Esso

BREAM FIELD STUDY

Vol. 1.

G.A. Lindsay
A. Djakic

July 1985

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- CONTENTS -

FIGURES

- APPENDICES -

ENCLOSURES

No.	Enclosure	Drawing No.
1.	CROSS SECTION	(2086/OP/6)
1A.	DIAGRAMMATIC WELL CORRELATION	(2104/OP/8)
2.	LAGGED T.W.T. MAP TOP OF LATROBE GROUP	(1818/OP/19)
3.	STRUCTURE MAP TOP OF LATROBE GROUP	(1818/OP/18)
4.	LAGGED T.W.T. MAP TOP OF LATROBE GROUP 'COARSE CLASTICS'	(1818/OP/17)
5.	STRUCTURE MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MOST LIKELY CASE)	(1818/OP/24)
6.	STRUCTURE MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MAXIMUM CASE)	(1818/OP/25)
7.	STRUCTURE MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MINIMUM CASE)	(1818/OP/26)
8.	TRUE AVERAGE VELOCITY MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MOST LIKELY CASE)	(1818/OP/15)
9.	TRUE AVERAGE VELOCITY MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MAXIMUM CASE)	(1818/OP/14)
10.	TRUE AVERAGE VELOCITY MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' (MINIMUM CASE)	(1818/OP/16)
11.	LAGGED T.W.T. MAP *P. asperopolus* SEISMIC MARKER	(1818/OP/20)
12.	STRUCTURE MAP *P. asperopolus* SEISMIC MARKER	(1818/OP/27)
13.	ISOPACH MAP TOP OF LATROBE GROUP to TOP OF LATROBE GROUP 'COARSE CLASTICS'	(1818/OP/21)
14.	ISOPACH MAP TOP OF LATROBE GROUP 'COARSE CLASTICS' to *P. asperopolus* SEISMIC MARKER	(1818/OP/10)
15.	LAGGED T.W.T. MAP *M. diversus* SEISMIC MARKER	(1818/OP/31)
16.	STRUCTURE MAP *M. diversus* SEISMIC MARKER	(1818/OP/28)
17.	LAGGED T.W.T. MAP UPPER *L. balmei* SEISMIC MARKER	(1818/OP/23)
18.	STRUCTURE MAP UPPER *L. balmei* SEISMIC MARKER	(1818/OP/29)
19.	LAGGED T.W.T. MAP LOWER *L. balmei* SEISMIC MARKER	(1818/OP/22)
20.	STRUCTURE MAP LOWER *L. balmei* SEISMIC MARKER	(2086/OP/4)
21.	DOLERITE SILL LOCALITY MAP	(1818/OP/38)
22.	SUMMARY OF SEISMIC STRATIGRAPHIC STUDY - UPPER *L. balmei* to LOWER *L. balmei* SEISMIC MARKER.	(1818/OP/37)
23.	STRUCTURE MAP TO TOP OF ZONE 4	(1818/OP/12)
24.	STRUCTURE MAP TO TOP OF ZONE 3	(1818/OP/11)
25.	STRUCTURE MAP TO TOP OF ZONE 2	(1818/OP/13)

SUMMARY

SUMMARY

BREAM FIELD

The Bream Field is located about 30 kilometres south east of the Barracouta Field and 25 kilometres to the north west of the Kingfish Field. Water depth is about 60 metres.

The field comprises a 13 metre oil column with a gas cap at the top of the Latrobe Group "Coarse Clastics", plus an uncertain number of intra Latrobe Group oil and gas columns of uncertain areal extent. The intra Latrobe Group hydrocarbons were intersected in the Bream-2, Bream-3 and Bream-5 wells.

Discovery Well:

Bream-2 Spud Date: 23/2/69 Completion Date: 24/4/69

Location:
Permit: Vic/P1
Seismic Line: EH-201A S.P. 915
Latitude: 38°31' 21"S
Longitude: 147°47' 53"E
Co-ordinates: X: 569568 Y: 5735893
Water Depth: 58m

Appraisal Wells:

Bream-1*	Spud Date:	20/1/69	Completion Date:	22/1/69
Bream-3	" " :	16/11/69	" " :	10/1/70
Bream-4*	" " :	21/7/81	" " :	11/8/81
Bream-4A	" " :	18/8/81	" " :	25/9/81
Bream-5	" " :	3/8/82	" " :	14/9/82

* abandoned before penetrating Latrobe Group

STRUCTURE:

The Bream field comprises a WSW-ENE trending anticlinal structure with a prominent lobe extending NE from the western end of the field. A series of shallow igneous intrusions have modified the top of Latrobe Group structure, increasing the height of closure in the western portion of the Bream field.

Faulting is relatively minor at the top of the Latrobe Group "Coarse Clastics" but becomes more intense with depth. The intra-Latrobe Group L. balmei zone structure is intensely faulted and the faults show increasing displacement with depth.

Structure maps for the field have been generated on reprocessed data (1980) from the G74A seismic survey (1km grid).

STRATIGRAPHY:

The Latrobe Group "Coarse Clastics" are divided into 5 intervals as outlined below in descending order.

Interval-1: Base of Gurnard Formation to the top of the *P. asperopolus* coal seismic marker. This interval is dominated by 5-10m sandstones with minor shales and coals. The uppermost sandstones are interpreted as shallow marine grading downwards into lower delta plain. The top of Latrobe Group oil and gas is contained within this interval.

Interval-2: Top of the *P. asperopolus* coal seismic marker to the base of the *M. diversus* coal seismic marker. This unit is characterised by thick, continuous coal seams and several thick (10-15m) sandstone units.

Interval-3: Base of *M. diversus* coal seismic marker to about 100m above Upper *L. balmei* seismic marker. Characteristic of this interval are thick (20m) channel sandstones, forming fining upward sequences, capped by thin discontinuous coal seams.

Interval-4: From 100 metres below the Upper *L. balmei* seismic marker to 100 metres above the Lower *L. balmei* seismic marker. This interval is composed of thin, apparently discontinuous coal seams and thin (5m) sandstones. This interval contains most of the intra-Latrobe Group hydrocarbons.

Interval-5: From 100 metres above Lower *L. balmei* seismic marker to a depth of at Least -3300 metres. This interval consists of interbedded sandstone (10m thick) and shale with some very minor thin coal. Hydrocarbons were encountered within this interval.

FORMATION/HORIZON TOPS

	Bream-2	Bream-3	Bream-4A	Bream-5
Top of Latrobe Group	-1794.9	-1816.8	-1836.0	-1842.5
Top of "Coarse Clastics"	-1855.6	-1856.8	-1892.6	-1903.0
P. asperopolus Marker	-1933.0	-1968.0	-2004.0	-1935.6
M. diversus Marker	-2100.0	-2110.0	-2126.5	-2074.0
Upper *L. balmei* Marker	-2313.0	-2392.0	-2333.0	-2305.0
Lower *L. balmei* Marker	-2696.0	-2825.0	-	-2672.0

HYDROCARBONS:

Top of Latrobe Group

Reservoirs at the top of the Latrobe Group contain a 13m oil column with a gas cap. The Gurnard Formation provides the seal for this accumulation. The current field O.W.C. is -1929m and the G.O.C. is -1916m. Porosity is estimated to average around 20-24%, water saturation about 20-25% and net to gross about 60-80%.

Fluid Properties at Surface (from Bream-2 & 5 P.V.T. analysis)

GOR ...	985 SCF/STB
FVF:	
Gas ...	1.002 Res. Bbls/KSCF
Oil ...	1.55 Res. Bbls/STB

Stabilised Crude Properties:

Oil gravity ...	44.3	ºAPI
Pour Point ...	45	ºF
Wax Content ...	3.74	%wt
Sulphur Content ...	0.16	%wt

Hydrocarbons-in-place Summary

	Minimum	Most Likely	Maximum
Gas (GSCF)	315	519	886
Oil (MSTB)	80	129	209

Intra Latrobe Group

Hydrocarbons encountered beneath the main top of Latrobe Group Reservoirs were in Bream-2 and Bream-5 with minor gas in Bream-3.

Bream-2: Main hydrocarbon zone between -2533m & -2643m with 25m net gas/condensate sand. Log and pressure data were inconclusive in determining column heights.

Bream-5: Numerous hydrocarbon bearing sands occur between -2450m and -2960m. These are interpreted as six separate accumulations, 4 gas, 1 oil and gas 1 oil. Net oil sands total 6m and net gas sands total 31m.

Porosities are estimated to average about 12-15%, water saturation about 35-55% and net to gross about 10-35%.

Bream-3: A gas sand was encountered at -2200m to a gas/water contact at -2211m. This accumulation is considered to be a very small stratigraphic trap.

Hydrocarbons-in-place Summary (For one reservoir system at Bream-5)

	Minimum	Most Likely	Maximum
Gas (GSCF)	1	4	10
Oil (MSTB)	1	1	2

PART 1

PART I

GEOLOGY

INTRODUCTION:

The Bream Field was discovered in mid 1969 with Bream-2. To date, six exploration wells have been drilled.

a) Bream-1 - spudded January 1969, T.D.-231m
b) Bream-2 - spudded April 1969, T.D. - 3239m
c) Bream-3 - spudded January 1970, T.D. - 3326m
d) Bream-4 - spudded July 1981, T.D. - 220m
e) Bream-4A - spudded August 1981, T.D. - 2421m
f) Bream-5 - spudded July 1982, T.D. - 3321m

Of these wells Bream-2, 3, 4A and 5 reached the top of the Latrobe Group. The field comprises a 13 metre oil column with a gas cap at the top of the Latrobe Group "Coarse Clastics", plus an uncertain number of intra Latrobe Group oil and gas columns of uncertain areal extent. The intra Latrobe Group hydrocarbons were intersected in the Bream-2, Bream-3 and Bream-5 wells.

The current hydrocarbon assessment is based on maps generated from a one kilometre grid of 1974 seismic data, reprocessed in 1980/81. The details of the mapping are covered in Part 2 of this report.

STRUCTURE

The underlying structural style of the Bream field is of a WSW/ENE trending anticline about 12km by 3km overall. At the top of the Latrobe Group the anticline is modified by a series of shallow igneous intrusions, one of which forms the prominent lobe extending to the north. At depth the anticline is extensively faulted by a series of NW/SE trending grabens. A more detailed description of the structure is provided in Part 2.

STRATIGRAPHY

Gurnard Formation

The Gurnard Formation is composed of a glauconite rich siltstone. The glauconite is mainly in the form of ovoid pellets. The interval contains a condensed palynological and micropalaeontological sequence and appears to contain numerous erosional or non-depositional gaps. The formation is of a relatively uniform thickness (Enclosure 13). At the wells it is between 55m and 60m thick except at Bream-3 where a small channel has removed the top 20m of the formation.

Latrobe Group "Coarse Clastics"

The stratigraphic interval encountered beneath the Gurnard Formation in the four wells can be divided, on the basis of log character, into five intervals:-

INTERVAL-1 - Base of Gurnard formation to the top of the *P. asperopolus* coal seismic marker.

INTERVAL-2 - Top of the *P. asperopolus* coal seismic marker to the base of the *M. diversus* coal seismic marker.

INTERVAL-3 - Base of *M. diversus* coal seismic marker to about 100 metres above Upper *L. balmei* seismic marker.

INTERVAL-4 - From 100 metres below Upper *L. balmei* seismic marker to about 100 metres above Lower *L. balmei* seismic marker.

INTERVAL-5 - From 100 metres above Lower *L. balmei* seismic marker to a depth of at least -3300 metres.

The intervals can be seen clearly on the cross-section (Enclosure 1). Refer to Part 2 of this report for seismic character of these intervals. The following observations were made from well log correlation of the four wells. Enclosure 1A shows a detailed correlation of intervals 1 and 2.

INTERVAL-1

This interval is dominated by sandstones five to ten metres thick with minor shales and coals. The quantity and quality of the coal decreases both up the sequence and from west to east, with no coal evident in Bream-2 and Bream-5.

The interval thins markedly from west to east. This is a regional thinning which can be seen from the isopach map of the interval (Enclosure 14). The apparent deterioration of the coals upwards and eastwards as well as the apparent condensing of the palynological age zonations, suggest that it is a depositional thinning rather than erosional thinning.

The uppermost sandstones in this interval appear to be marine and where cored are described as having extensive bioturbation. These marine sandstones are interpreted to represent a series of transgressions/regressions prior to the final Latrobe Group transgression at the base of the Gurnard Formation.

INTERVAL-2

This interval is characterised by the presence of thick, continuous coal seams which show some thinning and deterioration from Bream-4A to Bream-5. Several thick (10-15 metre) sandstone units are also present and show a "boxy" form on the gamma ray log. There is also some suggestion of fining upwards sandstones. The isopach of this interval remains quite constant within the field limits.

INTERVAL-3

Characteristic of this interval are thick channel sandstones, commonly 20 metres thick, showing a strong fining upwards character in the gamma ray log. The channel sandstones are frequently capped by thin, apparently discontinuous, coal seams. The coal seams occur predominantly in the upper half of the interval and as with interval 1 and 2 show some thinning and quality deterioration to the east.

INTERVAL-4

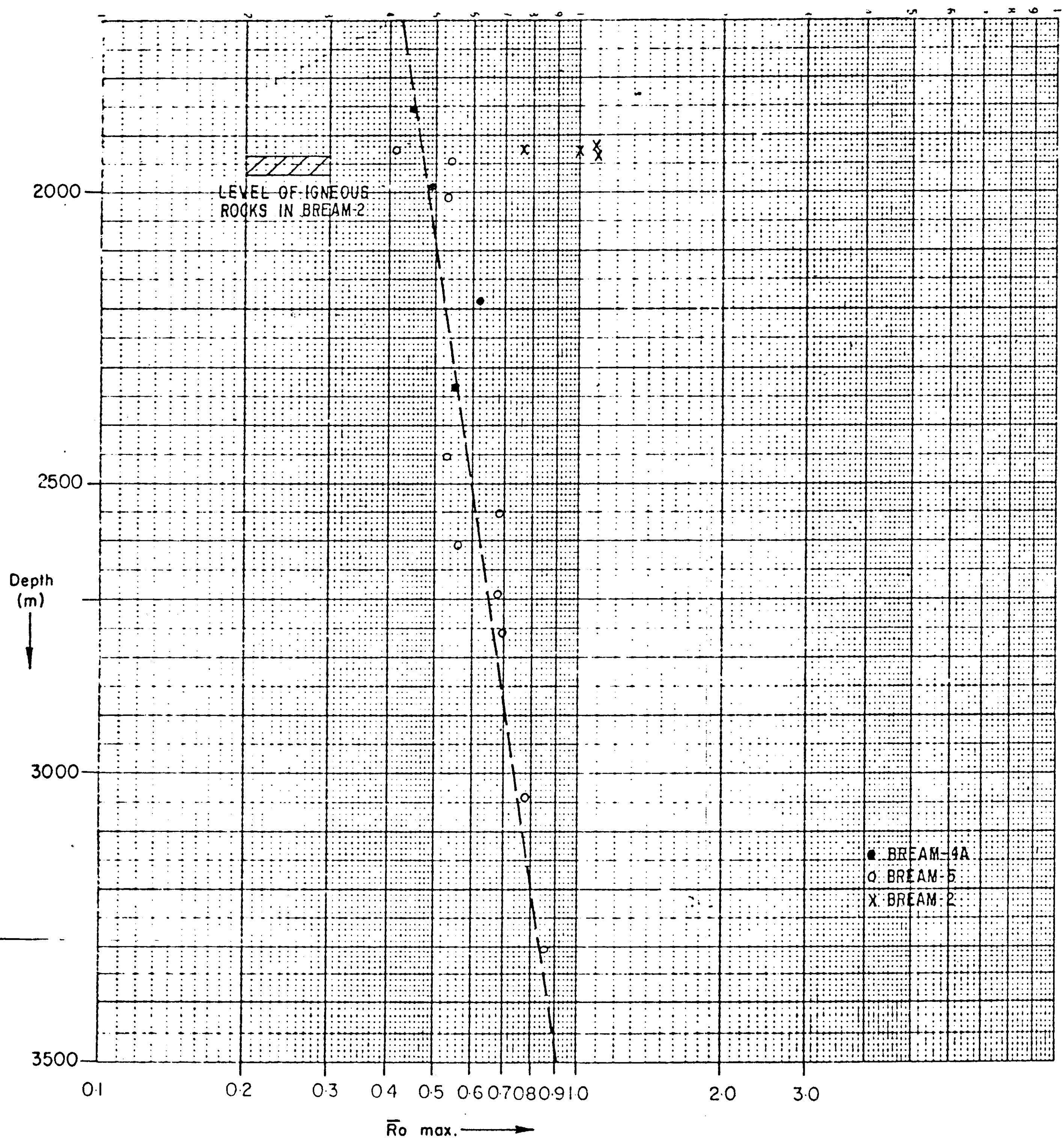
This interval is composed of thin, apparently discontinuous coal seams and thin sandstones, generally less than five metres in thickness.

INTERVAL-5

This interval down to a depth of at least -3300 metres consists of interbedded sandstone and shale with some very minor thin coal seams. The sandstones are generally less than 10 metres thick.

FIGURE 1

VITRINITE REFLECTANCE vs DEPTH



Dwg. 1818/OP/36

Igneous Rocks

The Bream Field contains numerous igneous bodies interpreted from seismic to occur within several different horizons near the top of the Latrobe Group. Part 2 of this study details the seismic character and distribution of these bodies.

Bream-2 intersected about 37 metres of one igneous body and cores were cut through most of it and some of the overlying sedimentary sequence. Numerous samples have been described and it has been classified as either an altered dolerite or an altered olivene basalt. It was found to be unsuitable for potassium-argon geochronology due to the extent of alteration. Appendix I contains various thin-section descriptions.

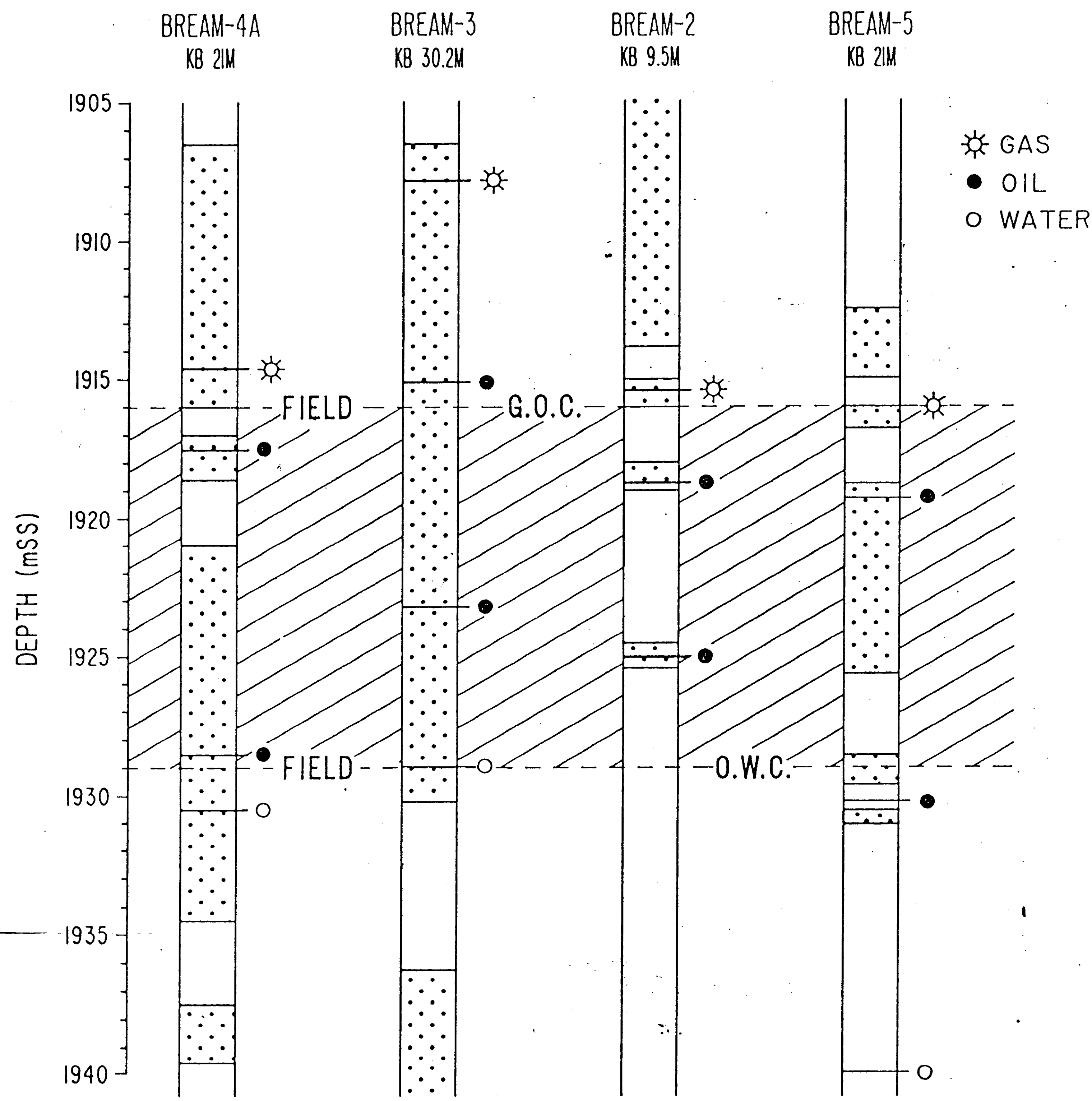
It has been suggested that the igneous bodies at Bream may be extrusives and in an attempt to substantiate this claim four coal samples were taken from the cored interval above the igneous body. Vitrinite reflectance was determined on each sample and the values are shown plotted on an $\%R_o$/depth plot (figure 1) along with the values obtained from Bream-5 and Bream-4A neither of which are near any known igneous rocks. As can be seen the rank of the coal immediately above the igneous rock is much higher than normal, suggesting that the coal has been subject to heating greater than the regional thermal gradient. This would be the case if the igneous body had been intruded into the sedimentary sequence. In addition to this evidence the seismic data shows no signs of sedimentary onlap of the igenous bodies. Onlap does occur at, or immediately above the top of the Latrobe Group, suggesting that this is the time of emplacement of the igneous bodies.

HYDROCARBONS

Top Of Latrobe Group

Reservoirs at the top of the Latrobe Group contain a 13 metre oil column with a gas cap. The Gurnard Formation is assumed to provide the seal for this accumulation.

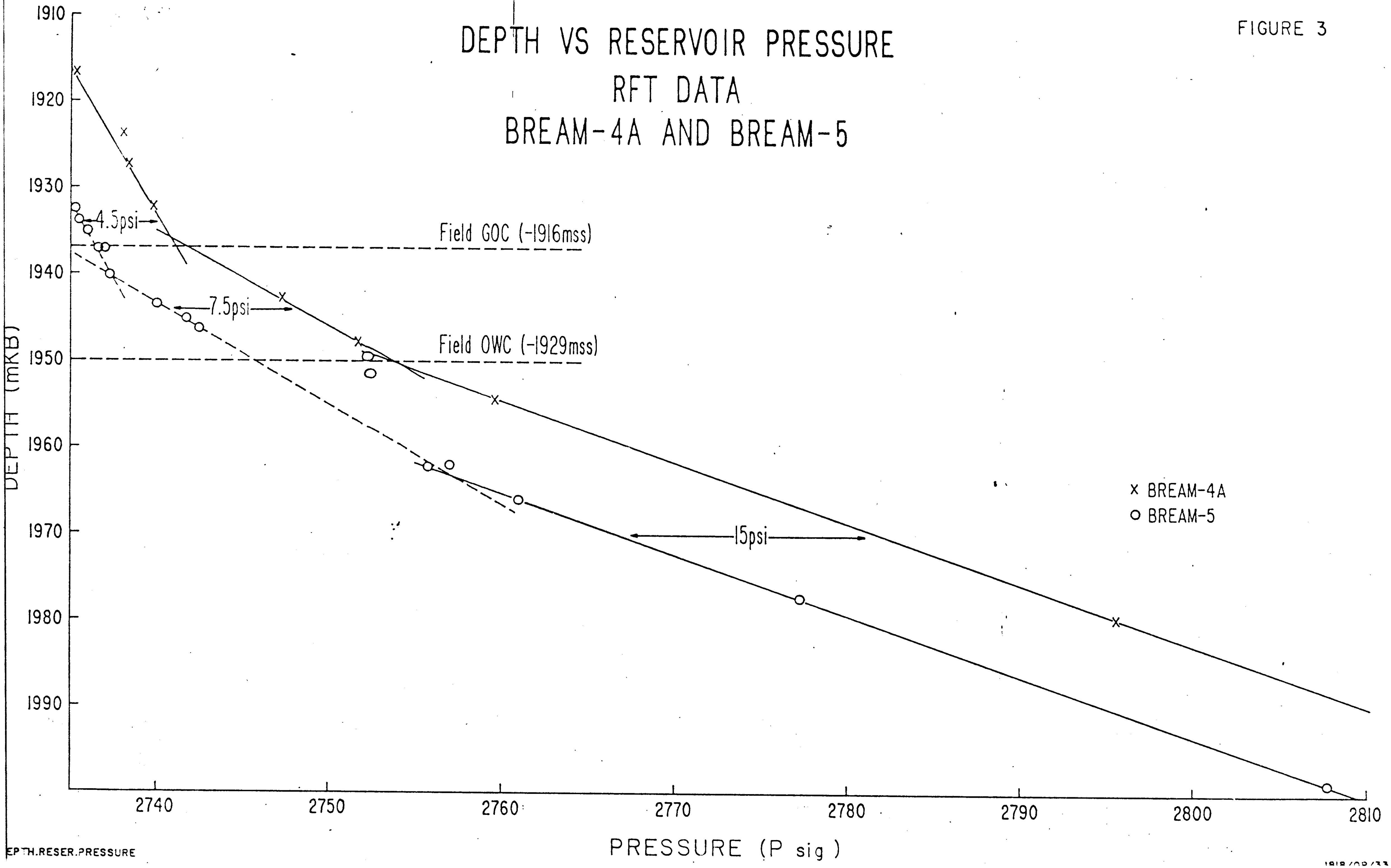
FIELD HYDROCARBON CONTACTS
RFT/FIT SAMPLE POINTS



THE SAMPLE POINTS SHOWN ARE ONLY THOSE SAMPLES THAT REPRESENT THE LOW PROVED GAS, HIGH AND LOW PROVED OIL AND LOW PROVED WATER.

THE SANDS INDICATED ARE THOSE WITH A CALCULATED LOG POROSITY OF GREATER THAN 15%, EXCEPT FOR BREAM-2 WHERE THEY ARE GREATER THAN 10%.

FIGURE 3



EPTH.RESER.PRESSURE

The results of Bream-4A allowed the gas-oil contact to be confidently located at -1916 metres and the oil-water contact at -1929 metres. Bream-2 and Bream-3 encountered poor quality sands or non-net lithologies at the contacts. The pressure data obtained from Bream-4A agree well with the contacts picked from the well logs (Figure 3).

Figure 2 summarizes the relevant FIT/RFT data from the four wells Bream-2 and Bream-3 recovered oil above the gas-oil contact and water from above the oil-water contact. These are attributed to aquifer pressure drawdown lowering the contact in the 12 years of basin production between the drilling of Bream-2 and Bream-3 and the drilling of Bream-4A.

The results of the Bream-5 well were inconclusive due to the presence of a thicker than expected, essentially non-net interval between about -1926 metres and -1945 metres. These lithologies obscured the oil-water contact. Oil was recovered from a thin (about 0.25 metres thick) sandstone unit at about -1930.3 metres and water from a similar sandstone at about -1940.9 metres. A plot of the RFT pressure data from Bream-5 (figure 3) suggests that the oil-water contact may be as deep as about -1940 metres. However, mapping suggests that a deeper contact is unlikely. A possible explanation for this anomaly can be attributed to the differential drawdown of the Latrobe Group aquifer and of the reservoir at Bream-5 due to production from the major fields. The Bream field water pressure gradient is mainly affected by the production from the Kingfish field 25 kilometres to the east. Hence, the water gradient in Bream-5 is drawn down further than in Bream-4A (figure 3). It is thought that the thick non-net interval seen between -1926 metres and -1945 metres in Bream-5 appears to terminate against the top of the Latrobe Group between Bream and Kingfish. This may have partially isolated the hydrocarbon column at Bream from the effects of the pressure drawdown. That is, the fluid system above -1926 metres is separate from the fluid system below -1945 metres at the Bream-5 location.

The differential drawdown of the two fluid systems has given rise to the oil/water contact observed from the pressure data, being too deep. Therefore, with the current level of knowledge of the Bream field, the field is assumed to have a common oil-water and gas-oil contact of -1929 metres and -1916 metres respectively.

Intra Latrobe Group

The main hydrocarbons encountered beneath the main top of Latrobe Group accumulations were in Bream-2 and Bream-5 with a minor gas accumulation in Bream-3.

Bream-2

The main hydrocarbon zone in Bream-2 is between -2553 metres and -2643 metres with about 25 metres of net gas sand. Of the six separate sands in this interval, five were tested by FIT - four recovered gas and condensate and one recovered filtrate. Log analysis of the interval was inconclusive (Appendix VI) due to the poor quality of the logs, however, two of the sands can be interpreted to be water wet. Pressure data was also inconclusive in trying to determine the height of the gas column(s) present (Figure 4). One other gas sand was sampled between -2476 metres and -2479 metres. Hydrocarbon flourescence and cut were observed in drill cuttings over much of the deeper part of the hole but no tests were carried out.

Bream-5

Bream-5 penetrated numerous hydrocarbon bearing sands between -2450 metres and -2960 metres. Within this interval some 21 RFT samples were attempted, resulting in two successful oil tests, nine successful gas tests and 10 inconclusive tests. Based on RFT recoveries and log analysis, the intervals intersected have been interpreted to represent six separate hydrocarbon accumulations, four gas, one oil and gas, and one oil. Net oil sands total about six metres and net gas sands about 31 metres. Hydrocarbon flourescence and cut were observed in drill cuttings of low porosity sandstones throughout the hole to T.D.

Bream-3

Bream-3 encountered a gas sand from -2200 metres to a gas/water contact at -2211 metres. This sand, however, appears to lense out up dip and is outside mapped closure at this depth. The accumulation is considered to be in a stratigraphic trap of very small areal extent.

DEPTH VS PRESSURE
FIT DATA
BREAM-2 DEEP GAS

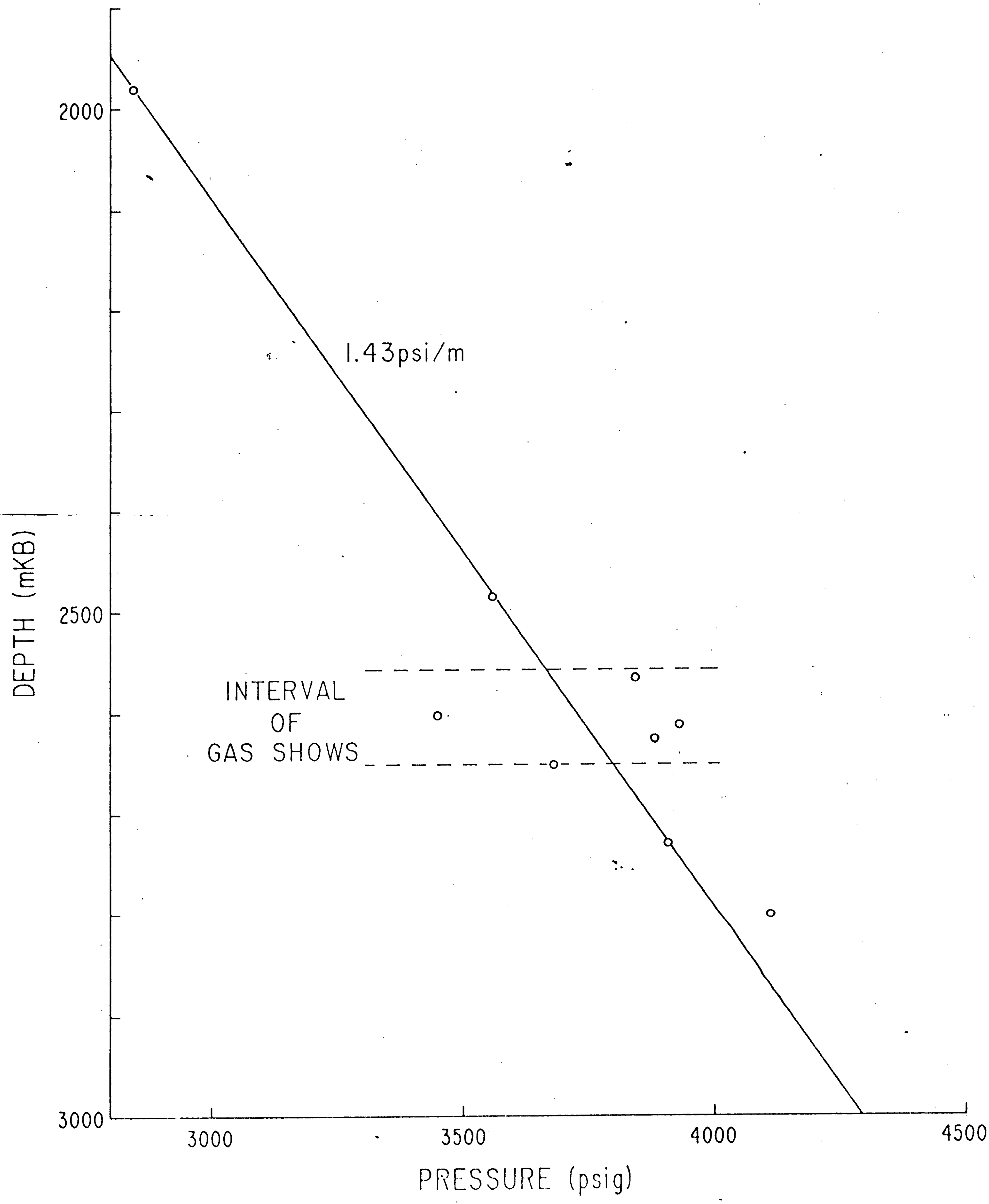
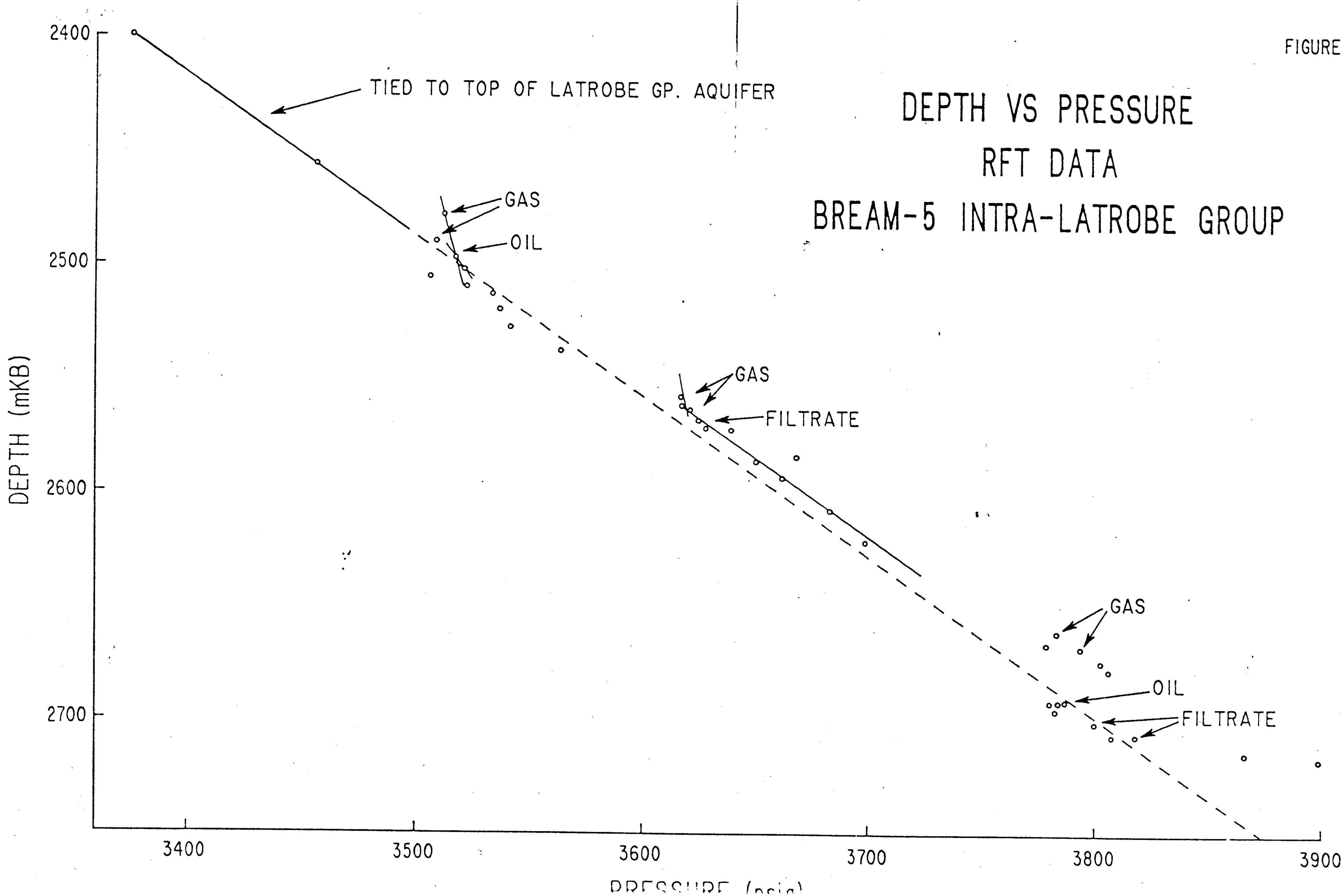


FIGURE 5


DEPTH VS PRESSURE
RFT DATA
BREAM-5 INTRA-LATROBE GROUP
TIED TO TOP OF LATROBE GP. AQUIFER
GAS
OIL
GAS
FILTRATE
GAS
OIL
FILTRATE
DEPTH (mKB)
2400
2500
2600
2700
3400
3500
3600
3700
3800
3900

PART 2

PART II

SEISMIC INTERPRETATION

INTRODUCTION

In 1980/81 307 kilometres of G74A seismic data providing a 1 kilometre grid over the Bream Field were reprocessed. The reprocessing resulted in a major improvement in seismic data quality.

The following section of the Bream Field report summarizes the procedures and results of the Bream Field remapping using the reprocessed seismic data.

DATA BASE

The Bream prospect is covered by a one kilometre grid of G74A seismic data. More recent data consists of two G77A lines intersecting at Bream-3, and an open grid of G81A lines off the eastern flank of the Bream Field.

SEISMIC REPROCESSING

The G74A seismic data was originally processed with conventional deconvolution before and after stack and with both a time variant filter and scaler being applied after stack. This processing stream resulted in good quality data at the top of the Latrobe Group and shallow Intra-Latrobe Group Seismic Markers. However, the data above the Latrobe Group and below the lower M. diversus level within the Latrobe Group is of poor quality. Below this level, seismic reflectors are of variable amplitude, discontinuous and difficult to correlate.

In an attempt to improve the quality of the data in these zones, 227 kilometres of G74A seismic were reprocessed in 1980. Reprocessing involved the use of designature wave shaping, deconvolution after stack, MSTACK (horizon consistant velocity migration) and a scaler after stack. The reprocessed data is of better quality than that produced by the original processing, particularly in the Miocene/Oligocene section above the Latrobe Group and in the L. balmei sequence within Latrobe Group. The migration process dramatically enhanced the resolution of the Miocene channels, fault cuts and deep structure.

In January 1981 a further 80 kilometres of G74A seismic data were reprocessed in order to provide adequate coverage of the deep structure at the eastern end of the field. The velocity analysis for this reprocessing made use of the GSI superscan package. The superscans were generated every 1.25 kilometres by a 5:1 smash of velscans which were 5 depth points apart.

TIME INTERPRETATION

Improvement in signal quality of the reprocessed data greatly increased the confidence levels at which all horizons could be mapped. This particularly applied to the intra-Latrobe Group seismic markers.

All observed intra-Latrobe Group sequence boundaries and marker horizons were mapped in this interpretation. The improved seismic resolution allowed the stratigraphy to be examined in far greater detail than was previously possible.

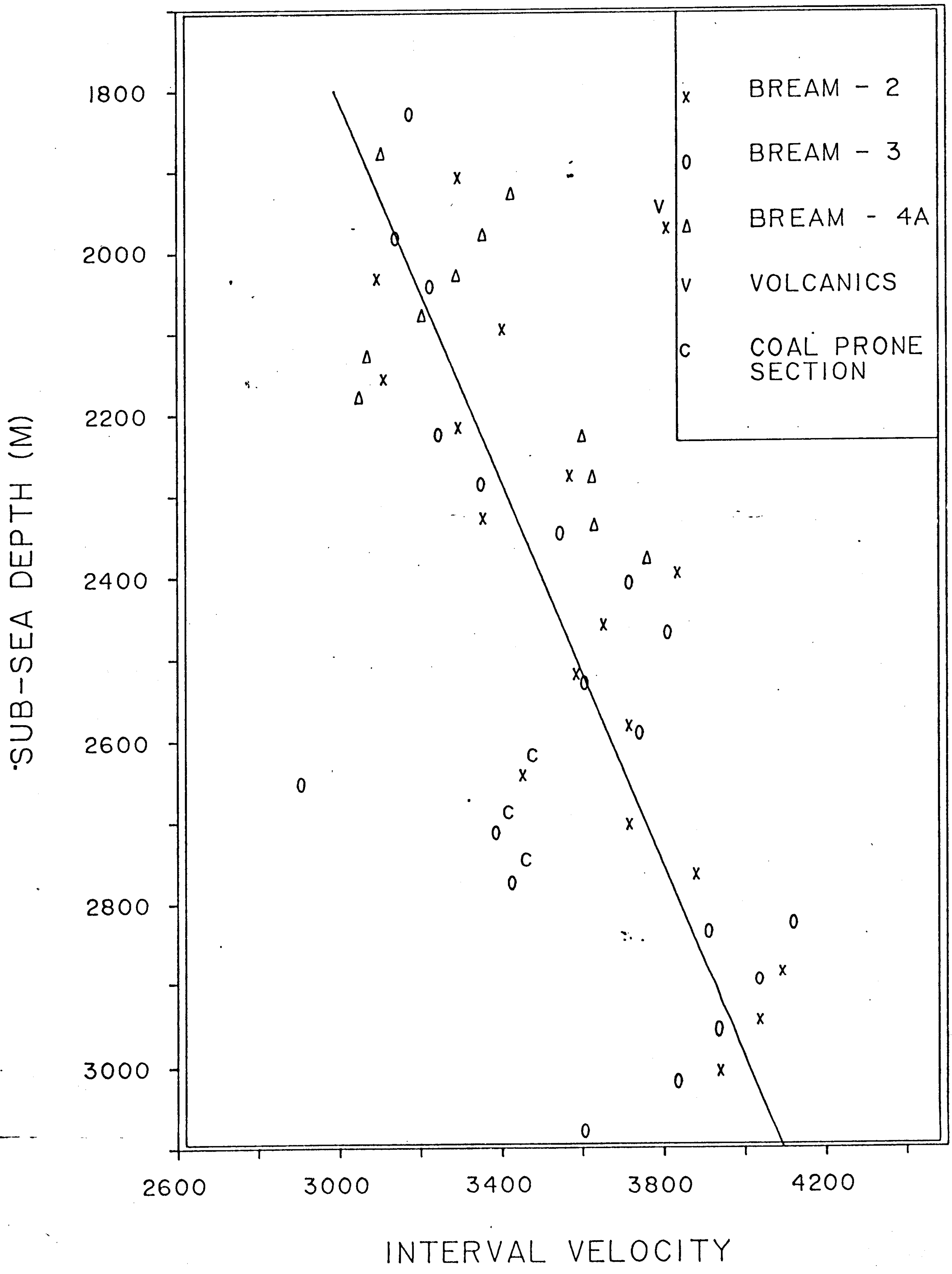
Synthetic seismograms were successfully generated (with the use of SYNSIN) for Bream-5, Bream-4A and Bream-2. The effect of bad hole conditions on the sonic and density logs for Bream-3 prevented generation of a usable synthetic seismogram for this well.

The synthetics confirmed the correct cycles were being mapped in the upper-Latrobe Group section. This was particularly important in defining the 'Top of Latrobe Group' and the 'Top of Latrobe Group Coarse Clastics' seismic events.

An indication of lag values was determined from the synthetics, with final lag values being evaluated by using T/D curves for the four Bream wells. A complete listing of lag and well tie data is given in Appendix (iii).

Due to the composite nature of the reflections it was difficult to tie the deeper intra-Latrobe Group seismic markers to the wells.

BREAM - 2,3,4A
DEPTH VS INTERVAL VELOCITY



BREAM.NOEL

Dwg. 2086/OP/1

The following T.W.T. maps are enclosed:-

TOP OF LATROBE GROUP (Enclosure 2)
TOP OF LATROBE GROUP 'COARSE CLASTICS' (Enclosure 4)
P. asperopolus SEISMIC MARKER (Enclosure 11)
M. diversus SEISMIC MARKER (Enclosure 15)
Upper L. balmei SEISMIC MARKER (Enclosure 17)
Lower L. balmei SEISMIC MARKER (Enclosure 19)

VELOCITY ANALYSIS

All reprocessed velscans were reanalysed to determine the V_{NMO} to the top of Latrobe Group 'Coarse Clastics' event - the top of the Bream Field reservoir. Smoothed velocity profiles were constructed for each line from both in-line and cross line data.

Velscan picks over the crest of the structure show only marginal scattering. However, on all flanks, except the steeply dipping southern flank, the scatter of velocity picks represents a source of considerable uncertainty.

Conversion factors were determined from the well data for the Bream-2, 3, 4A and 5 wells. A constant conversion factor of 94.3% was used over the field, with an adjustment of -1.35% used in order to tie the Bream-3 well. A summary of velocity conversion factor data is given in appendix III.

A true velocity map to the top of the "coarse clastics" was constructed using smoothed V_{NMO}'s and conversion factors (Enclosure 8). Trends on this map directly reflect the distribution and thickness of high velocity channel fill within the Miocene strata. Additional complication is provided by a depth of burial effect producing a slow velocity within in the lower Miocene/Oligocene strata over the Bream structural high.

Depth conversion within the Latrobe Group was achieved by isopaching all horizons from the Top of Latrobe Group 'Coarse Clastics' structure map. Velocities applied to respective intra-Latrobe Group isochrons for depth conversion were determined by constructing an interval velocity/depth plot (Figure 6), from which a linear approximation of the intra-Latrobe Group velocity gradient was made. Data for the interval velocity/depth plot was derived from the Bream-2, 3 and 4A integrated sonic logs.

This velocity gradient could not, however, be used for depth conversion in regions where intrusives were present in the section. In these areas an "average interval velocity" was computed by determining the ratio of sediment to dolerite, where the average velocity of the sediments in a particular interval was taken from the calculated intra-Latrobe Group velocity gradient, and the velocity of the dolerite was determined from the Bream-2 sonic log. The ratio of sediment to dolerite in the section was estimated from seismic data, where in most cases the top and base of the intrusives could be established.

Structure maps have been generated from each of the time maps listed above (Enclosures 12, 16, 18 and 20).

STRUCTURE

Folding/Uplifting

At the top of the Latrobe Group, the Bream structure consists of an asymmetric anticline, striking ENE/WSW which has been altered by structural uplift associated with the intrusion and emplacement of a number of dolerite sills (see Enclosure 1).

It is evident from inspection of the *M. diversus* structure map (Enclosure 16) that the western and northern 'lobes' of the Bream structure as mapped at the top of the Latrobe Group, have been formed by structuring associated purely with the emplacement of the dolerite sills.

The Upper *L. balmei* Seismic Marker structure map shows the general form of the Bream anticline. The emplacement of the intrusives has little influence on the structure at this depth, although some broad structuring in the west of the field may have taken place due to thermal uplift occurring prior to the intrusion of the dolerite sills.

At the lower *L. balmei* Seismic Marker the Bream structure is represented by an asymmetric anticline, the crest of which is offset by a series of NW-SE grabens intersecting the anticline at a high angle to its fold axis.

Anticlinal development appears to have started in the Late Eocene, with marked thinning of the Oligocene/Lower Miocene section across the Bream structure indicating a rapid period of growth.

Anticlinal development wained soon after the Mid-Miocene, but did not cease entirely until well into the Miocene (see seismic lines G74A-1142, 1143).

Faulting

As stated, fault definition was greatly enhanced on the reprocessed G74A seismic data. Mapping of faults over the Bream prospect shows a series of parallel graben zones trending northwest - southeast (Enclosure 20). The grabens appear to have developed through a number of major discrete normal faults accompanied by antethetic fault development.

The major normal faults have not developed preferentially to one side of a particular graben but tend to alternate from side to side along strike in a 'relay-like' fashion.

Many faults show substantial growth particularly in the southwest of the prospect (see seismic line G74A-1095).

Movement ceased on most of the deep seated faults during the Upper Eocene with only two faults showing displacement during the Lower Oligocene (line G74A-1094).

No definite conclusion can be drawn as to the mechanism producing the fault pattern, however, the following may be stated.

a) There was a dominant tensional component present, producing space for the grabens to develop.
b) The'relay-like' switching in the direction of hade of the major normal faults suggests some shearing may have been involved in the deep seated fault development.

Tensional faulting also occurred during the Miocene/Oligocene with most movement occurring during the Upper Oligocene/Lower Miocene. This corresponds to the major period of anticlinal development.

The faults can be traced well up into the Miocene section, appearing to terminate just below the 'Miocene Channelling' (see seismic section G74A-1094).

This faulting is unrelated to the deep fault system and appears to be produced in conjunction with anticlinal development.

Regional Trends and Further Play Concepts

The remapping has shown the fold axis of the Bream anticline to be consistent in direction with the general structural grain of the Gippsland Basin.

The Bream anticline (strike ENE/WSW) may well be part of a general antiform trend extending through the centre of the basin, including the Veilfin and John Dory prospects and the Marlin field, running approximately parallel to the Barracouta antiform trend.

IGNEOUS ACTIVITY

The nature and distribution of the intrusives over the Bream prospect has been more accurately determined from the current mapping (see Enclosure 21 for distribution of intrusives).

The timing of intrusion appears to have been during or soon after the deposition of the Gurnard Formation. This conclusion is supported by the following evidence:-

a) The mapped upper boundary of the Gurnard Formation shows extensive structuring directly related to the intrusion of the dolerite sills. Since this boundary is erosional, the structuring of the surface must have occurred either at the time of erosion or soon after.

b) To the north of the Bream Field a "cauldera-like" feature occurs at the top of the Gurnard Formation. The depression is infilled with Oligocene sediments.

The deep seated faults appear to have formed a 'plumbing system' for the intruding magma. The intruding magma has greatly complicated the structure directly underlying the dolerite sills. Seismic mapping in these regions has a very low confidence level.

The presence of two thin sills within the reservoir zone has significance for detailed reservoir studies. These were recognised as amplitude anomalies (on seismic lines G74A-1090, G74A-1144) and an increase in the isopach between the 'Top of Latrobe Group' and 'Top of Latrobe Group Coarse Clastics' (for location of these intrusives see enclosure 21).

SEISMIC STRATIGRAPHY

'Top of Latrobe Group' event to the 'Top of Latrobe Group Coarse Clastics' event.

The interval between these two seismic markers represents the Gurnard Formation.

Extensive erosion of the Gurnard Formation has occurred directly over the region occupied by the dolerite sills, but not necessarily directly related to individual sills. This erosion appears to have been due to a broad thermal up-lift occurring prior to igneous intrusion. (See enclosure 13 and seismic line G74A-1147).

Erosion of the Gurnard Formation is also apparent over the eastern end of the Bream prospect (line G74A-1142), most-probably associated with the early stages of growth on the developing Bream anticline.

It should be noted that some uncertainty still exists in the seismic definition of the Top of the Latrobe Group in coming off structure to the southwest of the Bream Field.

Examination of Edina-1 should lead to the resolution of this uncertainty.

'Top of Latrobe Group Coarse Clastics' to the *P. asperopolus* Seismic Marker

An isopach map constructed for this interval shows a marked thinning towards the east (Enclosure 14).

The basinward thinning of this interval appears to have been due to marine transgression, resulting in the landward retreat of terrigenous sediment deposition.

P. asperopolus Seismic Marker to the M. diversus Seismic Marker

The sequence is dominated by high amplitude parallel events produced from the laterally extensive coal seams.

The interval shows a minor basinward thinning. Many of the high amplitude parallel events generated from coal seam interfaces show a distinct degeneration of character to the east of the Bream Field. This may represent a facies change as the terrestrial sequence grades into more marginal marine deposits.

M. diversus Seismic Marker to the Upper L. balmei Seismic Marker

High amplitude events generated from coal seams are representative of this interval.

A broad channel (3 to 4km wide, striking northwest-southeast) occurs within the interval over the east-Bream region. This channel was most likely cut during a rapid fall in relative sea level, possibly being the terrestrial equivalent of submarine erosion occurring in the M. diversus section seaward of Bream (see seismic lines G74A 1137, 1138). The channel truncates underlying units in the vicinity of Bream-5.

Upper L. balmei Seismic Marker to the Lower L. balmei Seismic Marker

During the time of deposition of this interval there appears to have been a large embayment, open to the north, present over the area of the Bream Field. At least one discrete lobate body of sediment can be mapped prograding into this embayment. The principal direction of sediment transport is interpreted to be from the south (Enclosure 22).

RECOMMENDATIONS AND CONCLUSIONS RELATING TO BREAM FIELD MAPPING

Remapping of the Bream Field has lead to a tightening of reserve estimates for the west Bream development area, and recognition of an upside potential, which if proved will provide sufficient reserves to support an east Bream development.

The following recommendations are made with the view of upgrading present mapping.

a. Data spacing be decreased to at least a half kilometre grid spacing. Decreased data spacing is needed in the west Bream development area to define with greater precision the location of igneous intrusions which are known to occur within the reservoir zone. Mapping of potential extensions to the east Bream lobe will also benefit from a decrease in seismic grid interval.

b. For future velocity analysis it is recommended that velscans be produced at 600 metre intervals, (present velocity sample interval is 1.25km over the majority of the field).

c. A Bream-6 well is needed to test the highside potential of the east Bream 'C' Block. The greatest variation in the mapping occurs in 'C' Block, and hence another control point is needed in order to further tighten the reserve estimates presently being carried for east Bream.

FUTURE PLAY CONCEPTS GENERATED FROM THE BREAM FIELD REMAP

In the Bream Region and near vicinity the northwest/southeast striking grabens are of particular interest. Providing closure can be found along the northwest/southeast trend of these faults, viable plays will have been generated by roll-over and fault drape associated with the northwest/southeast trending grabens. This type of play concept is well illustrated on seismic lines G74A-1093 and G74A-1138.

Following the recovery of oil from intra-Latrobe Group sediments at the Bream-5 locality the intra-Latrobe Group sequence in the south-west Gippsland Basin region warrants detailed exploration. Intra-Latrobe Group structures should be up-graded from secondary drilling targets associated with 'Top of Latrobe Group' plays to stand alone primary drilling targets.

PART 3

PART III

HYDROCARBON ASSESSMENT

ASSESSMENT

Introduction

The current series of assessments commenced after the drilling of Bream-4A in 1981. This allowed detailed correlations to be made between Bream-4A and Bream-3. The assessment was carrried out using maps constructed in 1976 and which were hand migrated and tied into the Bream-4A well results. The logs of Bream-2 and Bream-3 were re-examined in November, 1981 (Appendix VI) and the resulting log analysis incorporated into this assessment.

In 1981/82 the field was completely re-mapped using the reprocessed 1974 seismic data which necessitated an assessment update. The drilling of Bream-5 in 1982 resulted in modification to the mapping in the eastern half of the field and necessitated a further assessment update which is the assessment included in this report. Details of the reservoir parameters used in the assessment are contained in Appendix VII.

TOP OF LATROBE GROUP

Field Subdivisions

The field was subdivided into five separate blocks and each block assessed individually. Enclosure 5 shows the field subdivisions.

Blocks A and B - The major subdivision divides the field into two, blocks A and B representing the approximate drainage area of the proposed 'A' platform. Bream-3 and Bream-4A were correlated in detail and the interval between the top of the "Coarse Clastics" and the *P. asperopolus* marker was subdivided into four zones on the basis of lithology and porosity trends. Structure maps were constructed for the top of each zone by proportioning out the top of "Coarse Clastics" to *P. asperopolus* marker isopach according to the thickness of each zone in the two wells (See enclosures 23, 24 and 25). The gross reservoir volume was calculated for each zone using these maps.

Reservoir properties were calculated by averaging the properties derived from log analysis of the two wells. Where any doubts existed more emphasis was placed on the Bream-4A log analysis due to the poorer quality of the Bream-3 logs.

Blocks C and D - These two blocks represent the approximate drainage area for the potential Bream 'B' platform.

The correlation of the reservoir zone in Bream-2 with Bream-3 is very poor and hence no attempt was made to stratigraphically subdivide block C. The gross reservoir volume was calculated for the interval between the top of the "Coarse Clastics" to the *P. asperopolus* marker, below which the strata is essentially non-net igneous intrusives. Initially average reservoir properties were determined from the Bream-2 well logs, however, because of the very poor log quality, the Bream-5 results were taken into account in this assessment.

Block D was assessed using parameters derived from the Bream-5 well results. The gross reservoir volume was determined for the sand interval between -1910 metres and -1929 metres, by calculating the volume between a phantom horizon isopached down from the top of the "Coarse Clastics" and a phantom horizon isopached up from the *P. asperopolus* marker. This assumes a sheet sand over the area of the block.

Block E - This is a small separate closure to the northeast of block 'D'. The reservoir parameters used were the same as for block 'D'. The closure was assured to be full with oil to a spill point about 11 metres deeper than the main field.

Summary of Top of Latrobe Group Assessment

	Hydrocarbons-in-place		
	Min	M.L.	Max.
BLOCK 'A'			
Gas (GSCF)	254	352	521
Oil (MSTB)	53	71	100
BLOCK 'B'			
Gas (GSCF)	10	64	130
Oil (MSTB)	13	28	50
BLOCK 'C'			
Gas (GSCF)	51	103	235
Oil (MSTB)	13	28	50
BLOCK 'D'			
Gas (GSCF)	.1	.1	.4
Oil (MSTB)	.6	2.0	8.7
BLOCK 'E'			
Gas (GSCF)	-	-	-
Oil (MSTB)	.3	2.5	6.1

INTRA LATROBE GROUP

Bream-2

No assessment has been carried out on the deep hydrocarbon zones encountered in Bream-2. The poor seismic resolution and the extensive faulting at this depth made the production of a reliable structure map very difficult. Also, the poor quality of the logs, and hence the uncertain log analysis results, and the poor quality pressure data, have meant that the height of the hydrocarbon columns could not be accurately determined. These factors combined mean that any volume assessment would be of very low confidence.

Bream-5

Due to the excellent quality of logs and better pressure data obtained from Bream-5, an assessment of oil bearing zones was attempted. The structuring in the immediate vicinity of Bream-5 at depth is largely unfaulted and thus the mapping has a higher confidence rating. The average gross column height was taken to be between 22 metres and 27 metres, and only those intervals containing oil were assessed. The reservoir quality is very poor and despite RFT recoveries of oil it is doubtful whether the two intervals would produce.

SUMMARY OF INTRA LATROBE GROUP ASSESSMENT

	Hydrocarbons-in-place		
	Min	M.L.	Max.
Upper Zone			
Gas (GSCF)	0.9	3.9	9.5
Oil (MSTB)	0.1	0.7	2.0
Lower Zone			
Oil (MSTB)	0.3	0.8	2.6

APPENDIX 1

APPENDIX I

THIN SECTION DESCRIPTIONS

BREAM-2

EXAMINATION OF DOLERITE FROM BREAM NO. 2

Sample: 6393.5; TS 39204

Location:
Bream No. 2, Core 4.

Rock Name:
Altered dolerite

The sample is an extensively altered doleritic rock which is not suitable for whole rock potassium-argon geochronology.

About 50% of the rock consists of laths of plagioclase which are clear and fairly fresh. Most of these laths are of the order of 0.5 mm in length and they form a random mosaic throughout the whole of the rock. In the interstices between the crystals of plagioclase clinopyroxene forms equant anhedra and small aggregates probably less than 0.6 mm in size; individual crystals of clinopyroxene are generally not more than about 0.2 mm. The rock contains about 25% of patches of secondary brown material. For the most part this forms aggregates with colloform or granular textures in rather irregular aggregates which do not pseudomorph any pre-existing phase. In some places these aggregates occur in a cellular structure which is as much as 1 mm in size. The presence of this secondary brown material (?bowlingite) would prohibit whole rock potassium-argon dating of the rock and the sample is probably too young for dating by means of potassium argon measurements on a plagioclase concentrate.

The sample was probably originally an olivine dolerite but the olivine has now been altered to a secondary brown phase although clinopyroxene and plagioclase are still fairly fresh.

PETROGRAPHIC DESCRIPTION OF VOLCANICS FROM 6,392-6, 395 feet IN ESSO'S BREAM 2 WELL

1. Sample: Core sample selected from Core 9, in the interval 6,392 to 6,395 feet, from Esso's Bream 2 well, Gippsland Shelf.

2. Hand Specimen Description (Regd. No. 16613)

The rock is a greenish black (5GY) to olive black (5Y), very fine-grained, hard and crystalline, and appears to be basaltic. In addition to feldspars, there are dark green sub-rounded patches of clay mineral, but no obvious phenocrysts.

3. Thin Section Description (Slide No. 9564)

3.1 Review

The thin section reveals that the rock is a basic igneous type and that it is inequigranular-porphyritic (though not markedly), fine-grained, and hypocrystalline (?), with a pilotaxitic texture. It is composed of rare, severely altered phenocrysts in a groundmass of plagioclase feldspar, pyroxene, iron ore, chlorite and ?volcanic glass. The relative proportions are estimated visually to be:

	%
Phenocrysts	negl.
Plagioclase	45
Pyroxene	20
Chlorite/?glass	30
Iron Ore	5

3.2 Details

There is only one subhedral crystal in the thin section that can be considered as a small phenocryst, 1.4 mm long and now completely chloritised. It has a hexagonal- pyramidal outline, and was probably olivine prior to alteration.

In the groundmass the plagioclase feldspar (sodic labradorite) occurs as laths up to 1.7 mm long (average slightly more than 1 mm) as well as less common interstitial crystals. The laths are randomly orientated and frequently interlocking. As a result of chlorite replacement the plagioclase crystals have a somewhat tattered appearance with the chlorite occurring around the crystal margins and along fine cracks within. The alteration is sometimes rather severe.

The pyroxene is colourless to faint pink augite, which is slightly titaniferous, in the form of subhedral to anhedral crystals up to 0.6 mm (average approx. 0.3 mm). The crystals are occasionally twinned. The augite has undergone the same partial chloritisation as the plagioclase. Carbonate is rarely an alteration product.

Chlorite, one of the more abundant constituents of the rock, is somewhat variable in its growth forms (and, hence, its optical properties). Other than its partial replacement of the plagioclase and augite, and its complete replacement of the olivine phenocryst, it also occurs as shapeless patches up to 3 mm across. The latter sometimes have the appearance of being former voids or vesicles in the rock. A layer of brownish chlorite lines the walls of the voids which have then been filled with a crenulated layer of light green to honey brown material, which is isotropic, and, in the centre of the voids, is brownish chlorite in the form of clusters of spherulites or as concentric lamellae.

The isotropic material could be volcanic glass - hence the reference, under Review, that the rock is "hypocrystalline (?)" - in which case the spherulitic chlorite that it encloses could be devitrefied glass. However, but for its paler colour, it also resembles the mineraloid chlorophaeite which is found associated with chlorite in a similar growth form in the Perch volcanics (Hocking, 1969).

Iron ore occurs as long threads of skeletal ?ilmenite up to 1.4 mm long.

4. Conclusions

4.1 Rock Classification

The rock is a partially altered olivine basalt.

4,2 Stratigra hic Implications

Mineral composition and texture of this olivine basalt are comparable to those of other olivine basalts from South Gippsland and the Gippsland Shelf such that one might group it with the 'Older Volcanics'.

Berry Hocking

30th January, 1970

J.B. HOCKING
Geologist,
Sedimentary Basin Studies Section

Bream 2

Petrographic Description of igneous rock extending from 6377-6501'.

Sample 1 (From Core # 8, 6334-6374')

Medium grained basaltic igneous rock, with intersertal texture defined by euhedral laths of labradorite plagioclase. Former mafic material (pyroxene) and glassy interstices replaced by fine grained aggregates of carbonate and chalcedony. Vesicles also show fillings of these minerals. Primary ilmenite remains.

Partially carbonate altered basalt.

Sample 2 (From Core # 9, 6374-6437)

Coarse grained amygdaloidal volcanic with intergranular texture and consisting of plagioclase (labradorite) and light pink clinopyroxene (angite?). A few euhedral montmorillonite pseudomorphs may be after olivine. Interstitial material (formerly glassy) replaced by fine aggregates of dusty opaque and greenish layer silicates (montmorillonite or smectite materials). Amygdales are also filled with similar material, with cores of light coloured (?)nontronite layer silicate.

Somewhat altered dolerite.

Conclusions

From its petrology, texture and chilled, carbonatized margin this altered basalt-dolerite is interpreted as part of a shallow intrusive igneous body.

Bryan Griffiths

ESSO STANDARD OIL (AUSTRALIA) LTD.

CORE DESCRIPTION

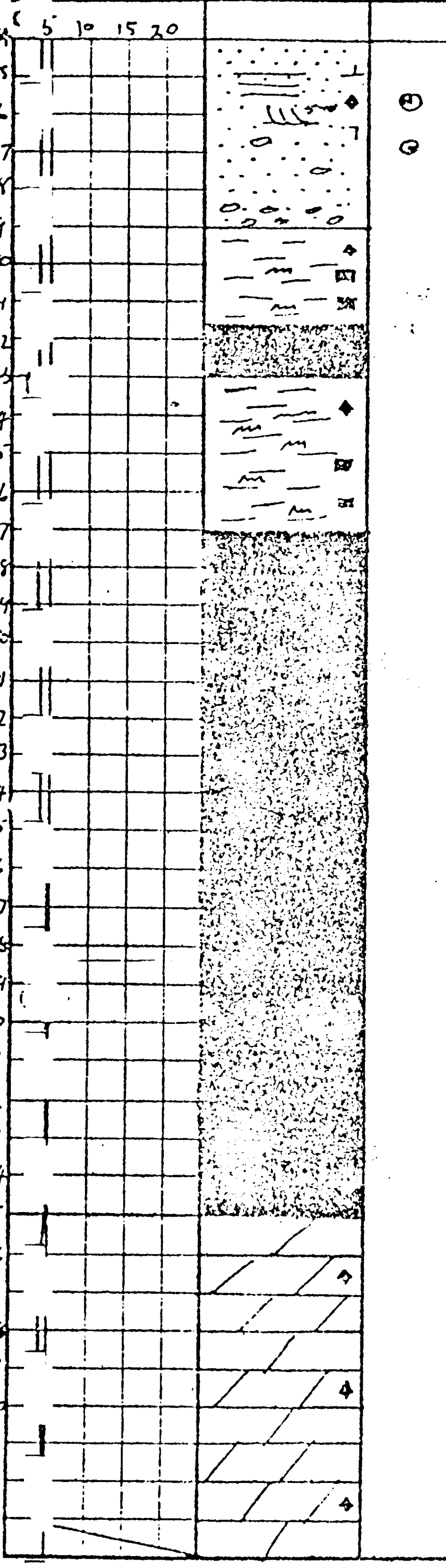
Core No. 8

WELL: BREAM 2

Interval Cored 6334-74 ft., Cut 40 ft., Recovered 40 ft., (100 %) Fm. LATROBE

Bit Type C20, Bit Size 8 5/16 in., Desc. by R.L. GRAHAM Date 15/3/'69

Depth & Coring Rate (min./ft.)	Graphic (1" = 5')	Shows	Interval (ft.)	Descriptive Lithology



6334-39': SANDSTONE: buff, f.-v.crs. gr becoming pebbly towards the base; sub-ang-ang. matrix with sub-rounded pebbles to 1cm. Sl. calc, pyritic and micaceous; some even // bedding and poss. cross bedding at 5-10°. Qtzose w/ some lithic pebbles. V. porous and perm. V. strong blue white fluor. and cut. Good hydro. odour.

6339'-41½': SHALE: V. carb. grading to coal, black, hd, w/ parallel wavy laminae of pyrite and silt.

6341½'-43': COAL: grading to v. carb. shale. The coal is mostly shiny with conchoidal fracture + quite good quality. Bleeding gas.

6343-47': SHALE: as above.

6347'-6365': COAL: as above grading over the last 3' to v. carbonaceous shale, as above.

6365'-74': DOLOMITE: grey, v. hd, with small vughs to one cm filled with qtz and calcite. Very pyritic with small integral crystals + with large concretions to 6 cms. Pyrite also fills veins and cracks. Does n't appear sandy - poss. a dolomitised limestone. Contains numerous small black metallic, needle-like crystals. (manganese?)

REMARKS:

ESSO STANDARD OIL (AUSTRALIA) LTD.

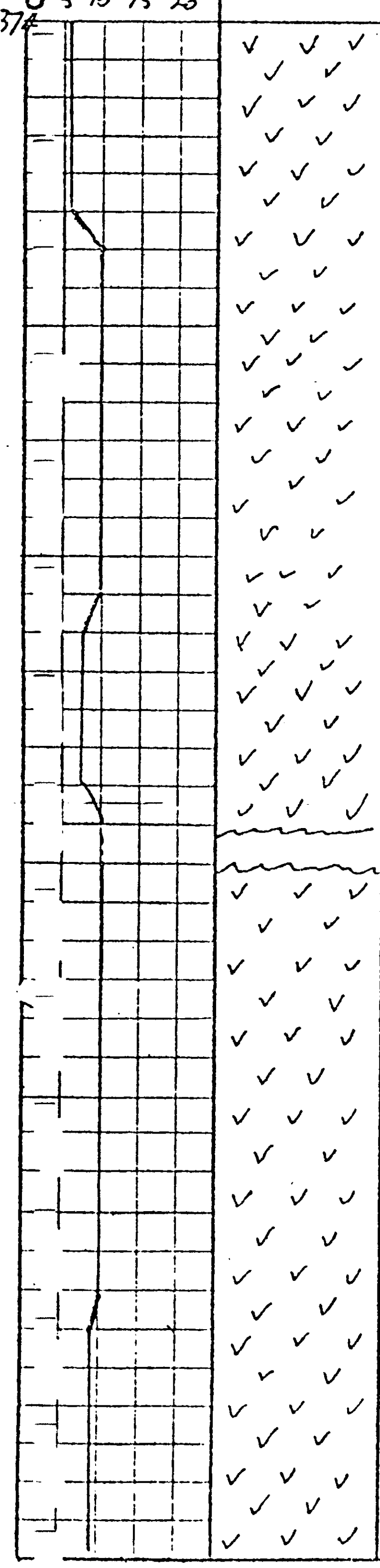
CORE DESCRIPTION

Core No. 9

WELL: BREAM #2

Interval Cored 6374-6437 ft., Cut 63 ft., Recovered 63 ft., (100 %) Fm. ?LATROBE?

Type C 8, Bit Size 8 5/16" in., Desc. by R.L. GRAHAM Date 16/3/'69

Depth & Coring Rate (min./ft.)	Graphic (1" = 5')	Shows	Interval (ft.)	Descriptive Lithology
0 5 10 15 20 / 6374			6374-6437	VOLCANICS: possibly basalt: dk grey, finely crystalline groundmass of grey feldspar lathes and in places what may a brownish mesostasis. Dk green phenocrysts up to 5mm are very common in places and occ. there are large irregular yellowish green phenocrysts (xenocrysts?) to 1cm. These may be olivine or a calcic? pyroxene. They are at times altered to a white subst. reacting with conc. HCl. The dk-green crystals are irregular in shape & may be diopside. The rock appears fairly calcic & contains some veins and small vughs containing carbonate material & ?zeolites. In the groundmass the edges of biotite lathes present a needle-like appearance. Hornblende may also be present. The yellowish-green phenocrysts often show a dk green reaction rim which may contain biotite. Minor slickensiding is present.

REMARKS:

WELL: CORRECTED DEPTH TO FDC 6345' - 6385

Core No. 8 | Depth: 6334 - 6374 | Horizon: Latrobe

Scale: 1" = 5' | Cut 40 | Rec 40 | Described by: NPW

Environment	Facies	Depth	Porosity (GOOD / FAIR / POOR / NIL)	Lithology	Grain Size (SILT / VF / F / M / C / >C)	Sorting (GOOD / FAIR / POOR)	Rounding (R / SR / SA / A)	Grain / Matrix Ratio	Structure	Contact	Description
	BRAIDED STREAM	6334						5:1			SANDSTONE: buff, f-vc - pebbly
DELTA PLAIN	INTERDISTRIBUTARY / MARSH	6340								S.	SHALE dk gy carb grading coal silty in pt.
											COAL - blk. tr py.
		6345									SHALE A/A
	MARSH	6350, 6355, 6360		COAL						S.	COAL. blk anthracitic
VOLCANIC	INTRUSIVE	6365, 6370								S.	DOLERITE altered contact metasomatized hd. py.
		6374									

SEE THIN SECTION DESCRIPTIONS.

WELL: BREAM-2

Core No 9 | Depth 6374 – 6437 | Horizon: INTRUSIVE Dolerite

Scale: | Cut 60' | Rec 63' | Described by BRG

Environment	Facies	Depth	Porosity (Good / Fair / Poor / Nil)	Lithology	Grain Size (Silt / VF / F / M / C / VC)	Sorting (Good / Fair / Poor)	Rounding (R / SR / SA / A)	Grain/Matrix Ratio	Structure	Contact	Description
		6374 6375		V V							Massive dolerite
		6380		V V							
		6385		V							
		6390		V							
		6395		V							
		6400		V							
		6405		V							
		6410		V							
		6415		V							
		6420									

APPENDIX 2

APPENDIX II

REFLECTANCE MEASUREMENTS

ESSO AUSTRALIA LTD.

VITRINITE REFLECTANCE REPORT

BASIN - GIPPSLAND
WELL - BREAM 4A

SAMPLE NO.	DEPTH	AGE	FORMATION	AN	MAX. RO	FLUOR. COLOUR	NO. CNTS.	MACERAL TYPE
72312 A	1875.50		GURNARD	5	.45	YELLOW TO OR	6	RARE SPORIN & DINO
72312 U	2009.80		LATROBE GROUP	5	.49	GREEN TO ORA	20	EXINITE ABUND
72312 V	2204.90		LATROBE GROUP	5	.62	SPOR YEL-OR	23	EXIN COMMON
72312 W	2353.50		LATROBE GROUP	5	.55	SPOR DULL OR	20	EXIN ABUND

BASIN - GIPPSLAND
WELL - BREAM 5

SAMPLE NO.	DEPTH	AGE	FORMATION	AN	MAX. RO	FLUOR. COLOUR	NO. CNTS.	MACERAL TYPE
72507 A	1947.60	EOCENE-LATE CRET.	LATROBE GROUP	5	.41	GRN/YEL-OR	20	E>V>I D.O.M. ABUNDANT
72507 Q	1964.20	EOCENE-LATE CRET.	LATROBE GROUP	5	.54	YEL TO OR	20	V>>E=I
72490 B	2029.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.53	GRN/YEL-OR	20	V=I>E D.O.M. ABUNDANT
72506 B	2472.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.53	YEL TO OR.	20	V>>E>I D.O.M. ABUNDANT
72507 R	2571.93	EOCENE-LATE CRET.	LATROBE GROUP	5	.68	YEL TO OR.	25	V>I>E.
72506 M	2624.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.56	GRN/YEL TO O	22	V>I>E D.O.M. ABUNDANT
72507 S	2712.60	EOCENE-LATE CRET.	LATROBE GROUP	5	.68	YEL TO OR.	20	V>I>E.
72507 T	2731.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.69	YEL-OR/D.OR	20	V=I>E D.O.M. ABUNDANT
72506 V	3062.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.77	GRN/YEL-OR.	5	RARE-SPARSE SPORINITE
72506 A	3320.00	EOCENE-LATE CRET.	LATROBE GROUP	5	.85	OR-DULL OR.	20	V>I>E D.O.M. ABUNDANT

BREAM 2

KK No.	Esso No.	Depth m	$\bar{R}_v$ max %	Range R_v max %	N	Exinite fluorescence (Remarks)
15585	BS/B5	1932 Core	0.76	0.59-0.86	20	Rare dull brown resinite. Sporinite present but does not fluoresce. (Coal, dominated by detrovitrinite. V>90%, fungal sclerotinite abundant. Bireflectance approx. 0.03%.)
15586	BS/B6	1937 Core	1.09	1.01-1.15	23	No fluorescing exinite. (Coal, vitrinite-rich, exinite can be distinguished in reflected light. Calcite mineralization abundant, some marcasite present. Sclerotinite present. Bireflectance approx 0.06%.)
15587	BS/B7	1938 Core	1.00	0.82-1.06	22	No fluorescing exinite. (Coal, vitrinite-rich with sclerotinite. Bireflectance approx. 0.08%. Exinite can be distinguished in reflected light.)
15588	BS/B8	1940 Core	1.09	0.85-1.21	30	No fluorescing exinite. (Coal, vitrinite-rich, occurring as thin layers in sandy siltstone. Bireflectance approx. 0.04%. No coke mosaic or vesicles present. The large range of reflectance found may be due to the inclusion of some suberinite with the vitrinite.)

The samples have all been thermally altered. Coke structures are not present, indicating that the rate of heating and the final temperature were relatively low. The optical properties are clearly anomalous as compared with the properties which result from a "normal" coalification history.

APPENDIX 3

APPENDIX III

LAG AND WELL TIE DATA

APPENDIX III

LAG AND WELL TIE DATA

WELL NAME: BREAM-2

SEISMIC EVENT	SUBSEA DEPTH FROM LOGS	T/D CURVE TWT	SEISMIC TWT	LAG	NATURE AND SOURCE OF EVENT
TOP OF LATROBE GROUP	1794.9	1.453	1.476	.023	composite event, top of glauconitic sandstone.
TOP OF LATROBE GROUP 'COARSE CLASTICS'	1855.6	1.490	1.516	.026	composite event base of glauconitic sandstone
P. asperopolus Seismic Marker	1933	1.538	1.563	.025	base of thick coal seam
M. diversus Seismic Marker	2100	1.640	1.656	.016	top of thick coal
Upper *L. balmei* of Seismic Marker	2313		1.770	-	follow cycle from top thick sandstone sequence
Lower *L. balmei* Seismic Marker	2696		2.000	-	Composite event at the base of a thick sequence dominated by coal

WELL NAME: BREAM-3

SEISMIC EVENT	SUBSEA DEPTH FROM LOGS	T/D CURVE TWT	SEISMIC TWT	LAG	NATURE AND SOURCE OF EVENT
TOP OF LATROBE GROUP	1816.8	1.476	1.496	.020	composite event, top of glauconitic sandstone
TOP OF LATROBE GROUP COARSE CLASTICS	1856.8	1.506	1.524	.018	composite event base of glauconitic sandstone
P. asperopolus Seismic Marker	1968	1.568	1.588	.020	base of coal seam
M. diversus	2110	1.648	1.668	.020	top of coal seam
Upper *L. balmei* Seismic Marker	2392		1.825		follow cycle from top of sandy sequence
Lower *L. balmei* Seismic Marker	2825		2.086		Composite event at the base of a thick seqence dominated by coal.

APPENDIX 1II CONTINUED

LAG AND WELL TIE DATA

WELL NAME: BREAM-4A

SEISMIC EVENT	SUBSEA DEPTH FROM LOGS	T/D CURVE TWT	SEISMIC TWT	LAG	NATURE AND SOURCE OF EVENT
TOP OF LATROBE GROUP	1836	1.470	1.504	.034	composite event, top of glauconitic sandstone
TOP OF LATROBE GROUP COARSE CLASTICS	1892.6	1.505	1.529	.024	composite event base of glauconitic sandstone
P. asperopolus Seismic Marker	2004	1.574	1.595	.021	base of thick coal seam
M. diversus Seismic Marker	2126.5	1.650	1.674	.024	top of thick coal seam
Upper *L. balmei* Seismic Marker	2333		1.804	-	composite event top of a shale/sandstone sequence
Lower *L. balmei* Seismic Marker	-	-	-	-	-

Note: A lag value of 25 milliseconds was decided upon, with localised adjustments being made to tie wells in disagreement with this value.

APPENDIX III CONTINUED

LAG AND WELL TIE DATA

WELL NAME: BREAM-5

SEISMIC EVENT	SUBSEA DEPTH FROM LOGS	T/D CURVE TWT	SEISMIC TWT	LAG	NATURE AND SOURCE OF EVENT
TOP OF LATROBE GROUP	1842.5	1.472	1.498	.026	Composite event, top of glauconitic sandstone
TOP OF LATROBE GROUP COARSE CLASTICS	1903	1.512	1.536	.024	Composite event of base of glauconitic sandstone
P. asperopolus Seismic Marker	1935.6	1.531	1.553	.022	base of thick coal
M. diversus Seismic Marker	2074	1.618	1.640	.022	top of thick coal
Upper *L. balmei* Seismic Marker	2305	1.760	1.790	.030	Composite event, vicinity of shale/sandstone sequence increased amplitude due to dolomitic matrix in sandstones
Lower *L. balmei* Seismic Marker	2672	1.969	1.996	.027	Composite event at the base of thick sequence dominated by coal

VELOCITY CONVERSION FACTORS

WELL	SUBSEA DEPTH FROM LOGS	T/D Va	Vnmo	% (Va / Vnmo)
Bream-2	1855.6	2489m/s	2636	94.42%
Bream-3	1856.8	2467m/s	2654	92.95%
Bream-4A	1892.6	2513m/s	2667	94.2%
Bream-5	1903	2518m/s	2673	94.2%

Note: A velocity conversion factor of 94.3% was decided upon, with a manual adjustment of -1.35% being applied at Bream-3.

APPENDIX 4

APPENDIX IV

DEPTH CONVERSION OF INTRA-LATROBE MARKERS

APPENDIX IV

DEPTH CONVERSION OF INTRA-LATROBE MARKERS

Derivation of the depth equation used to depth convert intra-Latrobe Group seismic markers (including the Top of Latrobe Group event) is given below. (After A.R. Limbert 1980)

The method determines a linear relationship between depth and interval velocity. The intra-Latrobe Group horizons are then isopached from the Top of Latrobe Group 'Coarse Clastics' structure map.

Assume $V_{int} = \frac{dz}{dt} = az + b$, where a and b are constants determined emperically

$$dt = \frac{1}{az+b} \cdot dz$$

$$\frac{t}{2} = {}_{Ztl}^{\;z} \frac{1}{az+b} \, .dz$$

let

$$x = az+b$$

$$dx = adz$$

$$\frac{1}{az+b} \cdot dz = \frac{1}{a} \; \frac{1}{x} \, .dx$$

$$= \frac{1}{a} \; \log x + c$$

$$\frac{t}{2} = \left[\frac{\log (az+b)}{a} + c \right]_{Ztl}^{Z}$$

$$= \frac{\log(az+b)}{a} + c - \frac{\log(aZtl+b)}{a} - c$$

$$\log(az+b) = \frac{a\,t}{2} + (aZtl+b)$$

$$az+b = e^{\left(\frac{a\,t}{2} + \log (aZtl+b)\right)}$$

$$= e^{\frac{a\,t}{2}} \; e^{\log(aZtl+b)}$$

$$= e^{\frac{a\,t}{2}} \, (aZtl+b)$$

$$z = \frac{e^{\frac{a\,t}{2}} \, (aZtl+b) - b}{a}$$

where:
- t = TWT from Top Latrobe to marker horizon
- Ztl = Depth to Top Latrobe
- z = Depth of marker horizon
- a = Interval velocity gradient constant
- b = Interval velocity at zero depth

DEPTH CONVERSION OF INTRA-LATROBE MARKERS

The constant a and b were numerically calculated from a plot of interval velocity versus depth (figure 1). The interval velocities were taken from the Bream-2, 3 and 4A well integrated sonic logs, averaged over 200 feet, and 50m in the case of Bream-4A.

Values for a and b were determined to be: -

a = .86
b = 1428

APPENDIX 5

APPENDIX V

MAXIMUM AND MINIMUM CASE

TOP OF RESERVOIR MAPS

APPENDIX V

'MAXIMUM' AND 'MINIMUM' CASE TOP OF RESERVOIR MAPS

In assessing the in-place hydrocarbon potential of the Bream field maximum and minimum case oil and gas reserve figures were required. The calculation of these reserve figures required maximum and minimum interpretations of gross reservoir volumes resulting in the need to generate the above mentioned maps.

The following is a summary of how these volumes were calculated, justifying the method used for constructing the 'maximum' and 'minimum' case top of reservoir maps.

Firstly, the dimensions of the Bream field are controlled by the following:-

a) height of closure on the structure at the locations of the Bream-2, 3, 4A and 5 wells.

b) the base of the hydrocarbon column as defined by the well intersections with the O.W.C.

By assuming the O.W.C. to be flat and unique over the field any variation in the gross reservoir volume will be due to variation in the top of the reservoir map.

Having defined the base of reservoir a maximum gross reservoir volume will be obtained from having the shallowest possible surface defining the the top of reservoir, the converse applying for a minimum gross reservoir volume.

To obtain the 'minimum' and 'maximum' case top of reservoir maps the appropriate geophysical errors, as summarised below were applied.

In obtaining the maximum case one further assumption was used. The field is assumed to be full to spill. Hence for the maximum case another control point is made available being that of the spill point.

The above 'maximum' and 'minimum' maps also give an indication of the error bar associated with the most-likely top of reservoir map.

SUMMARY OF GEOPHYSICAL ERROR MARGINS USED IN CONSTRUCTING 'MAXIMUM' AND 'MINIMUM' CASE DEPTH MAPS TO THE TOP OF RESERVOIR

i) T.W.T. Mapping:

The top of reservoir event (mapped as the Top of Latrobe Group 'Coarse Clastics) has a 10 millisecond half wavelength, hence an error of ±5 milliseconds was used in constructing maximum and minimum case maps. The mapped event is of high signal quality and consistent in character across the prospect.

ii) Velocity Interpretation

a) a velscan pick error of ± 20m/sec was used.

b) In the construction of smoothed velscan velocity profiles a maximum and minimum velocity interpretation was undertaken. From this data maximum and minimum velocity maps were constructed (Enclosures 9 and 10). These maps also included the appropriate velscan pick error factor.

Resulting maximum and minimum case depth maps have been enclosed (see Enclosures 13 and 14).

APPENDIX 6

APPENDIX VI

LOG ANALYSES

Bream-2
Bream-3
Bream-4A
Bream-5

BREAM-2 LOG ANALYSIS

GENERAL

An analysis of wireline log data for the interval 1806m to 2033m was carried out using the HP41CV "LOOKLOG" log analysis program

INPUT LOGS

GR, ILD, and FDC.
The quality of the logs are generally poor. The GR log in particular has to be depth shifted in the interval 1909 to 1914m to match the SP and resistivity logs. In addition density log values over shale intervals were also adjusted.

Depth intervals for analysis were delineated on the FDC logs which were run in Imperial Units. The depth intervals were converted to metric values by hand.

INPUT PARAMETERS

a	0.8
m	2.0
N	2.0
Matrix density	2.65 gms/cc
Fluid Density	1.0 gms/cc
Hydrocarbon density - gas	0.2 gms/cc
Hydrocarbon density - oil	0.70 gms/cc
Density log value for shale	2.50 gms/cc
Resisitivity log value for shale	7.0 ohm/m
GR minimum	15 API units
GR maximum	135 API units
Salinity	40000 ppm NaCl equiv.

SUMMARY OF ANALYSIS RESULTS

INTERVAL(m)	NET THICKNESS (m)	TYPE OF HC	AV. Ø	AV. SW
1806.7-1811.0	4.3	gas	0.192	0.297
1868.9-1880.7	6.5	gas	0.159	Q.403
1882-1883.5	1.5	gas	0.166	0.226
1883.5-1893.6	10.1	gas	0.169	0.201
1893.6-1903.6	9.3	gas	0.170	0.240
1903.6-1912.2	7.3	gas	0.220	0.155
1914.0-1925.6	10.2	gas	0.155	0.293
1927.4-1928.6	1.2	oil	0.143	0.570

Analysis indicates the presence of 49.2m of gas and 1.2m of oil.

K. KUTTAN

18th November 1981

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-2

LOG RUN #

DATE 16th November 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER K. KUTTAN

NOTE: Depth int. from FDC log. Dep. int. converted to metric.

WELL DATA

TEMPERATURES °F or °C ?	MUD SYSTEM O (oil based) or W (water based)?	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
		158 °	40 °F	67.7	2050.6m	1.04 @ 76 °F	° /

ANALYSIS PARAMETERS

ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
1.0	0.8	2	2	-	15	115	2.50	7.0	-	-	2.650	0.55
									use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

Rw & FORMATION SALINITY DETERMINATION

KEY G, KEY H, KEY I

Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	FROM SP. Rw	FROM SP. Equivalent Salinity	FROM RATIO Rt/Rxo Rw	FROM RATIO Rt/Rxo Equivalent Salinity	FROM ARCHIE EQUATION Rw	FROM ARCHIE EQUATION Equivalent Salinity	FROM INDONESIAN EQUATION Rw	FROM INDONESIAN EQUATION Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρmac	Φe	Sxo	Sw	Remarks
1	1806.7-1808.5m	1.80	35	2.200	10.0	-	40,000	0.25	-		0.200		0.202		0.374	gas prod
2	1808.5 - 1811.0m	2.50	30	2.230	33.0	-	40,000	"			0.150		0.174		0.242	gas prod.
3	1868.9 - 1871.6m	-	60	2.470	4.0	-	40,000	"			0.450		0.068		1.082	non net
3a	1871.6 - 1873.5m	-	55	2.470	18.0	-	40,000	"			0.400		0.070		0.793	non net
4	1873.5 - 1874.6m	1.10	60	2.320	11.0	-	"	"			0.450		0.140		0.411	gas prod
5	1875.3 - 1878.0m	2.70	65	2.280	9.0	-	"	"			0.500		0.159		0.403	gas prod
6	1878.0 - 1879.3m	1.30	67	2.275	8.5	-	"	"			0.520		0.161		0.407	gas prod. radioactive sand?
6a	1879.3 - 1880.7m	1.40	90	2.240	15.0	-	"	"			0.750		0.170		0.391	gas prod. radioactive sand?
7	1882.0 - 1883.5m	1.50	45	2.250	33.3	-	"	"			0.300		0.166		0.226	gas prod.
7a	1883.5 - 1886.6m	3.10	70	2.350	13.0	-	"	"			0.550		0.119		0.400	gas prod.
8	1886.6 - 1889.0m	2.40	37	2.175	70.0	-	"	"			0.220		0.189		0.146	"
9	1889 - 1893.6m	4.60	25	2.125	180.0	-	"	"			0.100		0.193		0.096	"
10	1893.6 - 1896.6m	3.0	52	2.300	20.0	-	"	"			0.370		0.147		0.307	"
11	1896.6 - 1898.8m	2.2	30	2.250	35.0	-	"	"			0.150		0.166		0.243	"
12	1898.8 - 1899.7m	-	60	2.400	8.0	-	"	"			0.450		0.102		0.597	"
13	1899.7 - 1901.5m	1.80	37	2.180	20.0	-	"	"			0.220		0.200		0.259	"
	-															
	-															
	-															
	-															

LOG ANALYSIS WORKSHEET (HP-41CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-2

LOG RUN #

DATE 16th November 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER K. KUTTAN

NOTE: DEPTH INT. FROM FDC LOG. DEPTH INT. CONVERTED TO METRIC.

WELL DATA

TEMPERATURES °F or ℃?	MUD SYSTEM O (oil based) or W (water based)?	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
		158°	40 °F	67.7m	2050.6m	1.04 @ 76 °F	° /

ANALYSIS PARAMETERS

ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
1.0	0.8	2	2	-	15	115	2.50	7.0	-	-	2.65	0.55
									use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

Rw & FORMATION SALINITY DETERMINATION

Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	KEY G FROM SP. Rw	Equivalent Salinity	KEY H FROM RATIO Rt/Rxo Rw	Equivalent Salinity	KEY I FROM ARCHIE EQUATION Rw	Equivalent Salinity	FROM INDONESIAN EQUATION Rw	Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρma c	Φe	Sxo	Sw	Remarks
14	1901.5 - 1903.6m	2.10	30	2.150	71.0	-	40,000	0.25	-		0.150		0.196		0.147	gas prod.
15	1903.6 - 1904.9m	-	77	2.40	16.0	-	"	"			0.620		0.087		0.413	non net
16	1904.9 - 1906.1m	1.20	45	2.075	60.0	-	"	"			0.300		0.234		0.125	gas prod.
16a	1906.1 - 1907.3m	1.20	40	2.070	135.0	-	"	"			0.250		0.226		0.088	"
17	1907.3 - 1909.7m	2.40	37	2.100	100.0	-	"	"			0.220		0.215		0.109	"
18	1909.7 - 1912.2m	2.50	45	2.150	18.0	-	"	"			0.300		0.215		0.246	gas prod.
19	1912.2 - 1914.0m	-	80	2.380	5.0	-	"	"			0.650		0.101		0.671	non net
20	1914.0 - 1915.8m	1.80	23	2.225	60.0	-	"	"			0.080		0.168		0.191	gas prod.
21	1915.8 - 1917.1m	1.30	23	2.300	50.0	-	"	"			0.080		0.143		0.244	"
22	1917.1 - 1918.0m	0.70	23	2.370	60.0	-	"	"			0.080		0.115		0.272	"
23	1918.0 - 1919.5m	1.50	25	2.250	140.0	-	"	"			0.100		0.158		0.130	"
23a	1919.5 - 1921.3m	1.80	75	2.230	18.0	-	"	"			0.060		0.176		0.251	"
24	1921.3 - 1923.2m	1.90	32	2.300	11.0	-	"	"			0.170		0.160		0.440	"
25	1923.2 - 1924.4m	-	80	2.430	5.7	-	"	"			0.650		0.072		0.750	non net.
26	1924.4 - 1925.6m	1.20	52	2.360	5.7	-	"	"			0.370		0.130		0.624	gas prod.
27	1925.6 - 1927.4m	-	97	2.460	7.0	-	"	0.70			0.820		0.040		0.770	non net
28	1927.4 - 1928.6m	1.20	52	2.350	6.0	-	"	0.70			0.370		0.143		0.570	oil prod.
	-															
	-															
	-															

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-2

LOG RUN #

DATE 16th November 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER K. KUTTAN

NOTE: DEPTH INT FROM FDC LOG DEPTH INT CONVERTED TO METRIC

WELL DATA	TEMPERATURES	MUD SYSTEM	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
	°F or °C ?	O (oil based) or W (water based)?	158 °	40 °	67.7	2050.6	1.04 @ 76 °	° /

ANALYSIS PARAMETERS	ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
	1.0	0.8	2	2	-	15	115	2.50	7.0	-	-	2.65	0.55
										use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

KEY G / KEY H / KEY I

Rw & FORMATION SALINITY DETERMINATION	Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	FROM SP. Rw	FROM SP. Equivalent Salinity	FROM RATIO Rt/Rxo Rw	FROM RATIO Rt/Rxo Equivalent Salinity	FROM ARCHIE EQUATION Rw	FROM ARCHIE EQUATION Equivalent Salinity	FROM INDONESIAN EQUATION Rw	FROM INDONESIAN EQUATION Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρmac	Φe	Sxo	Sw	Remarks
29	1928.6 - 1933.8m	-	99	2.550	6.0	-	40,000	0.7			0.840		0.010		1.07	water bearing
30	1982.9 - 1984.7m	-	22	2.325	1.30	-	40,000				0.070		0.191		1.143	water bearing
31	1984.7 - 1986.5	-	30	2.270	1.20	-	"				0.150		0.217		1.009	"
32	1988.4 - 1990.8m	-	35	2.360	1.90	-	"				0.200		0.158		1.035	"
33	1990.8 - 1993.9	-	32	2.270	1.20	-	"				0.180		0.196		1.088	"
34	1993.9 - 1996.9	-	33	2.300	1.20	-	"									
35	2000.0 - 2004.0	-	32	2.260	1.20	-	"				0.170		0.221		0.988	"
36	2009.7 - 2012.2	-	32	2.250	1.10	-	"				0.170		0.227		0.995	"
37	2012.2 - 2014.6m	-	30	2.250	1.10	-	"				0.150		0.229		0.997	"
38	2023.5 - 2024.7m	-	65	2.380	1.60	-	"				0.500		0.118		1.153	"
39	2024.7 - 2026.8m	-	38	2.275	1.20	-	"				0.230		0.206		1.005	"
40	2030.5 - 2031.7m	-	37	2.270	2.00	-	"				0.220		0.206		0.783	"
41	2031.7 - 2032.9m	-	70	2.280	1.50	-	"				0.600		0.170		0.881	"
	-															
	-															
	-															
	-															
	-															
	-															
	-															

BREAM-3 LOG ANALYSIS

The Bream-3 logs have been re-analysed using the HP41CV "LOOKLOG" analysis program. Results of this analysis follow. For comparative purposes, an analysis was also carried out using "REITEROLOG", a computer analysis program. REITEROLOG results were generally found to be in agreement with LOOKLOG results.

LOGS AVAILABLE

A limited suite of logs is available for analysis, and log quality is generally poor. Logs used for analysis purposes were the IES Deep Induction Resistivity, Gamma Ray, and Formation Density Logs. The caliper on the formation Density Log indicates a very thick mud cake, in the order of one inch, through the interval of interest, and hence recorded bulk densities are likely to be lower than they should be. Obviously anomolous bulk density readings were corrected to read in the order of the surrounding values. Several gamma ray peaks through the interval of interest were interpreted to be due to "hot" streaks rather than clay content, and these readings were modified to be representative of estimated shalyness, before being input into the program.

ANALYSIS PARAMETERS

a	0.8
m	2
n	2
Matrix Density	2.65 gm cc^{-1}
Fluid Density	1 gm cc^{-1}
Hydrocarbon Density - gas	0.25 gm cc^{-1}
Hydrocarbon Density - oil	0.7 gm cc^{-1}
Apparent Shale Density	2.5 gm cc^{-1}
Apparent Shale Resistivity	8 ohm m
Gamma Ray minimum	10 API units
Gamma Ray maximum	90 API units
Formation water salinity	40000 NaCleq
Saturation exponent	0.55

SUMMARY

Depth Interval	Thickness	Porosity Range	Average	SW Range	Average	Producible Fluid
1895.3-1896.5m	1.2m	21%		37%		Gas
1897.7-1914.8m	17.1m	19-24%	(23%)	18-27%	(22%)	Gas
1914.8-1920.3m	5.5m	20-24%	(21%)	23-36%	(28%)	Gas
1921.5-1925.1m	3.6m	22%		24%		Gas
1925.1-1926.7m	1.5m	14%		45%		Gas
1926.7-1932.5m	5.8m	19-23%	(21%)	16-31%	(25%)	Gas
1936.7-1940.4m	3.7m	20-21%	(20%)	32-44%	(37%)	Gas
1944-1955.6m	11.6m	23-26%	(24%)	23-48%	(33%)	Oil
1957.4-1962.9m	5.5m	24-28%	(26%)	76-98%		Water
1969.3-1977m	7.7m	22-27%	(23%)	84-100%		Water
1980.3-1983.1m	2.8m	24%		94%		Water
1985.5-1990.1m	4.6m	17-25%	(21%)	77-100%		Water

NET	Gas Column	38.4m
NET	Oil Column	11.6m

NOTE: Low log bulk density readings due to thick mud cake will have given rise to the calculated porosities being too high. The above figures should thus be taken as being optimistic.

T.M. FRANKHAM

18th November 1981

LOG ANALYSIS WORKSHEET (HP 41CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

Rmc = 1.54

WELL BREAM-3

LOG RUN #

DATE NOVEMBER 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER T. FRANKHAM

WELL DATA

TEMPERATURES °F or °C ?	MUD SYSTEM O (oil based) or W (water based)?	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
		155 °F	40 °F	293	6714	63 @ 63° F	0.018 °F/ ft

ANALYSIS PARAMETERS

ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
1	.8	2	2		10	90	2.5	8	2.65			.55
									use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

Rw & FORMATION SALINITY DETERMINATION

KEY G — FROM SP.; KEY H — FROM RATIO Rt/Rxo; KEY I — FROM ARCHIE EQUATION; FROM INDONESIAN EQUATION

Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	FROM SP. Rw	FROM SP. Equivalent Salinity	FROM RATIO Rt/Rxo Rw	FROM RATIO Rt/Rxo Equivalent Salinity	FROM ARCHIE EQUATION Rw	FROM ARCHIE EQUATION Equivalent Salinity	FROM INDONESIAN EQUATION Rw	FROM INDONESIAN EQUATION Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρmac	Φe	Sxo	Sw	Remarks
1	1890.4 - 1892.2	1.8m	35	2.57	7		40000	.25			.313		.03	1	1.55	Non net.
2	1892.2 - 1893.4	1.2m	55	2.38	5.7		"	"			.56		.12	.76	.60	Non net. Minor gas saturation
3	1893.4 - 1895.3	1.9m	55	2.45	5.5		"	"			.56		.08	.87	.77	Non net,
4	1895.3 - 1896.5	1.2m	20	2.18	10		"	"			.13		.21	.58	.37	Gas Productive
5	1896.5 - 1897.7	1.2m	32	2.45	7.2		"	"			.28		.10	.86	.77	Non net.
6	1897.7 - 1900.2	2.5m	25	2.09	25		"	"			.19		.24	.42	.21	Net gas productive sand.
7	1900.2 - 1902.6	2.4m	30	2.14	15		"	"			.25		.23	.49	.27	"
8	1902.6 - 1904.4	1.8m	30	2.08	30		"	"			.25		.24	.39	.18	"
9	1904.4 - 1905	0.6m	15	2.19	33		"	"			.06		.19	.45	.24	"
10	1905 - 1905.9	0.9m	14	2.13	36		"	"			.05		.21	.42	.21	"
11	1905.9 - 1910.5	4.6m	16	2.08	33		"	"			.08		.23	.41	.19	"
12	1910.5 - 1912.9	2.4m	30	2.10	22		"	"			.25		.24	.43	.21	"
13	1912.9 - 1914.8	1.9m	60	2.16	15		"	"			.31		.21	.49	.27	" (Corrected spurious GR pea
14	1914.8 - 1916.6	1.8m	40	2.23	9.5		"	"			.38		.20	.57	.36	Slightly shaly net gas productive sand
15	1916.6 - 1918.1	1.5m	50	2.13	14		"	"			.5		.24	.45	.24	" " "
16	1918.1 - 1920.3	2.2m	40	2.17	20		"	"			.38		.21	.45	.23	" " "
17	1920.3 - 1921.5	1.2m	COAL				"	"			COAL					
18	1921.5 - 1925.1	3.6m	17	2.13	23		"	"			.09		.22	.46	.24	Net gas productive sand
19	1925.1 - 1926.7	1.5m	24	2.34	13		"	"			.18		.14	.64	.45	Low porosity but net gas productive
	-															

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-3

LOG RUN #

DATE NOVEMBER 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER T. FRANKHAM

WELL DATA

TEMPERATURES	MUD SYSTEM	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
°F or °C ?	O (oil based) or W (water based)?	°	°			@ °	° /

ANALYSIS PARAMETERS

ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
									use if ΦN log available		use if no ΦN lg	use if no Rxo lg

Rw & FORMATION SALINITY DETERMINATION

Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	KEY G FROM SP. Rw	Equivalent Salinity	KEY H FROM RATIO Rt/Rxo Rw	Equivalent Salinity	KEY I FROM ARCHIE EQUATION Rw	Equivalent Salinity	FROM INDONESIAN EQUATION Rw	Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo	V shale	ρmac	Φe	Sxo	Sw	Remarks
20a	1926.7 - 1928.2	1.5m	14	2.07	29		40000	.25		.05		.23	.42	.21	Net gas productive sand
20b	1928.2 - 1929.7	1.5m	16	2.08	50		"	"		.08		.22	.37	.16	"
21	1929.7 - 1932.5	2.8m	15	2.2	18		"	"		.06		.19	.52	.31	"
22	1932.5 - 1934.3	1.8m	COAL				"	"		COAL					COAL
23	1934.3 - 1936.7	2.4m	40	2.38	7.5		"	"		.38		.13	.73	.57	Tight shaly sand, probably non net.
24	1936.7 - 1937.9	1.2m	28	2.22	11		"	"		.23		.20	.57	.36	Net gas productive sand.
25	1937.9 - 1939.2	1.3m	15	2.17	14.5		"	"		.06		.21	.54	.32	
26	1939.2 - 1940.4	1.2m	17	2.22	8		"	"		.09		.20	.64	.44	
27	1940.4 - 1942.8	2.4m	40	2.30	8		"	"		.38		.16	.66	.47	Low porosity shaly sand } probably non
28	1942.8 - 1944.0	1.2m	30	2.30	6.5		"	"		.25		.17	.70	.52	Low porosity shaly sand }
29	1944 - 1945.3	1.3m	20	2.2	16		"	.7		.13		.24	.48	.26	Net oil productive sand
30	1945.3 - 1947.1	1.8m	18	2.19	11.5		"	.1		.1		.25	.51	.30	"
31	1947.1 - 1949.5	2.4m	19	2.17	19		"	"		.11		.26	.44	.23	"
32	1949.5 - 1951.4	1.9m	28	2.16	6.5		"	"		.23		.26	.57	.36	"
33	1951.4 - 1953.2	1.8m	20	2.22	10.5		"	"		.13		.23	.54	.33	"
34	1953.2 - 1955.6	2.4m	42	2.22	4		"	"		.40		.23	.67	.48	Net oil productive sand
35	1955.6 - 1957.4	1.8m	80	2.30	1.5		"	"		.88		.16	.93	.87	Non net shale/shaly sand
36	1957.4 - 1959.3	1.9m	25	2.17	1.3		"	"		.19		.28	.86	.76	Water productive sand
37	1959.3 - 1962.9	3.6m	20	2.24	1.1		"	"		.13		.24	.99	.98	Water productive sand
38	1962.9 - 1963.9	1m	COAL							COAL					COAL

LOG ANALYSIS WORKSHEET (HP 41CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-3

LOG RUN #

DATE NOVEMBER 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER T. FRANKHAM

WELL DATA	TEMPERATURES	MUD SYSTEM	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
	°F or °C ?	O (oil based) or W (water based)?	°	°			@ °	° /

ANALYSIS PARAMETERS	ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
										use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

Rw & FORMATION SALINITY DETERMINATION	Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	KEY G FROM SP. Rw	Equivalent Salinity	KEY H FROM RATIO Rt/Rxo Rw	Equivalent Salinity	KEY I FROM ARCHIE EQUATION Rw	Equivalent Salinity	FROM INDONESIAN EQUATION Rw	Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρma c	Φe	Sxo	Sw	Remarks
39	1963.0 - 1965.4	1.5m	.45	2.40	5.6		40000	1			.44		.13	.78	.64	Shale/shaly sand, low porosity
40	1965.4 - 1966.6	1.2m	COAL				"	"			COAL					COAL
41	1966.6 - 1969.3	2.7m	50	2.35	2.5		"	"			.50		.15	.88	.80	Low porosity shaly sand
42	1969.3 - 1971.8	2.5m	14	2.25	.74		"	"			.05		.24	1	1.24	Water productive
43	1971.8 - 1972.7	0.9m	42	2.16	.95		"	"			.40		.27	.91	.84	"
44	1972.7 - 1973.9	1.2m	30	2.25	.91		"	"			.25		.23	1	1.07	"
45	1973.9 - 1975.7	1.8m	20	2.28	1.5		"	"			.13		.22	.96	.93	"
46	1975.7 - 1977	1.3m	48	2.24	1.1		"	"			.48		.22	.95	.91	"
47	1977.0 - 1977.9	0.9m	COAL								COAL					COAL
48	1977.9 - 1978.5	0.6m	60	2.4	6.3		"	"			.63		.11	.74	.57	Shale
49	1978.5 - 1979.4	0.9m	COAL								COAL					COAL
50	1979.4 - 1980.3	0.9m	55	2.33	1.1		"	"			.56		.16	1.00	1.13	Water productive, tight
51	1980.3 - 1983.1	2.8m	17	2.24	1.2		"	"			.09		.24	.97	.94	Water productive
52	1983.1 - 1985.5	2.4m	COAL								COAL					COAL
53	1985.5 - 1986.7	1.2m	38	2.33	1.2		"	"			.35		.17	1.00	1.12	Water productive
54	1986.7 - 1988.5	1.8m	15	2.23	1.7		"	"			.06		.25	.87	.77	"
55	1988.5 - 1990.1	1.6m	30	2.3	1.25		"	"			.25		.20	1	1.04	"
56	1990.1 - 1995.2	5.1m	COAL				"	"			COAL					COAL
57	1995.2 - 1996.2	1m	58	2.28	11		"	"			.60		.19	.52	.31	Water productive?
58	1996.2 - 1998.3	2.1m	COAL				"	"			COAL					COAL

BREAM-4A LOG ANALYSIS

An analysis of wireline log data for the interval 1915 - 2065M of Bream-4A has been carried out using the HP41C "LOOKLOG" analysis program. The analysed interval includes the Bream-4A pay zone (1916 - 1950), that part of the underlying section which would come into the reservoir up dip (1950 - 2025), and approximately 40 metres of further underlying section (2025 - 2065).

LOGS AVAILABLE:

GR, ILD, SFL, MSFL, DLT (LLs & LLd), BHC, LDT & CNL.

NOTE:- The DLT appeared to give anomolous readings through many of the water sand intervals i.e. LLs < LLd < MSFL in a situation where the mud salinity is less than formation water salinities. This anomoly has been tentatively attributed to the effect of very high resistivity shoulder beds (in Bream-4A, the abundant coals) overfocusing the LLd.

LOGS USED:

GR, ILD, MSFL, LDT and CNL.

MSFL readings were multiplied by a factor of 0.8 to allow for mudcake effects, and CNL values corrected for pressure and temperature effects.

ANALYSIS AND SHALE PARAMETERS USED:

a	0.8
m	2
n	2
Matrix density limits	2.65 - 2.665 gm/cc
Fluid density	1.0 gm/cc
Hydrocarbon density - gas	0.25 gm/cc
Hydrocarbon density - oil	0.7 gm/cc
Apparent shale density	2.55 gm/cc
Apparent shale neutron porosity	38%
Apparaent shale resistivity	10 ohm m
Gamma ray minimum	15 API units
Gamma ray maximum	140 API units

SALINITIES:

Apparent formation water salinities were calculated from a number of representative water sands using the standard LOOKLOG options i.e. from SP, from ratioing resistivities and by backing out from the Archie relationship and from the Indonesia shaly sand relationship.

Each technique, except for resistivity ratioing, gives similar apparent formation water salinities when applied to any particular sand. Resistivity ratioing appears to give anomolously high salinities, and for the purposes of this analysis, the technique is ignored.

S.P.,Archie,and Indonesia salinity determinations indicate that formation water salinity is in the order 35000 ppm in the vicinity of pay zone, and that salinities increase with depth, being in the order of 50,000 ppm by 2050m.

For the purposes of this log analysis, a salinity of 35000 ppm was input for the interval 1915 - 2030m, 45000 ppm for the interval 2030 - 2047m, and 50,000 ppm for the interval 2047 - 2065m.

CONTACTS

The Oil-Water contact is clearly defined at 1950m RKB.

The Gas-Oil contact appears to fall within a shale bed which occurs between 1937 and 1938m RKB.

T. FRANKHAM
2nd October 1981

BREAM-4A

LOG ANALYSIS SUMMARY SHEET

Depth Interval	Thickness	V. Shale	Matrix Density	Av. Porosity	Sxo	Sw	Comment
1916 - 1918m	2m	10%	2.65 gm/cc	16%	65%	49%	Gas ↑
1922 - 1923m	1m	22%	2.66 gm/cc	16%	74%	38%	
1923 - 1925m	2m	24%	2.65 gm/cc	25%	51%	7%	
1926.5 - 1930m	3.5m	8%	2.65 gm/cc	20%	73%	12%	
1930 - 1933m	3m	14%	2.64 gm/cc	24%	64%	13%	
1933 - 1935m	2m	18%	2.66 gm/cc	24%	68%	16%	
1935 - 1936m	1m	25%	2.67 gm/cc	24%	63%	22%	↓
1936 - 1937m	1m	30%	2.67 gm/cc	24%	59%	24%	Gas
1938 - 1939.5m	1.5m	12%	2.65 gm/cc	25%	61%	25%	Oil ↑
1942 - 1945m	3m	2%	2.66 gm/cc	22%	65%	21%	
1945 - 1948m	3m	9%	2.67 gm/cc	20%	78%	29%	↓
1948 - 1950m	2m	10%	2.67 gm/cc	24%	75%	31%	Oil
1950 - 1955.5m	5.5m	12%	2.65 gm/cc	23%	90%	90%	Water ↑
1958.5 - 1960.5m	2m	14%	2.64 gm/cc	22%	100%	100%	
1964.5 - 1965.5m	1m	19%	2.64 gm/cc	14%	100%	100%	
1965.5 - 1966.5m	1m	22%	2.65 gm/cc	21%	95%	95%	
1969.5 - 1971.5m	2m	36%	2.65 gm/cc	15%	71%	71% *	
1976 - 1981m	5m	2%	2.64 gm/cc	24%	100%	100%	
1981 - 1984.5m	3.5m	14%	2.65 gm/cc	26%	100%	100%	
1986.5 - 1993.5m	7m	11%	2.65 gm/cc	24%	100%	100%	
1999 - 2000m	1m	3%	2.67 gm/cc	25%	91%	91% *	↓
2001 - 2004.5m	3.5m	10%	2.64 gm/cc	22%	100%	100%	Water

BREAM-4A

LOG ANALYSIS SUMMARY SHEET

Depth Interval	Thickness	V. Shale	Matrix Density	Av. Porosity	Sxo	Sw	Comment
2013.5 - 2015.5m	2m	10%	2.64 gm/cc	23%	100%	100%	Water ↑
2017.5 - 2021m	3.5m	11%	2.65 gm/cc	21%	100%	100%	
2026 - 2027.7m	1.7m	11%	2.65 gm/cc	22%	100%	100%	
2027 - 2029m	1.3m	6%	2.65 gm/cc	18%	100%	100%	
2036 - 2038m	2m	6%	2.64 gm/cc	27%	100%	100%	
2038 - 2039m	1m	16%	2.67 gm/cc	17%	100%	100%	
2044 - 2047m	3m	9%	2.65 gm/cc	23%	100%	100%	
2047 - 2049.5m	2.5m	13%	2.67 gm/cc	25%	100%	100%	
2050.5 - 2052.3	2.3m	7%	2.66 gm/cc	24%	100%	100%	
2059.2 - 2065m	5.8m	15%	2.66 gm/cc	25%	95%	95%	Water

* Apparent low saturations in these water sands probably due to shoulder bed effect of interbedded shale laminations in the sands, on the deep resistivity readings.

2

BREAM-4A

NET - GROSS INTERVAL SUMMARY

SECTION	DEPTH INTERVAL	GROSS THICKNESS	NET THICKNESS	NET:GROSS - %age
Gas Zone	1915 - 1937m	21m	15.5m	74%
Oil Zone	1937 - 1950m	13m	9.5m	73%
OWC - P Asperopolus Marker	1950 - 2025m	75m	37m	49%
Total Analysed Interval	1915 - 2065m	150m	81.6m	54%

TM [signature]
2-10-87

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL BREAM-4A

LOG RUN # 2

DATE SEPTEMBER 1981

SERVICE CO. SCHLUMBERGER

INTERPRETER T. FRANKHAM

WELL DATA	TEMPERATURES °F or °C ?	MUD SYSTEM O (oil based) or W (water based)?	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
			77 °C	10 °C	80m	2426m	.388 @14.4° C	0.029 °C/m

ANALYSIS PARAMETERS	ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L (use if ΦN log available)	ρma - U (use if ΦN log available)	ρma (use if no ΦN lg.)	Z (use if no Rxo)
	1	0.8	2	2	0.38	15	140	2.55	10	2.650	2.665		

KEY G — FROM SP; KEY H — FROM RATIO Rt/Rxo; KEY I — FROM ARCHIE EQUATION; FROM INDONESIAN EQUATION

Rw & FORMATION SALINITY DETERMINATION							FROM SP		FROM RATIO Rt/Rxo		FROM ARCHIE EQUATION		FROM INDONESIAN EQUATION	
Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	Rw	Equivalent Salinity	Rw	Equivalent Salinity	Rw	Equivalent Salinity	Rw	Equivalent Salinity
1953	-20	38	1.6	3.2	2.25	.24	.096	36000	.082	43000	.118	29,000	.118	29,000
1978	-20	25	0.95	2.8	2.25	.20	.095	36000	.055	67500	.070	51,400	.065	56,000
1983	-20	33	1.0	2.9	2.21	.27	.095	36000	.056	66,000	.089	39,000	.092	37,500
1990	-25	42	1.5	1.5	2.25	.24	.086	40000	.061	60,000	.110	30,500	.108	31,000

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo	V shale	ρma c	Φe	Sxo	Sw	Remarks
1	1916 - 1918m	2m	43	2.34	12	.11	35000	.25	11	.1	2.65	.16	.65	.49	
2	1922 - 1923m	1m	43	2.35	17.5	.18	35000	.25	7	.22	2.66	.16	.74	.38	
3	1923 - 25m	2m	38	2.14	200	.21	35000	.25	6.4	.24	2.65	.25	.51	.07	
4	1926.5 - 1930m	3.5m	55	2.265	125	.14	35000	.25	5.6	.08	2.65	.20	.73	.12	
5	1930 - 1933m	3m	55	2.165	70	.17	35000	.25	4.8	.14	2.64	.24	.64	.13	
6	1933 - 1935m	2m	60	2.18	45	.21	35000	.25	4	.18	2.66	.24	.68	.16	
7a	1935 - 1936	1m	43	2.18	23	.24	35000	.25	4.4	.25	2.67	.24	.63	.22	
7b	1936 - 1937	1m	45	2.17	19	.26	35000	.25	4.7	.30	2.67	.24	.59	.24	
8	1938 - 1939.5	1.5m	52	2.195	18	.24	35000	.7	5	.12	2.65	.25	.61	.25	
9	1942 - 1945m	3m	18	2.27	38	.18	35000	.7	6.4	.02	2.66	.22	.65	.21	
10	1945 - 1948m	3m	23	2.31	22	.20	35000	.7	4.8	.09	2.67	.20	.78	~~.28~~ .29	

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL ____________

LOG RUN # ____________

DATE ____________

SERVICE CO. ____________

INTERPRETER ____________

WELL DATA	TEMPERATURES	MUD SYSTEM	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
	°F or °C ?	O (oil based) or W(water based)?	°	°			@ °	° /

ANALYSIS PARAMETERS	ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
										use if ΦN log available		use if no ΦN lg.	use if no Rxo lg.

Rw & FORMATION SALINITY DETERMINATION							KEY G FROM SP		KEY H FROM RATIO Rt/Rxo		KEY I FROM ARCHIE EQUATION		FROM INDONESIAN EQUATION	
Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	Rw	Equivalent Salinity	Rw	Equivalent Salinity	Rw	Equivalent Salinity	Rw	Equivalent Salinity
2048	-50	25	0.8	2.4	2.24	.27	.058	62,000	.053	69,000	.062	58,000	.070	50,000
2051	-40	24	.9	2.7	2.25	.23	.066	53,000	.053	69,000	.066	53,000	.068	51,500
2063	-35	34	.9	2.8	2.23	.27	.071	48,500	.051	72,000	.073	47,500	.077	45,000

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS   KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED   KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	ρH	Rxo		V shale	ρma c	Φe	Sxo	Sw	Remarks
11	1948 - 1950	2m	24	2.24	13.5	.24	35000	.7	3.7		.10	2.67	.24	.75	.31	
12	1950 - 1955.5m	5.5m	38	2.25	1.6	.24	35000	1	3.2		.12	2.65	.23	.90	.90	
13	1958.5 - 1960.5	2m	40	2.27	1.1	.23	35000	1	3.2		.14	2.64	.22	1.0	1.15	
14a	1964.5 - 1965.5	1m	50	2.4	3	.17	35000	1	7		.19	2.64	.14	1.0	1.04	
14b	1965.5 - 1966.5	1m	50	2.28	1.6	.26	35000	1	6.4		.22	2.65	.21	.95	.95	
15	1965.5 - 1971.5	2m	75	2.37	4.5	.27	35000	1	8		.36	2.65	.15	.71	.71	
16	1976 - 1981	5m	25	2.25	.95	.20	35000	1	2.8		.02	2.64	.24	1.0	1.19	
17	1981 - 1984.5	3.5m	33	2.21	1	.27	35000	1	2.9		.14	2.65	.26	1.0	1.03	
18	1986.5 - 1993.5	7m	40	2.24	1	.24	35000	1	3		.11	2.65	.24	1.0	1.11	
19	1999 - 2000	1m	42	2.25	1.5	.24	35000	1	4		.03	2.67	.25	.91	.91	

LOG ANALYSIS WORKSHEET (HP 41 CV)

KEY F TO INPUT WELL DATA AND CALCULATE GG

WELL ____________

LOG RUN # ____________

DATE ____________

SERVICE CO. ____________

INTERPRETER ____________

WELL DATA	TEMPERATURES	MUD SYSTEM	BHT	SBT	WD+KB	TD	Rmf @ T(Rmf)	GG
	°F or °C ?	O (oil based) or W(water based)?	°	°			@ °	° /

ANALYSIS PARAMETERS	ρf	a	m	n	ΦN shale	GR min.	GR max.	ρb shale	R shale	ρma - L	ρma - U	ρma	Z
										use if ΦN log available		use if no ΦN log	use if no Rxo log

Rw & FORMATION SALINITY DETERMINATION	Depth	SP(±)	GR	Rt	Rxo	ρb	ΦN	KEY G FROM SP Rw	Equivalent Salinity	KEY H FROM RATIO Rt/Rxo Rw	Equivalent Salinity	KEY I FROM ARCHIE EQUATION Rw	Equivalent Salinity	FROM INDONESIAN EQUATION Rw	Equivalent Salinity

POROSITY & SATURATION : KEY A TO PERFORM ANALYSIS KEY B IF ANALYSIS PARAMETERS PREVIOUSLY ENTERED KEY C TO REDISPLAY RESULTS

Zone #	Depth Interval	Thickness	GR	ρb	Rt	ΦN	Fm. Salinity	pH	Rxo		V shale	ρma c	Φe	Sxo	Sw	Remarks
20	2001 2004.5	3.5m	35	2.28	1.5	.21	35000	1	4		.10	2.64	.22	1.0	1.01	
	-															
21	2013.5 -2015.5m	2m	43	2.25	1	.23	35000	1	3.3		.10	2.64	.23	1.0	1.14	
	-															
22	2017.5 - 2021	3.5m	33	2.3[illegible]	1.4	.21	35000	1	4		.11	2.65	.21	1.0	1.08	
	-															
23a	2026 - 2027.7	1.7m	36	2.28	1.3	.22	35000	1	3		.11	2.65	.22	1.0	1.06	
b	2027.7 - 2029	1.3m	33	2.35	2	.16	35000	1	5.2		.06	2.65	.18	1.0	1.07	
	-															
24a	2036 - 2038	2m	26	2.19	.7	.245	35000	1	2.2		.06	2.64	.27	1.0	2.0323	
b	2038 - 2039	1m	35	2.35	1.2	.21	45000	1	3.2		.16	2.67	.17	.1	1.23	
	-															
25a	2044 - 47	3m	30	2.26	1.1	.22	45000	1	3.2		.09	2.65	.23	.1	.1	
b	2047 - 49.5	2.5m	25	2.24	.8	.27	50000	1	2.4		.13	2.67	.25	1	1.02	
	-															
26	2050.5 - 2052.3	2.3m	24	2.25	.9	.23	50000	1	2.7		.07	2.66	.24	1.0	1.01	
	-															
.27	2059.2 - 2065	5.8m	34	2.23	.9	.27	50000	1	2.8		.15	2.66	.25	.95	.95	
	-															
	-															

BREAM #5

QUANTITIVE LOG ANALYSIS

The Bream #5 wireline log data has been analysed to provide effective porosity, clay volume, water saturation, Sxo, and hydrocarbon volume data for the interval 1900m - 3300m. Drilling history, mud log data, and wireline formation test data have indicated hydrocarbon accumulations at the top of Latrobe (1933m - 1952m) and intra-Latrobe below 2477m.

Porosities and water saturations were calculated by an iterative technique which converged on a calculated grain density window of 2.65 - 2.67 gm/cc by appropriately incrementing Vcl. The initial Vcl was derived from the GR log, and porosities by crossplotting neutron and density logs and then correcting for clay and hydrocarbon effects. Saturations were computed from the Indonesian Shaly sand relationship. Below 3000m the density log tended to read too low as a result of bad hole conditions. For this interval, sonic porosities were calculated and normalised to density/neutron porosities in non-washed-out hole sections. The minimum of the neutron/density porosity and the normalised sonic porosity was then taken as being the best estimate of porosity below 3000m.

Logs Used

LLD, LLS, MSFL, GR, RHOB, CNL, SONIC, Caliper.
The LLD, LLS, MSFL and CNL logs were all corrected for borehole and environmental effects. An RT "log" was then derived by correcting the LLD for invasion effects.

Analysis Parameters

Apparent shale density and neutron porosity values were derived from density neutron cross plots (Figures #1 & #2) a and m values were derived by plotting log RT versus log Porosity (Pickett plot - Figures #3 & #4).

	1930-1980m	1980-2400m	2400-2650m	2650m-T.D.
a	0.65	-	1.00	1.000
m	2.15	-	2.00	2.014
N	2.00	-	2.00	2.000
Gamma Ray Minimum	20.00	20.00	20.00	20.000
Gamma Ray Maximum	150.00	150.00	145.00	145.000
Apparent Shale Density	2.53	2.60	2.62	2.620
Apparent Shale Neutron Porosity	0.32	0.31	0.31	0.310
Apparent Shale Resistivity	10.00	10.00	10.00	10.000
Formation Water Salinity	28000.00	28000.00	28000.00	28000.000

Saturations were not calculated for the interval 1980-2400m on the basis that no hydrocarbons were present in the interval.

Discussion and Results

Calculated results are presented in the form of a clay, porosity and hydrocarbon fraction of total volume versus depth plot and in the form of a depth, Vcl, Sw, Sxo, porosity and hydrocarbon volume listing at 0.25m increments.

Coals and coal rich shale sequences were set to a bulk density value of 1 gm/cc. In these zones Vcl output was set to 0 and porosity to 0.

In the top of Latrobe hydrocarbon accumulation, RFT sampling has proved low gas at 1937m KB, high oil at 1940m KB and low proved oil at 1951.5 m KB. The log analysis calculates minor hydrocarbons in the top of the next sand below low proved oil, however it is believed that this is due to the failure of the LLD to give correct values in the 0-1.5 ohm.m range in this environment (c.f. Bream #4A where the LLD read 1.5 ohm.m in good porosity water sands where the ILD was reading in the order of 1 ohm.m). The sands below 1965m are believed to be water wet.

Resistivities and hence hydrocarbon saturations are lower in the top of Latrobe gas zone than might be expected. However the formation here is rather shaly - as evidenced by the lack of significant crossover of the density neutron logs. This shaly character will significantly increase irreducible water saturation over that of the cleaner, underlying oil sand.

Intra-Latrobe hydrocarbons are first encountered in the two small gas sands at 2477m and 2488m. These are underlain by an oil bearing sand with an oil water contact at 2498m. Minor hydrocarbons, presumably residual are calculated in sands below this to 2550m. The sand from 2556m to 2563m is gas bearing. Below this the sands again contain residual hydrocarbons as far as a gas bearing sand occuring between 2659m and 2666m. Minor hydrocarbon saturations occur in the sands below this, with oil recovered from a sand at 2692.5m. Good hydrocarbon saturations can be derived for sands occurring in the interval 2810m to 2980m, and gas has been recovered on test from a number of these. Below 3000m calculated porosities are of dubious validity owing to poor hole conditions adversly affecting the density log. However sand porosities appear to be in the 5-10% range. Log analysis does indicate hydrocarbon saturations; however at these low porosities, significant errors are inherent in the saturation relationship, a factor further complicated in this case by the lack of accuracy in calculated porosities. Irrespective of hydrocarbon presence, the interval below 3000m must be considered non net on the basis of lack of porosity.

T.M. FRANKHAM
December 1982

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NET TO GROSS SUMMARY

Interval mKB	Assuming 10% Net/gross cut off		Assuming 15% Net/gross cut off	
	Net to gross	Average Porosity of net interval	Net to gross	Average porosity of net interval
1933-1939	84%	16%	52%	18%
1939-1952	72%	18%	59%	20%
2470-2570	29%	14%	13%	17%
2650-2800	29%	13%	5%	18%
2800-3000	12%	13%	2.5%	16%
	Average Sw of net interval	Average Hydrocarbon volume of net interval	Average Sw of net interval	Average Hydrocarbon volume of net interval
1933-1939	60%	6.9%	54%	8.6%
1939-1952	45%	10.5%	37%	12.2%

APPENDIX 7

APPENDIX VII

RESERVOIR PARAMETERS

APPENDIX VII

RESERVOIR PARAMETERS

	ZONE 1			ZONE 2			ZONE 3			ZONE 4		
	Min	MLC	Max	Min	MLC	Max	Min	MLC	Max	Min	MLC	Max
BLOCK 'A'												
Volume - Gas	18192	21038	27894	13557	15678	20786	5928	6142	8143	3144	3636	4820
(hectare metres) - Oil	3443	3841	4720	4279	4775	5866	3054	3407	4187	2187	2440	2998
Porosity	.20	.22	.24	.19	.21	.23	.22	.24	.26	.20	.22	.24
1-Sw	.78	.82	.86	.74	.77	.80	.77	.79	.81	.73	.75	.77
Net to Gross %	63	64	65	54	66	78	86	93	100	32	44	56
BLOCK 'B'												
Volume - Gas	862	4205	10004	475	2867	5510	81	487	936	3	19	36
(hectare metres) - Oil	1076	2045	3092	1314	2449	3777	328	623	941	212	403	610
Porosity	.20	.22	.24	.19	.21	.23	.22	.24	.26	.20	.22	.24
1-Sw	.78	.82	.86	.74	.77	.80	.77	.79	.81	.73	.75	.77
Net to Gross %	63	64	65	54	66	78	86	93	100	32	44	56

APPENDIX VII CONTINUED

RESERVOIR PARAMETERS

	ZONE 1		
	Min	MLC	Max
BLOCK 'C'			
Volume - Gas	13139	18708	36101
(hectare metres) - Oil	5062	8475	11855
Porosity	.14	.19	.24
1-Sw	.65	.73	.80
Net to Gross %	50	60	70
BLOCK 'D'			
Volume - Gas	5	18	64
(hectare metres) - Oil	312	546	2655
Porosity	.17	.19	.21
1-Sw	.45	.57	.70
Net to Gross % - Gas	50	72	100
- Oil	50	63	76

NOTE: The reservoir section in Blocks 'C', 'D' and 'E' were not subdivided.

RESERVOIR PARAMETERS

	ZONE 1 Min	ZONE 1 MLC	ZONE 1 Max
BLOCK 'E'			
Volume - Gas	-	-	-
(hectare metres) - Oil	136	800	1234
Porosity	.17	.19	.21
1-Sw	.45	.57	.70
Net to Gross %	60	72	100

NOTE: Block 'E' is a separate accumulation from the main Bream field. The reservoir parameters were calculated from Bream-5, with the assumption that Block 'E' is full to a spill point about 11 metres deeper than the Bream field oil-water contact at -1929 metres subsea.

BREAM-5 DEEP HYDROCARBONS

RESERVOIR PARAMETERS

	Minimum	Most Likely	Maximum
UPPER ZONE			
(-2455mss to -2477mss)			
Volume (hectare metres)			
Gas	1114	2714	4313
Oil	559	1255	1951
Porosity	.12	.13	.15
$1-S_w$	.45	.55	.65
Net to Gross	.10	.23	.35
1/Formation Volume Factor			
Gas		1.4	
Oil		0.65	
LOWER ZONE			
(-2670mss to -2697mss)			
Volume (hectare metres)			
Oil	946	1707	2707
Porosity	.12	.13	.14
$1-S_w$	.25	.30	.65
Net to Gross	.20	.30	.40
1/Formation Volume Factor			
Oil		0.65	

MSTB/Hectare Metre = 0.0628981

Doc. 0145L

APPENDIX 8

APPENDIX VIII

SUMMARY OF RESERVOIR FLUID PROPERTIES

E. RESERVOIR FLUID PROPERTIES

COMPONENT	MOL PERCENT			
	GAS		OIL	
	Bream	Bream-4A	Bream-2	Bream-5
HYDROGEN SULPHIDE	Nil	Nil	Nil	Nil
CARBON DIOXIDE	1.80	0.86	1.91	1.49
NITROGEN	0.92	0.70	0.23	0.35
METHANE	81.32	81.17	37.39	44.29
ETHANE	6.64	7.05	6.63	6.25
PROPANE	4.17	4.71	6.40	5.68
iso-BUTANE	0.73	0.86	1.41	1.35
n-BUTANE	1.48	1.49	3.65	2.77
iso-PENTANE	0.41	0.57	1.53	1.18
n-PENTANE	0.54	0.50	1.94	1.65
HEXANES	0.68	0.29	4.37	1.09
HEPTANE	0.86	0.28	7.01	5.89
OCTANES	0.23	0.60	3.64	4.83
NONANES	0.16	0.34	4.15	3.69
DECANES PLUS	0.06	0.52	20.74	19.49
	100.00	100.00	100.00	100.00

Viscosity at Reservoir T & P

Gas	0.019	centipoise
Oil[1]	0.29	centipoise

Saturation Pressure at Reservoir T

Gas (dew point)	unknown	psig
Oil (bubble Point)[1]	2737	psig

Density at Reservoir T & P

Gas	0.171	gm/cc
Oil[1]	0.625	gm/cc

Revised: January 1983

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F. FLUID PROPERTIES AT SURFACE CONDITIONS

Gas/Oil Ratio (after stabilization)	985	SCF/STB
Formation Volume Factor (Res. Vol/Surface Vol.)		
Gas	1.002	Res.Bbls/kSCF
Oil (PVT separator tests)	1.64	Res.Bbls/STB
Oil (after stabilisation)	1.55	Res.Bbls/STB
Shrinkage Factor (2% C4-) est.	1.315	Metered PLB/STB
Stabilised Crude Properties		
Oil Gravity	44.3	°API
Pour Point (Bream-2)	45	°F
Wax Content (Bream-2)	3.74	percent by wt.
Sulphur Content (Bream-2)	0.16	percent by wt.

G. PROCESS YIELD[2]

Gas Cap (Per unit of wet gas produced)		
Dry Gas (1038 Btu/SCF)	0.8858	SCF/SCF
Ethane Product (1793 Btu/SCF)	0.0246	SCF/SCF
Propane Product (3791 kBtu/Bbl)	22.9	Bbl/million SCF
Butane Product (4277 kBtu/Bbl)	16.6	Bbl/million SCF
Condensate (4857 kBtu/STB)	30.4	STB/million SCF
Oil		
Dry Gas (1092 Btu/SCF)	737.5	SCF/STB
Ethane Product (1812 Btu/SCF)	40.6	SCF/STB
Propane Product (3807 kBtu/Bbl)	0.0597	Bbl/STB
Butane Product (4271 kBtu/Bbl)	0.0476	Bbl/STB
Crude (5217 kBtu/STB)	0.6446	STB/Res.Bbl

Notes:

1. Gas data derived from Bream-4A gas sample PVT analysis
   Oil data derived from Bream-5 oil sample PVT analysis except where shown.

2. Process yields derived from Bream-2 sample analysis to be consistent with 1982 year end reserves. These will be updated at the next reserves update.

January 1983

(3090f68)

PE804540

Enclosure 1

GEOLOGICAL CROSS SECTION A-A'

PE804541

Enclosure 1A

Diagrammatic well correlation

Enclosure 2

PE804543

Structure Enclosure 3 Map

Top of Latrobe Group.

PE804544

TWT Map **Enclosure 4**

Top of Latrobe coarse clastics

PE804545

Depth Map Enclosure 5

Top of Latrobe Group Coarse clastics

PE804546

Depth Map Enclosure 6

Top of Latrobe Group Coarse Clastics

PE804547

Depth Map Enclosure 7

Top of Latrobe Group Coarse Clastics

PE804548

Tree Ave. Enclosure 8.

Velocity map top of Latrobe Group

PE804549

Trere Aver Enclosure 9

Velocity top of Latrobe Group