE; medium to very dark grey, dense, micaceous, calcareous, carbonaceous with few light grey laminated SILTSTONE bands and darker grey carbonaceous lenses. Very fractured with calcite infilling and vein calcite, cross-bedded.

No hydrocarbons. Apparent dip 10° to 15°.

Core No. 28 — 10,574 to 10,588 feet. Recovered 16 inches.
Top 8 inches SILTSTONE; medium to dark grey, dense, carbonaceous with some golden mica. Interlaminated with light grey SANDSTONE to SILTSTONE; very fine, calcareous. Golden yellow fluorescence.

2 inches SANDSTONE; light grey, very fine, tight, calcareous, angular to subround, fairly well sorted, 90% feldspar, 10% carbonaceous fragments. Some golden yellow fluorescence as for Core No. 23.

6 inches SILTSTONE to MUDSTONE; very dark grey to black, dense, rare mica, carbonaceous fragments.

9 Cut: Greenish yellow greasy residue with golden yellow fluorescence.

Apparent dip 50° to 55°. Core is slickensided and moderately fractured.

Core No. 29 — 10,660 to 10,668 feet. Recovered 5 feet.
SANDSTONE; light to medium grey, very fine to medium, mainly fine, angular to rare rounded, well sorted, slickensided. Feldspar 80%, dark fragments 15%, quartz 5%. Calcareous. Chlorite, zeolite and few biotite, coarse dark brown grains of siderite. Feldspar is fresh to kaolinised. Argillaceous matrix. No bedding observed. Core breaks at angle 15° to 30°.

No fluorescence. No hydrocarbons.

Core No. 30 — 11,080 to 11,094 feet. Recovered 12 feet.
SILTSTONE-MUDSTONE; brown to very dark grey to black, carbonaceous. Very fractured and slickensided, with calcite filled fractures running in all directions. No apparent dip, some cross bedding.

Fluorescence: Dull, golden yellow. Colourless, greasy residue after cut with bright golden yellow fluorescence.

Core No. 31 — 11,419 to 11,432 feet. Recovered 12 feet.
5 feet SILTSTONE-MUDSTONE; medium to very dark to brown grey, carbonaceous, in places laminated, fissile, broken up and slickensided.

4 feet SILTSTONE interbedded with SANDSTONE, light grey to green grey, very fine to fine, mainly very fine, angular to subrounded, with black patches of tar-like carbonaceous matter both in siltstone and sandstone - more often in siltstone. Fractured, slickensided, with calcite filling.

Core No. 31 (Cont'd)

1 foot SANDSTONE; light to green grey, fine, angular to rounded, well sorted, 80% to 90% feldspar, 10% to 20% rock fragments, less than 5% quartz. Rock fragments and feldspar often encapsuled by white film, probably zeolite. Matrix calcareous. Little biotite and chlorite.

3 feet SILTSTONE-MUDSTONE as for top of core, but more fractured.

Dip approximately 10°. Dull brown fluorescence.
Soxhlet: Brown greasy residue with bright yellow fluorescence.

Core No. 32

11,519 to 11,534 feet. Recovered 5 feet.
TALCOSE and micaceous SCHIST; light grey to green grey, with pearly lustre. The rock is composed of mica and talc, with minor quartz. Accessories are pyrite, magnetite, tourmaline and actinolite. The core is highly foliated and closely folded in parts. Some whole microcrystalline spherules are abundant. Some bedding, and dips of the order of 50% can be observed. Density: 2.76.

Core No. 33

11,582 to 11,593 feet. Recovered 2 feet.
MICA SCHIST, with quartzitic appearance in parts. Greenish grey, polished, composed of quartz and phyllosilicates, probably muscovite, or the green variety may be chlorite or chloritoid. Mica appears to be colourless to silvery white to green with pearly lustre on cleavage surfaces. The core is greener and contains more quartz and is more massive than Core No. 32. Qaurtz is a major constituent, macro to cryptocrystalline usually without sharp boundaries. Accessory mineral is pyrite in fine crystalline form.

Core No. 34

11,616 to 11,622 feet. Recovered 3 feet.
MICA SCHIST; green, very foliated, schistose, micaceous, silvery white, with pearly lustre. Main constituents are quartz and mica. Quartz also appears as pebble-like pieces. The rock is soft, with a greasy feel.
Foliation dips 53° to axis of core.

SIDEWALL CORES

1,831 feet	1½"	SANDSTONE; dark grey-green, glauconitic, chloritic, fine to coarse, mainly medium, angular to subround, well sorted quartz set in a green glauconitic matrix.
1,951 "	1½"	SAND-SANDSTONE; light grey, very fine to fine, mainly fine, well sorted quartz, micaceous, slightly chloritic, silty.
1,982 "	1½"	SILTSTONE; sandy, light grey, fine to very coarse, mainly medium, quartz set in glauconitic and chloritic matrix.
2,032 "	1"	MUDSTONE; dark grey, micaceous, silty, soft, very slightly chloritic and glauconitic.
2,046 "	1"	SAND-SILTSTONE; sand is all clean quartz, fine to pebble, mainly medium, angular to subround and some round set in a dark grey silty, clayey matrix. Abundant pyrite and carbonaceous matter.
2,048 "	1½"	SAND; light grey to white, very fine to medium, loose, slightly silty, mainly fine to medium, angular to subround, all quartz.
2,051 "	1½"	SAND; as for 2,048 feet, but very fine to granule, mainly medium, all quartz.
2,063 "	1"	SAND; loose, white, slightly silty (due to mud filtrate), very porous, very fine to very coarse and some granule, mainly medium, angular to subround, mainly angular, poor sorting, all quartz.
2,072 "	1½"	SAND as for 2,063 feet.
2,105 "	1"	SAND; white to light grey, slightly silty (due to mud filtrate), very fine to granule, mainly coarse, angular to subround, fair sorting, very porous, all quartz.
2,117 "	1¼"	SAND; white, silty (mud filtrate), very fine to very coarse, mainly medium to coarse, angular to subround, very porous, all quartz.
2,123 "	1½"	SILT to VERY FINE SAND; light grey, micaceous, carbonaceous, soft.
2,175 "	1½"	SILTSTONE; medium grey, micaceous, slightly more compact than 2,133 foot sample.
2,189 "	1"	SAND; white, slightly silty (due to filtrate), very fine to granule, angular to subround, granules and very coarse sand usually round, poor sorting, quartz, some pink quartz.
2,219 "	No recovery.	

2,299	feet	1"	SAND; light grey, silty (filtrate), made up of clear, very fine to coarse, mainly medium, angular to round loose quartz.
2,319	"	1¼"	SAND; loose. white, light grey, silty (filtrate), made up of clear, fine to coarse, angular to round quartz.
2,356	"	1"	SAND; as for 2,319 feet, except very slightly coarser.
2,400	"	1½"	SAND; as for 2,319 feet - carbonaceous.
2,419	"	Lost in hole.	
2,430	"	2"	SILT to VERY FINE SAND; interbedded, white and grey layers, carbonaceous, pyritic.
4,618	"	¼"	SANDSTONE; light grey, buff, argillaceous, very fine to medium, tight, slightly carbonaceous, made up of feldspar, dark rock fragments, quartz, slightly calcareous. Slight gold-yellow fluorescence. No cut.
4,725	"	¼"	SANDSTONE; light grey, fine to medium, angular to subround, feldspar, rock fragments and quartz, tight. Slightly carbonaceous, argillaceous.
4,815	"	½"	SANDSTONE; light grey, mottled, fine to coarse, mainly medium, angular to subround. Same constituents. No fluorescence.
4,952	"	No recovery.	
5,241	"	¾"	SANDSTONE; light grey, very fine to coarse, mainly medium, angular to subround, compact, tight, calcareous, feldspar, rock fragments, dolomite grains. No fluorescence.
5,439	"	No recovery.	
5,735	"	No recovery.	
5,830	"	No recovery.	
5,913	"	¼"	SANDSTONE; light grey, mottled, very fine to medium, calcareous, feldspar, rock fragments, quartz, angular to subround. No fluorescence.
11,333	"	No recovery.	
11,349	"	1¼"	MUDSTONE; very dark grey to brown grey, carbonaceous, tight.
11,350	"	¾"	SANDSTONE; light grey, very fine to medium, mainly fine, calcareous, feldspar, rock fragments, chlorite, carbonaceous. Slight fluorescence. Acetone: Negative. Chlorothene: Fair cut.

11,385 feet		¼"	SANDSTONE; very light grey, very fine to medium, mainly fine, very argillaceous, calcareous. Acetone: Weak. Chlorothene: Weak.
11,396	"		No recovery.
11,400	"	¾"	SANDSTONE; light grey, very fine to medium, mainly fine, calcareous, feldspar, rock fragments, chlorite, carbonaceous, argillaceous. Slight fluorescence. Acetone: Positive. Chlorothene: Good.
11,405	"	1"	SANDSTONE; light grey, very fine to medium, mainly fine, calcareous, feldspar, rock fragments, chlorite, carbonaceous, blue fluorescence. Acetone: Good. Chlorothene: Good.
11,407	"		No recovery.
11,410		¾"	SANDSTONE; light grey, very fine to medium, mainly fine, calcareous, feldspar, rock fragments, chlorite, carbonaceous. Fluorescence: Blue. Acteone: Good. Chlorothene: Good.
11,415	"		No recovery.
11,420	"	1½"	SANDSTONE; light grey, very fine to medium, mainly fine, feldspar, quartz, rock fragments, chlorite. Brown fluorescence. Acetone: Good positive. Chlorothene: Good cut.
11,435	"		No recovery.
11,438	"	2¼"	COAL.
11,445	"	1"	SANDSTONE; light grey, very fine to medium, mainly fine, feldspar, quartz, rock fragments, chlorite, calcareous cement. Blue fluorescence. Acetone: Positive. Chlorothene: Fair.
11,450	"	¾"	MUDSTONE; dark grey to brown grey, carbonaceous.
11,455	"	1¼"	SANDSTONE; white to light grey, very fine to medium, mainly fine, angular quartz, feldspar, rock fragments. White fluorescence. Chlorothene: Fair.
11,460	"	¾"	SANDSTONE; light grey, fine, quartz, feldspar, rock fragments, chlorite, calcareous matrix. Blue fluorescence. Acetone: Good. Chlorothene: Fair.
11,465	"		No recovery.
11,470	"	1¼"	SANDSTONE; light grey, quartz, fine to medium, angular to subrounded, calcareous, micaceous. No fluorescence. No cut.

11,481 feet		¼"	SILTSTONE to very fine SAND; dark grey, very carbonaceous, tight.
11,845	"	1¼"	MUDSTONE; dark to brown grey, tight, slickensided.
11,487	"	1"	MUDSTONE; dark grey to brown grey, tight, broken up.
11,489	"	Lost bullet.	
11,490	"	1¼"	SILTSTONE-MUDSTONE; dark grey, carbonaceous, tight, with calcite fracture filling.
11,490	"	No recovery.	
11,491	"	No recovery.	
11,492	"	1"	MUDSTONE-SILTSTONE; dark grey to brown grey, tight, carbonaceous.
11,493	"	Lost bullet.	
11,494	"	1"	SANDSTONE; light grey, very fine to medium, quartz, feldspar, rock fragments, chlorite, mica. Calcareous matrix. Very slight blue fluorescence. Acetone: Very weak positive. Chlorothene: Weak cut.
11,494	"	½"	SANDSTONE; light grey, very fine to medium, angular to subrounded, quartz, feldspar, rock fragments, chlorite, compact, calcareous, some sercite in matrix. Strong fluorescence. Acetone: Weak positive. Chlorothene: Weak cut.
11,495	"	¾"	SANDSTONE; very light grey, very fine to medium, mainly fine, angular to subrounded, quartz, feldspar, rock fragments, green chlorite, micaceous, cemented, very calcareous, fairly argillaceous. Acetone: Weak positive. Chlorothene: Weak cut.
11,496	"	1¼"	SANDSTONE; very light grey, very fine to medium, mainly fine, angular to subrounded, quartz, feldspar, rock fragments, green chlorite, micaceous, cemented, very calcareous. No fluorescence. Acetone: Slight positive. Chlorothene: Weak cut.
11,496	"	¾"	SANDSTONE; very light grey, very fine to medium, angular to subrounded, mainly quartz, some feldspar, chlorite and rock fragments. Interbedded with coal. Silty, calcareous matrix. No fluorescence. Acetone: Positive.
11,497	"	No recovery.	
11,497	"	No recovery.	

11,498 feet		¼"	SANDSTONE, very light grey, very fine to medium, angular to subrounded, mainly quartz, some feldspar, chlorite and rock fragments. Interbedded with COAL. Silty, calcareous matrix. No fluorescence. Acteone: Weak positive. No cut.
11,499	"	1"	SAND to SILT; light grey, micaceous, with rock fragments and feldspar. Fluorescence: Golden yellow. Acetone: Very slight positive. Chlorothene: Good cut.
11,499	"	No recovery.	
11,500	"	No recovery.	
11,500	"	No recovery.	
11,501	"	No recovery.	
11,501	"	Lost bullet.	
11,502	"	Lost bullet.	
11,502	"	Lost bullet.	
11,503	"	¾"	SANDSTONE; white to very light grey, very fine to coarse, clear quartz, poorly sorted, angular, very few subrounded, silty. Some green schist material, silvery white mica and/or talc. Few pyrite, red and pink quartz, feldspar, tourmaline fragments. Generally loose, however well cemented in parts. Cement is silty, non-calcareous. Acetone: Postive. Chlorothene: Weak cut.
11,504	"	1¼"	SAND; white to very light grey, silty, argillaceous, non-calcareous, angular, very fine to coarse, unsorted. Some pyrite. Fluorescence: Blue white. Chlorothene: Weak cut.
11,505	"	1¼"	SANDSTONE; as for 11,503 feet. Blue white fluorescence. Acetone: Positive.
11,506	"	1¼"	SANDSTONE; light grey to white, as for 11,503 feet. Acetone: Faint positive. Chlorothene: Weak cut.
11,507	"	No recovery.	
11,507	"	No recovery.	
11,508	"	Lost bullet.	
11,508	"	No recovery.	

11,509 feet		1¼"	SANDSTONE; white to very light grey, very fine to very coarse, clear quartz, poorly sorted, angular, very few subrounded. Some green schist material, silvery white mica and/or talc. Few pyrite, red and pink quartz, feldspar, tourmaline fragments. Generally loose, however well cemented in parts. Cement is silty, non-calcareous. White fluorescence. Acetone: Positive. Chlorothene: Fair cut. Fairly strong gas smell after opening bottle.
11,510	"		Lost bullet.
11,511	"		no recovery.
11,512	"		No recovery.
11,513	"		No recovery.
11,514	"	¾"	SAND; loose quartz, clear to slightly yellow, angular, orientated quartz grains, with appearance of broken glass. Weathered and bleached appearance. Strong blue fluorescence. Acetone: Weak positive. Chlorothene: Fair cut.
11,515	"	1"	MICA SCHIST; white, with quartz and silvery white mica. Apparently slightly bleached, loose grains. Weak fluorescence. Acetone: Slight, positive. Chlorothene: Slight cut.

CORE ANALYSIS

The Bureau of Mineral Resources made the following determinations in regard to Cores 15 and 16.

(a) Porosity and Permeability:

Core 15	5,554 to 5,556 feet, and	
	5,556 to 5,558 feet	
Core 16	5,934 to 5,936 feet, and	
	5,936 to 5,938 feet	

One vertical cylinder and two horizontal cylinders at right angles to each other, were cut from each sample.

Permeabilities in all tests were nil, and effective porosities in all tests 9% to 10%.

(b) Acid Solubility:

Core 15	5,554 to 5,556 feet	33%
	5,556 to 5,558 feet	39%
Core 16	5,934 to 5,936 feet	10%
	5,936 to 5,938 feet	18%

APPENDIX 5

SUMMARY OF OPERATIONS

SUMMARY OF OPERATIONS

FERGUSONS HILL NO. 1

Drilling Contractors (Aust.) Pty. Ltd. moved their National 80B rig from Sherbrook No. 1 to Fergusons Hill No. 1 and rigged-up. This well was spudded at 0800 hours on the 24th of December, 1963.

Drilled 12¼" hole to 392 feet and lost circulation. Regained circulation after adding cotton seed hulls and sawdust to mud system. Circulation was again lost at 447 feet; regained circulation and finished drilling 12¼" hole to 1,050 feet. Ran electric and sonic-gamma ray logs before opening 12¼" hole to 17½". Opened hole without losing returns.

Ran and cemented 13⅜" casing at 1,049 feet, using 1,057 sacks of construction cement. Obtained an estimated 150 sacks of cement returns to surface. Released casing after 6 hours and nippled-up blow-out preventors. Tested casing and blow-out to 1200 psi before drilling floating equipment.

Drilled 8¾" hole from 1,050 to 7,330 feet. Opened 8¾" hole to 12¼" to a depth of 5,860 feet for running 9⅝" casing. The well was originally programmed to be drilled to total depth without an intermediate string of casing. However, because the hole started to deviate excessively at 4,300 feet, and with the subsequent occurrence of a dog-leg, it was necessary to case off as much of the deviated hole as possible if the well was to be carried to depth. Considerable drag of the drill string was experienced on pulling out of the hole down to 7,300 feet before the casing was set. The drill string was stuck once before casing was set. Spotting of diesel oil freed the string.

9⅝" casing was set at 5,825 feet and cemented with 170 sacks around the shoe and an additional 200 sacks through a stage collar at 250 feet. During the cementation the stage collar leaked, allowing the cement of the first stage around the shoe to be over-displaced. The bottom joints of the 9⅝" casing were repaired by squeeze cementing.

After the setting of the 9⅝" casing, the hole size was reduced to 8½" for the balance of the well.

Hole deviation continued to remain between 5 and 6 degrees to approximately 9,000 feet. From this point to total depth, deviation remained between 2 and 3 degrees. However, as the problem of deviation diminished, torquing of the drill string began. Torque was first experienced at about 9,400 feet and was most severe in the interval 10,200 to 10,400 feet. To eliminate torquing of the drill string the water loss was lowered and the mud weight and viscosity allowed to increase. However, no noticeable improvement resulted from these changes.

Penetration rates obtained throughout the drilling of the hole were very poor. From 5,000 to 9,000 feet the low penetration rates can be contributed to the low bit weights carried to control deviation. The use of stabilizers probably had only minor effect on controlling deviation, in view of the large hole diameters experienced.

From 9,000' to total depth, where high bit weights were carried, little improvement in penetration was obtained. The torque experienced in this interval was not a contributing factor to the low penetration rates. An interesting fact that should be noted is that little difference in penetration rates was obtained whether soft formation bits (YT-1) or hard formation bits (YM) were used. The use of jet bits showed no marked improvement over regular type bits. Most of the bits showed excessive bearing wear due to the high bit weights, and only minor tooth dulling regardless of the type of bit used.

When conditions such as these are encountered it may be possible to improve penetration rates by using an aerated mud system to reduce the hydrostatic head. Torquing could become more serious with this type system.

Total depth of 11,622 feet was reached on the 6th of May, 1964. $5\frac{1}{2}$" casing was set at 11,580 feet and cemented with 500 sacks of cement. Top of cement in annulus was estimated at 10,575 feet.

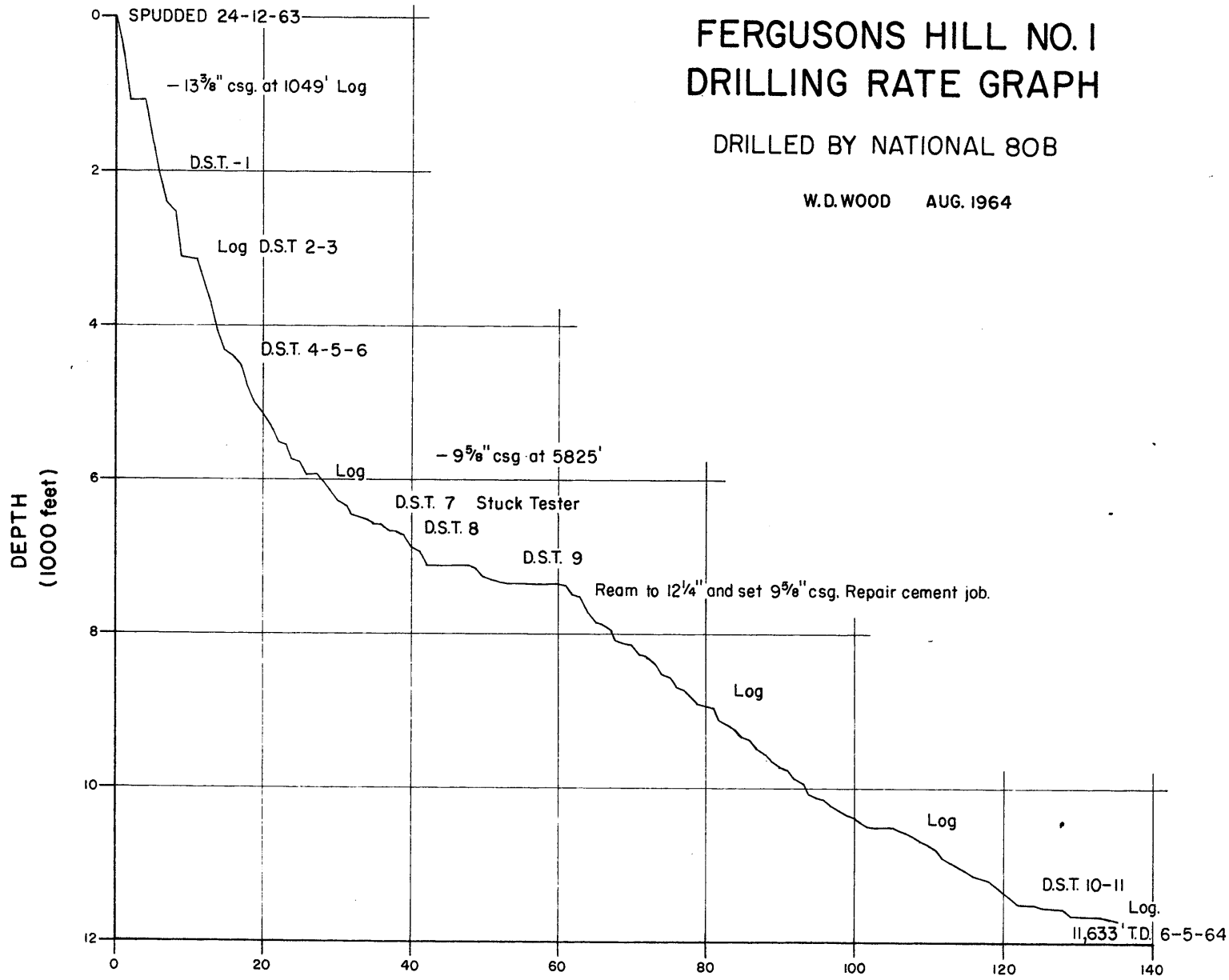
W. D. WOOD

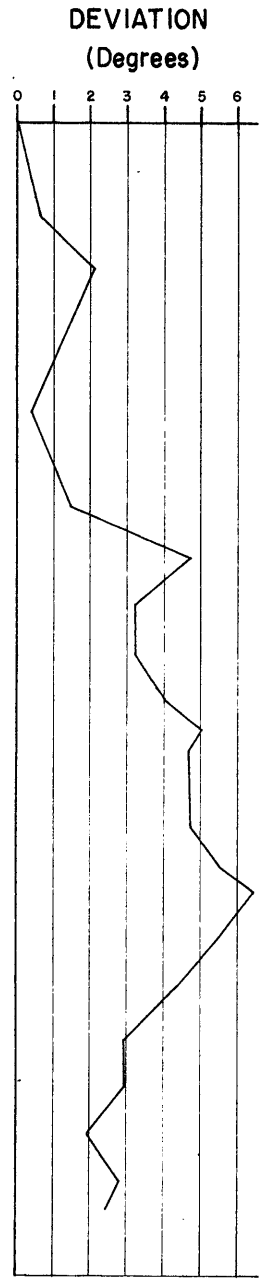
FROME-BROKEN HILL. CO. PTY. LTD.

FERGUSONS HILL NO. 1
DRILLING RATE GRAPH

DRILLED BY NATIONAL 80B

W. D. WOOD AUG. 1964





APPENDIX 6

SUMMARY OF TESTING OPERATIONS

SUMMARY OF TESTING OPERATIONS

Factual data relating to all drill stem tests made in Fergusons Hill No. 1 have not been included in this summary.

Open Hole Tests

D.S.T. No. 1 - 2,050 to 2,092 feet, Waarre Formation.

Received good blow in initial flow period and on opening tool for second flow. Blow decreased to nearly dead after 30 minutes.

Recovered 390 feet of mud, with filtrate salinity 1100 ppm Cl. Ten feet of loose sand was found packed on top of the test tool.

As the test tool and perforated pipe were plugged during the initial flow period, the bottom pressure recording chart showed shut in conditions during the test.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	1010 psi	1040 psi
I.S.I.P. 28 minutes	630 "	655 "
I.F.P.	200 "	-
F.F.P. 30 minutes	200 "	-
F.S.I.P. 15 minutes	920 "	655 "
F.H.P.	1010 "	1040 "

D.S.T. No. 2 - 3,074 to 3,105 feet, Otway Group.

Packer seat failed on opening tool.

D.S.T. No. 3 - 3,090 to 3,115 feet, Otway Group.

Packer seat failed on opening tool.

D.S.T. No. 4 - 3,043 to 3,111 feet, Otway Group.

Packer seat failed on opening tool.

D.S.T. No. 5 4,308 to 4,350 feet, Otway Group.

Packer seat failed on opening tool.

D.S.T. No. 6 - 4,293 to 4,350 feet, Otway Group.

A successful packer seat was obtained by using a dual packer assembly. Recovery amounted to 90 feet of rathole mud. The pressure charts showed a slight build-up during the initial and final closed-in periods indicating a very tight zone.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	2230 psi	2280 psi
I.S.I.P. 29 minutes	220 "	250 "
I.F.P.	70 "	110 "
F.F.P. 20 minutes	90 "	110 "
F.S.I.P. 19 minutes	135 "	165 "
F.H.P.	2230 "	2280 "

D.S.T. No. 7 - 6,414 to 6,440 feet, Otway Group.

As on the previous test, 4,293 to 4,350 feet, a slight build-up was indicated during the closed-in periods, which would again be indicative of a tight zone.

No fluid was recovered on the test, as the drill string became stuck while pulling out of the hole, making it necessary to establish reverse circulation through the pump-out sub.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	3560 psi	3570 psi
I.S.I.P. 30 minutes	160 "	165 "
I.F.P.	45 "	60 "
F.F.P. 24 minutes	45 "	60 "
F.S.I.P. 16 minutes	90 "	110 "
F.H.P.	3560 "	3570 "

D.S.T. No. 8 - 6,528 to 6,570 feet, Otway Group.

Approximately 20 feet of rathole mud was recovered. Build-up pressures indicated a very tight zone.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	3670 psi	3720 psi
I.S.I.P. 30 minutes	90 "	110 "
I.F.P.	20 "	45 "
F.F.P. 20 minutes	20 "	45 "
F.S.I.P. 14 minutes	45 "	65 "
F.H.P.	3670 "	3720 "

D.S.T. No. 9 - 7,288 to 7,330 feet, Otway Group.

The pump-out sub cut out on going in hole. Pulled out of hole and re-ran test tools without the pump-out sub. Approximately 30 feet of rathole mud was recovered. The zone appears to be tight.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	4020 psi	4070 psi
I.S.I.P. 30 minutes	110 "	160 "
I.F.P.	45 "	80 "
F.F.P. 40 minutes	45 "	80 "
F.S.I.P. 30 minutes	70 "	110 "
F.H.P.	4020 "	4070 "

D.S.T. No. 10 - 11,364 to 11,432 feet, Otway Group.

Packer seat failed to hold.

D.S.T. No. 11 - 11,376 to 11,467 feet, Otway Group.

Packer seat failed to hold.

In summary, a total of eleven open hole drill stem tests were made, with seven of this number resulting in failure. The four successful tests indicated zones of very low permeabilities. The pressure charts showed constant pressures during both initial and final flow periods. On each test only minor amounts of rathole mud were recovered above the tester. A slight pressure build-up was recorded on each test during the closed-in periods. It is possible that these build-up pressures are the result of leakage around the packer. The fact that on all tests the initial closed-in pressure was of a higher value than the final closed-in pressure for equivalent time periods would seem to rule out leakage as a factor.

The overall test time bordered on the minimum. However, it is doubtful that any useful purpose would have been accomplished by lengthening the test period.

Casing Tests

Production Tests 1 and 2 - 11,490 to 11,514 feet, Otway Group.

The first two tests made of this interval were mis-runs; the first due to a wash-out of the 5-position C.I.P. valve, and the second to a wash-out of a collar on top of the handling sub.

Production Test No. 3 - 11,490 to 11,514 feet, Otway Group.

800 feet water cushion. The tester was run using a three-position C.I.P. valve. On opening the tester no blow was received at the surface. The well remained dead throughout the 2 hour flow period and was then closed-in for 1 hour. Approximately 10 feet of drilling mud was recovered from above the tester in addition to 800 feet water cushion.

The charts showed a steady pressure during the flow period, with a pressure build-up commencing with the closing of the C.I.P. valve. It is believed that this pressure build-up is not a reflection of the formation but the result of a leak developing on the closing of the C.I.P. valve.

The test was considered valid and the zone interpreted to be barren. The zone was abandoned by setting a Howco DM bridge plug at 11,443 feet.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	6095 psi	6135 psi
I.S.I.P.	367 "	385 "
I.F.P.	365 "	385 "
F.F.P. 126 minutes	367 "	385 "
F.S.I.P. 60 minutes	1005 "	1015 "
F.H.P.	6095 "	6270 "

Production Test No. 4 - 11,380 to 11,416 feet, Otway Group.

This test was first run with the 3-position C.I.P. valve in the closed position. An initial C.I.P. was attempted by using the 10 ft. distance between the tester and C.I.P. valve as an air chamber. The air chamber proved to be too small. On opening the C.I.P. valve no blow was recorded at the surface. A two hour flow period followed by a two hour closed-in period was taken.

The pressure charts indicated that the C.I.P. valve had opened only momentarily during the test. The turning of the C.I.P. valve from its initial closed position to the open position did not occur. The final turning of the C.I.P. valve was sufficient to move it completely past the open position into its final closed position. Again, the pressure build-up obtained seemed to indicate that the annulus pressure was being transmitted below the packer. The build-up pressures reached a value of approximately 75% of that of the hydrostatic head of the mud column at test depth.

A thorough inspection of all the test tools failed to show anything to be out of order. The test was considered to be unsatisfactory.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	6055 psi	6080 psi
F.H.P.	6033 "	6050 "

Production Test No. 5 - 11,380 to 11,416 feet, Otway Group.

The tester was opened and no blow was received. After two hours the tester was closed and a 2 hour shut-in made.

The charts showed a slight pressure increase at the end of the flow period. However, this pressure increase had bled-off before the start of the closed-in period. The closed-in period showed an irregular pressure build-up and, as on the previous tests, there appears to be a leak developing when the C.I.P. valve is in the closed position.

The test was unsatisfactory.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	5855 psi	5860 psi
I.S.I.P.	605 "	655 "
I.F.P.	495 "	495 "
F.F.P. 120 minutes	605 "	655 "
F.S.I.P. " "	1945 "	1985 "
F.H.P.	5832 "	5900 "

Production Test No. 6 - 11,380 to 11,416 feet, Otway Group.

As on the previous test, no blow was received on opening the tester. The charts showed an irregular build-up during the first part of the flow period. The build-up appearance was very similar to that of a tool plugging. During the last half of the flow period, the pressure remained constant and at minimum value. A very slight build-up occurred during the closed-in period.

While pulling out of the hole at the conclusion of the test, the C.I.P. washed out. This washing out of the C.I.P. valve seems to confirm the fact that a leak may have been the reason for the build-up experienced during the closed-in period on previous tests.

The test was unsatisfactory.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	5900 psi	5862 psi
I.S.I.P.	388 "	357 "
I.F.P.	365 "	357 "
F.F.P. 7 hrs. 47 mins.	388 "	357 "
F.S.I.P. 2 " 23 "	528 "	495 "
F.H.P.	5255 "	5236 "

Production Test No. 7 - 11,380 to 11,416 feet, Otway Group.
800 feet water cushion.
This test was run without taking closed-in pressures.
No blow was received on opening the tester.

The charts showed a steady pressure during the first hour of the test, at the end of which time a sharp pressure increase occurred. This pressure increase returned essentially to the initial pressure value obtained at the start of the test. No explanation can be found for the occurrence of this strong pressure rise.

The test was considered satisfactory, and the zone interpreted to be barren.

Recovered water cushion and 150 feet of gas-cut mud.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	5835 psi	5855 psi
I.F.P.	342 "	355 "
F.F.P. 6 hours	388 "	412 "
F.H.P.	5832 "	5862 "

Recovery of $5\frac{1}{2}$" Casing

The wellhead and blow-out preventors were removed and stretch measurements taken on the $5\frac{1}{2}$" casing. These measurements indicated the casing to be free to a depth of 9,000 feet. Cut casing at 9,000 feet and pulled out of hole with 263 joints of good casing and 2 cut joints.

Isolation of Test Interval 5,660 to 5,690 feet.

Went in hole with open-ended tubing to 5,858 feet and laid a 60 sack cement plug across the $9\frac{5}{8}$" casing shoe. Top of plug was located at 5,807 feet.

Schlumberger perforated a 1 foot interval from 5,600 to 5,601 feet with 4 jets. Went in hole and set Howco DC squeeze packer at 5,567 feet. Squeeze cemented the isolation perforations. Broke formation down and squeezed 95 sacks to a final pressure of 2000 psi. Drilled out DC squeeze packer and cleaned out to 5,807 feet. Satisfactorily pressure tested isolation perforations to 1500 psi for 15 minutes.

Production Test No. 8 - 5,660 to 5,690 feet, Otway Group.

Ran tester using hydraulic adjustable bottom hole choke and no load water. Opened tester and received a fair blow that diminished to a very weak blow for the balance of the test. Rigged up and ran swab bar without cups and failed to locate fluid. Pulled tester out of hole and recovered approximately 1800 feet of drilling mud. This large recovery of drilling mud was evidently due to the large uncemented section existing in the test interval. It is felt that the cement squeezed through the isolation perforations at 5,600 to 5,601 feet must have gone up instead of down and across the test interval. Had swabbing of this zone taken place, it is possible that a representative formation sample may have been recovered. For all practical purposes the zone can be considered tight and barren.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	3028 psi	3030 psi
I.F.P. 15 minutes	92 "	85 "
I.S.I.P. 60 minutes	451 "	461 "
F.F.P. 466 minutes	115 "	111 "
F.S.I.P. 90 minutes	-	1235 "
F.H.P.	3005 "	3002 "

Isolation of Test Interval 5,436 to 5,464 feet.

Went in hole with open-ended tubing to 5,700 feet and laid a 50 sack cement plug to isolate the test perforations 5,660 to 5,690 feet. Located top of plug at 5,600 feet.

Schlumberger perforated a 1 ft. interval from 5,410 to 5,411 feet with 4 jets. Went in hole and set a Howco DC squeeze packer at 5,379 feet. Broke down formation and squeezed 95 sacks of cement to a final pressure of 2000 psi. Drilled out squeeze packer and cleaned out to 5,600 feet. Pressure tested isolation perforations to 1600 psi for 15 minutes.

Production Test No. 9 - 5,436 to 5,464 feet, Otway Group.

Ran tester using an hydraulic adjustable bottom hole choke with no load water. Obtained a fair blow on opening tester that diminished. Ran swab and swabbed well down to top of C.I.P. valve. A slight gas flow to surface was established. However, the quantity was too small to measure. The test tools were pulled and approximately 1½ bbls. of slightly gas-cut mud were recovered. No formation water was obtained on the test.

The test was considered satisfactory and the zone interpreted as being too tight to produce.

Pressures were as follows:

		Top Chart	Bottom Chart
I.H.P.		2740 psi	2765 psi
I.F.P.	20 minutes	93 "	110 "
I.S.I.P.	60 minutes	989 "	985 "
F.F.P.	28 hrs. 11 min.	275 "	300 "
F.S.I.P.		160 "	165 "
F.H.P.		Clocks run down	

Abandonment of Test Interval 5,436 to 5,464 feet.

Went in hole with open-ended tubing to 2,610 feet and laid a 40 sack cement plug. After 6 hours located top of plug at 2,510 feet.

Production Test No. 10 - 2,096 to 2,106 feet, Waarre Formation.

The tester was run with an hydraulic adjustable bottom hole choke and the C.I.P. valve in the closed position. After the packer was set a nitrogen blanket to 575 psi was added. The C.I.P. valve was opened and the nitrogen blanket bled off to zero. Ran swab and recovered 5½ bbls. of muddy water. On the second run the swab was stuck in the cross-over sub above the drill collars. Cut swab line and stripped out of hole.

The test was open 195 minutes.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	1055 psi	1070 psi
F.H.P.	1078 "	1095 "

Production Test No. 11 - 2,096 to 2,106 feet, Waarre Formation.

Went in hole with tester and full water cushion. Swabbed well and recovered approximately 32 bbls. of formation fluid - 100% water of salinity 250 ppm Cl. Fluid level remained 500 feet below surface during swabbing. The tool was open for 9 hours, 27 minutes. The test was considered satisfactory.

Pressures were as follows:

	Top Chart	Bottom Chart
I.H.P.	1055 psi	1080 psi
F.H.P.	-	1095 "

Abandonment of Test Interval 2,096 to 2,106 feet.

Went in hole with open-ended tubing to 2,148 feet and laid a 50 sack cement plug. Pulled up to 2,040 feet and reversed out excess cement. After 4 hours located top of plug at 2,050 feet.

A 10 sack cement plug was laid in the top of the $9\frac{5}{8}$" casing.

The well was abandoned at 8.00 am on June 3, 1964.

W. D. WOOD

APPENDIX 7

CASING AND CEMENTATION

CASING AND CEMENTATION

13⅜" casing

Depth	Description
0 to 1,049 feet	34 joints 48 lb./ft. H.40 ST&C

Drilled 12¼" hole from surface to 1,050 feet. Opened hole to 17½" after running logs. Ran and set 34 joints of 13⅜" casing with Baker float shoe at 1,049 feet and float collar at 1,019 feet. Cemented casing with 1,057 sacks of Adelaide construction cement. Obtained 100% circulation with an estimated 150 sacks returns at the surface. Bumped plug with 1500 psi.

9⅝" casing

Depth	Description
0 to 2,501 feet	78 joints 36 lb./ft. J.55 ST&C
2,501 to 2,502 "	Baker Type J Stage Collar
2,502 to 4,442 "	60 joints 36 lb./ft. J.55 ST&C
4,442 to 5,463 "	26 joints 40 lb./ft. J.55 LT&C
5,463 to 5,825 "	12 joints 40 lb./ft. N.80 LT&C

Safety factors:

Collapse @ 5,825 feet	-	1.21
(40 J.55)@ 5,463 feet	-	less than 1.0
(36 J.55)@ 4,442 feet	-	less than 1.0
Tension (minimum)	-	1.9

Ran and set 176 joints of 9⅝" casing with Howco float shoe at 5,825 feet, Howco float collar at 5,792 feet and a Baker Type J stage cementing collar at 2,501 feet. The first stage was cemented with 200 sacks of Adelaide construction cement through the shoe and the second stage with 170 sacks of Adelaide cement. An estimated 90 feet of cement was left in the casing above the float shoe.

At the start of the second stage cementation, the opening trip plug of the stage collar failed to seat properly. It was necessary to increase the displacement rate to fully open the stage collar parts. It was estimated that no more than 5 bbls. of fluid was pumped from the time the trip plug reached the stage collar until it was indicated that the ports were fully open. However, on pulling out, approximately 60 feet of solid cement, and stringers of cement, were found to 500 feet below the stage collar. No cement was found on drilling out the floating equipment.

A cement bond log was run approximately 64 hours after cementation and the following interpretation made:

First Stage

5,310 to 4,600 feet - slightly bonded.
4,600 to 4,300 " - good bonding.
4,300 to 4,000 " - slightly bonded.

Second Stage:

2,500 to 2,400 feet - slightly bonded.
2,400 to 1,700 " - fair to good bonding.

The height that the first stage was over-displaced indicates that the trip plug must have continued to leak after it was in place. The excessive channeling experienced can be attributed to the low annular velocity obtained as a result of the large hole diameter. Having to use the continuous method of stage cementing, it was impossible to obtain higher annular velocities. No explanation can be given for the absence of good bonding in the interval 2,500 to 2,400 feet.

Centralizers were run as follows:

Upper section - 2,165 feet. 2,225 feet, 2,285 feet, 2,345 feet and 2,405 feet.

Lower section - 5,675 feet, 5,705 feet, 5,735 feet, 5,765 feet and 5,810 feet.

$5\frac{1}{2}$" casing

Depth	Description
0 to 2,553 feet	64 joints 17 lb./ft. N.80 X-line
2,553 to 8,306 "	179 joints 17 lb./ft. N.80 LT&C
8,306 to 11,580 "	100 joints 20 lb./ft. N.80 LT&C

Safety factors: Collapse (minimum) - 1.3
Tension (minimum) - 1.9

Ran and set 343 joints of $5\frac{1}{2}$" casing with Howco float shoe at 11,580 feet, and float collar at 11,545 feet. Circulated for $1\frac{1}{2}$ hours before cementing. The casing was stuck on reaching bottom.

Cemented casing first with 400 sacks of Adelaide construction cement with D.4 retarder added to the mixing water, followed by 100 sacks of Unaflo oilwell cement. Average slurry weight - 15.2 lb./gal. Obtained 100% circulation while cementing. Bumped plug with 2500 psi.

Centralizers were run as follows:

10 from 11,565 to 11,235 feet
5 from 7,325 to 7,015 feet

Note: Retarder was added in the ratio of 2 pints of D.4 per sack of cement.

W. D. WOOD

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95 COLLINS STREET, MELBOURNE, C.1
ADDRESS MAIL TO P.O. BOX 384D, MELBOURNE, C.1

Not included in Published Report

Our Ref. 6244/6135
Your Ref. ....

November 5, 1964

Confidential

3092 "D"
12.12.64
M. Kenley

The Secretary for Mines,
Treasury Buildings,
Treasury Place,
MELBOURNE, C.2.

RECEIVED
-6 NOV 1964
MINES DEPT.

Dear Sir,

FERGUSONS HILL NO. 1 WELL

It is advised that we have had a nuclear age determination made of core 34 from the interval 11,627 to 11,633 feet in the above well. This rock has been described as a quartz-mica schist, and constitutes basement in the well.

The following results were obtained from whole rock measurements, there being no readily separable minerals for more precise dating.

Potassium-Argon	(1)	369 ± million years
	(2)	373 ± " "
Rubidium-Strontium	(1)	387 to 522 million years
	(2)	392 to 534 " "

The K/A age established a reliable minimum for the time of metamorphism. No extensive heating has occurred since that time. The range of possible age obtained from the Rb/Sr measurements is due to the low percentage of radiogenic strontium in the rock and uncertainty as to the initial strontium isotopic composition of the rock. The determinations establish the time of metamorphism to be no younger than Devonian and no older than Middle Cambrian, based on Kulp's 1961 geologic time scale.

Kulp J.L., 1961. Geologic Time Scale. Science 133, No. 3459, pp 1105–1114

Yours very truly,

L. B. Robertson

(L. B. Robertson)
General Manager

AFMcQ:jm

1 Reg. ... 2 Mr Kenley ... Noted on 12th Nov. why the delay?

Noted PKR 12/11/64.

ENCLOSURES:

PE903991

This is an enclosure indicator page.
The enclosure PE903991 is enclosed within the container PE903988 at this location in this document.

The enclosure PE903991 has the following characteristics:

ITEM_BARCODE	= PE903991
CONTAINER_BARCODE	= PE903988
NAME	= Geological & Locality Map
BASIN	= OTWAY
PERMIT	= PEP 6
TYPE	= WELL
SUBTYPE	= GEOL_MAP
DESCRIPTION	= Geological & Locality Map Port Campbell Embayment (enclosure from WCR) for Fergusons Hill-1
REMARKS	=
DATE_CREATED	= 31/07/64
DATE_RECEIVED	=
W_NO	= W480
WELL_NAME	= Fergusons Hill-1
CONTRACTOR	=
CLIENT_OP_CO	= Frome Broken Hill Co

(Inserted by DNRE - Vic Govt Mines Dept)

PE903989

This is an enclosure indicator page.
The enclosure PE903989 is enclosed within the container PE903988 at this location in this document.

The enclosure PE903989 has the following characteristics:

ITEM_BARCODE	= PE903989
CONTAINER_BARCODE	= PE903988
NAME	= Stratigraphic Column Prior to Drilling
BASIN	= OTWAY
PERMIT	= PEP 6
TYPE	= WELL
SUBTYPE	= STRAT_COLUMN
DESCRIPTION	= Stratigraphic Column Prior to Drilling (enclosure from WCR) for Fergusons Hill-1
REMARKS	=
DATE_CREATED	=
DATE_RECEIVED	=
W_NO	= W480
WELL_NAME	= Fergusons Hill-1
CONTRACTOR	=
CLIENT_OP_CO	= Frome Broken Hill Co

(Inserted by DNRE - Vic Govt Mines Dept)

PE903990

This is an enclosure indicator page.
The enclosure PE903990 is enclosed within the container PE903988 at this location in this document.

The enclosure PE903990 has the following characteristics:

ITEM_BARCODE	= PE903990
CONTAINER_BARCODE	= PE903988
NAME	= Geological Cross Sections
BASIN	= OTWAY
PERMIT	= PEP 6
TYPE	= WELL
SUBTYPE	= CROSS_SECTION
DESCRIPTION	= Geological Cross Sections Before & after drilling (enclosure from WCR) for Fergusons Hill-1
REMARKS	=
DATE_CREATED	= 31/07/64
DATE_RECEIVED	=
W_NO	= W480
WELL_NAME	= Fergusons Hill-1
CONTRACTOR	=
CLIENT_OP_CO	= Frome Broken Hill Co

(Inserted by DNRE - Vic Govt Mines Dept)

PE602059

This is an enclosure indicator page.
The enclosure PE602059 is enclosed within the container PE903988 at this location in this document.

The enclosure PE602059 has the following characteristics:

ITEM_BARCODE	= PE602059
CONTAINER_BARCODE	= PE903988
NAME	= Composite Well Log
BASIN	= OTWAY
PERMIT	= PEP 6
TYPE	= WELL
SUBTYPE	= COMPOSITE_LOG
DESCRIPTION	= Composite Well Log (enclosure from WCR) for Fergusons Hill 1
REMARKS	=
DATE_CREATED	= 3/06/64
DATE_RECEIVED	=
W_NO	= W480
WELL_NAME	= Fergusons Hill-1
CONTRACTOR	=
CLIENT_OP_CO	= Frome Broken Hill Co

(Inserted by DNRE - Vic Govt Mines Dept)