APPENDIX 6 FROM WCR
SIDEWALL CORE DESCRIPTION
BOGGY CREEK - 1
W1053.

APPENDIX-6

Sidewall Core Description

AMDEL SIDEWALL
CORE DESCRIPTION

AMDEL CORE SERVICES

3 March 1992

Gas and Fuel Exploration NL
GPO Box 1841Q
MELBOURNE VIC 3001

Attention: Val Akbari

REPORT: 009/1483

CLIENT REFERENCE:	REF: 23/VA:gk/M036
MATERIAL:	Sidewall Core Samples
LOCALITY:	Boggy Creek-1
WORK REQUIRED:	Source Rock Analysis

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

Brian Watson

BRIAN L WATSON
Laboratory Supervisor
on behalf of Amdel Core Services Pty Ltd

1. INTRODUCTION

Ten (10) samples were received for TOC analysis and Rock-Eval pyrolysis. This report is a formal presentation of results which were forwarded by facsimile on 6 and 11 February 1992.

2. ANALYTICAL PROCEDURES

2.1 Sample Preparation

Samples (as received) were ground in a Siebtechnik mill for 20-30 seconds.

2.2 Total Organic Carbon (TOC)

Total organic carbon was determined by digestion of a known weight (approximately 0.2 g) of powdered rock in HCl to remove carbonates, followed by combustion in oxygen in the induction furnace of a Leco IR-12 Carbon Determinator and measurement of the resultant CO_2 by infra-red detection.

2.3 Rock-Eval Pyrolysis

A 100 mg portion of powdered rock was analysed by the Rock-Eval pyrolysis technique (Girdel IFP-Fina Mark 2 instrument; operating mode, Cycle 1).

2.4 Organic Petrology

Representative portions of each sample (crushed to -14+35 BSS mesh) were obtained with a sample splitter and then mounted in cold setting Glasscraft resin using a 2.5 cm diameter mould. Each block was ground flat using diamond impregnated laps and carborundum paper. The surface was then polished with aluminium oxide and finally magnesium oxide.

Reflectance measurements were made with a Leitz MPV1.1 microphotometer fitted to a Leitz Ortholux microscope and calibrated against synthetic standards. All measurements were taken using oil immersion (n = 1.518) and incident monochromatic light (wavelength 546 nm) at a temperature of 23±1°C. Fluorescence observations were made on the same microscope utilising a 3 mm BG3 excitation filter, a TK400 dichroic mirror and a K510 suppression filter.

3. RESULTS

TOC and Rock-Eval data are listed in Table 1. Figure 1 is a plot of T_{max} versus Hydrogen Index illustrating kerogen Type and maturity. Table 2 lists recalculated T_{max} values.

FIGURE 1

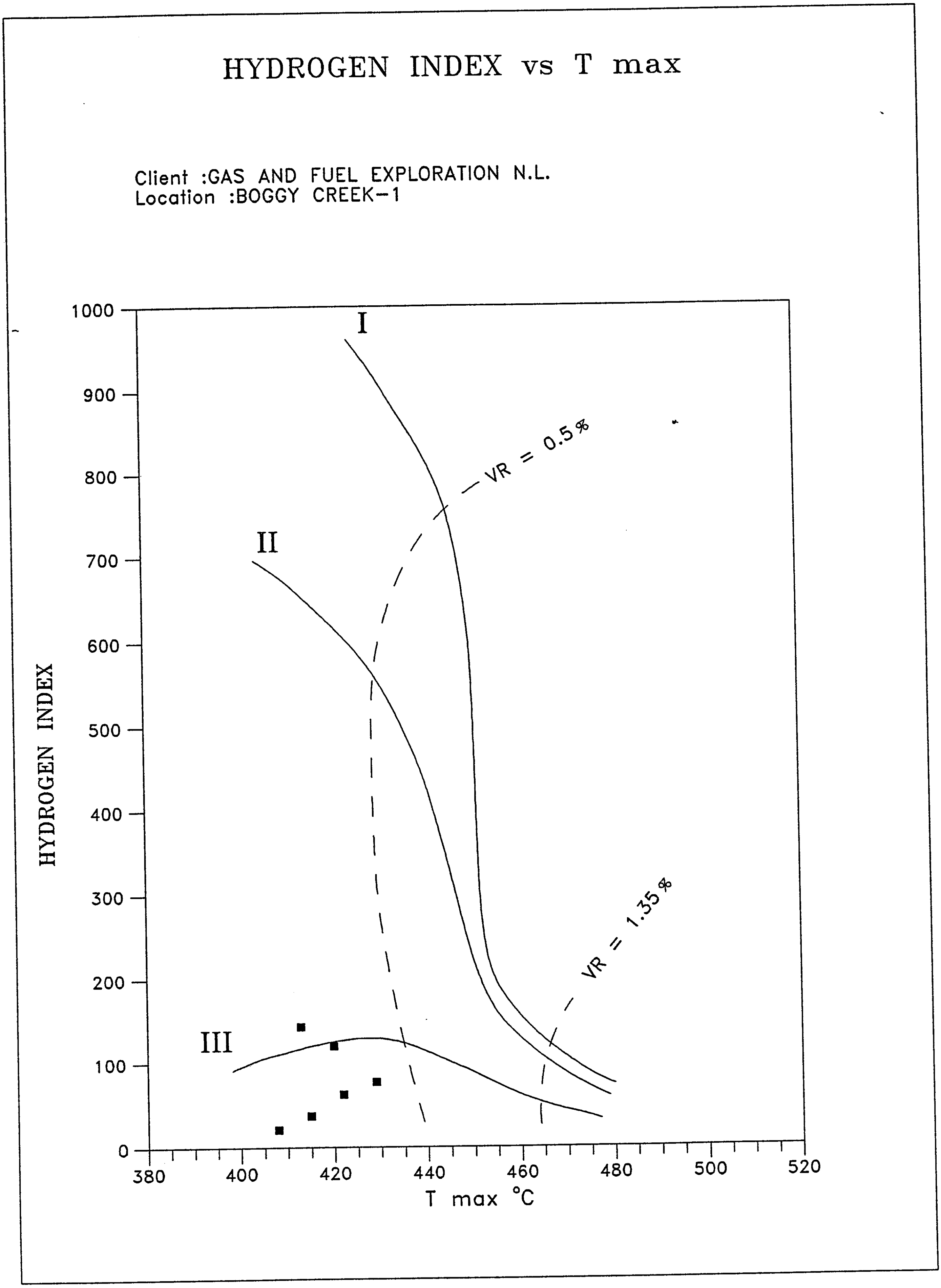
HYDROGEN INDEX vs T max
Client :GAS AND FUEL EXPLORATION N.L.
Location :BOGGY CREEK-1
HYDROGEN INDEX
T max °C
I
II
III
VR = 0.5%
VR = 1.35%
1000
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
520

TABLE 2

RECALCULATED T_{MAX} VALUES

Sample Depth (m)	T_{max} (°C)
1109	408
1579	415
1816	413

4. INTERPRETATION

4.1 Maturity

T_{max} values indicate that the sediments studied are all immature for the generation of liquid hydrocarbons (VR_{EQUIV} <0.4 approximately).

High production indices (P.I. >2.0; Table 1) suggest the presence of migrated hydrocarbons in samples from the following depths: 1109, 1579 and 1816 m. T_{max} values for these samples are likely to be depressed by the presence of these hydrocarbons.

Both the T_{max} value and the Production Index for the sample at depth 914.5 m are unreliable due to the very small S_2 peak.

Note that if further clarification of the maturity of this section is required the sample at depth 1722.5 m would be suitable for vitrinite reflectance analysis.

4.2 Source Richness

Organic richness ranges from poor to good in these samples (TOC = 0.09 - 5.85%; Table 1). Over the depth range 857 to 1722.5 m organic richness is generally fair, whilst below this depth range, organic richness is consistently poor.

Source richness for the generation of hydrocarbons is poor for all of the samples studied ($S_1 + S_2$ = 0.14 - 1.70 kg of hydrocarbons/tonne; Table 1), with the exception of the sample from 1722.5 m depth. This sample has good source richness ($S_1 + S_2$ = 7.70 kg of hydrocarbons/tonne; Table 1).

4.3 Kerogen Type and Source Quality

Hydrogen Index and T_{max} values (Table 1, Figure 1) indicate that these sediments contain organic matter which have bulk compositions ranging from Type III to Type IV kerogen.

Q.F.E SIDEWALL
CORE DESCRIPTION

(Ref:23/AT:gk/K428)

SIDEWALL CORE DESCRIPTION
BOGGY CREEK #1

NO.	DEPTH (m)	REC. mm.	DESCRIPTION
1	1878m	-	No Recovery
2	1856m	17	**Siltstone:** very light grey, soft-firm, moderately argillaceous, common-abundant lithics, rare carbonaceous detritus, grading in part to a very fine Sandstone.
3	1836m	15	**Claystone:** light-medium grey, soft, dispersive, common lithics, trace fine carbonaceous detritus, interlaminated with **Siltstone:** as per SWC #2.
4	1826m	35	**Sandstone:** medium green grey, friable-firm very fine, sub rounded, well sorted, multi coloured volcanoliths & minor quartz, rare partially altered feldspar, abundant dispersive argillaceous matrix, non-very poor visual porosity, no oil fluor, in part grading to **Siltstone:** as per SWC #2.
5	1816M	25	**Siltstone:** generally as SWC #2, dominantly medium brown grey.
6	1772m	25	**Siltstone:** as per SWC #2, interbedded & Interlaminated **with; Sandstone:** medium green grey, firm, hard in part, very fine-medium, dominantly fine, subangular-sub rounded, fairly sorted, abundant kaolinitic and occasional chloritic argillaceous matrix, poor visual porosity, no shows.
7	1722.5m	35	**Claystone:** very dark grey-very dark brown grey, firm-hard, occasionally soft, very dispersive, blocky, interlaminated with **Carbonaceous Claystone:** which in turn grades to **Coal:** black, firm, moderately argillaceous, dull luster.
8	1715m	15	**Siltstone:** light brown grey, firm-soft, very argillacous, abundantly arenaceous with banks of **Dolomite:** medium brown grey extremely hard, cryptocrystalline, no visual porosity.
9	1693m	22	**Sandstone:** medium grey, occasionally off white to transluscent, firm-friable, fine, subangular-subrounded, well sorted, common-abundant kaolinitic and other argillaceous matrix, trace fine carbonaceous detritus, fair-poor porosity, interlaminated with, **Claystone:** medium brown grey, soft, dispersive, trace lithics.

SIDEWALL CORE DESCRIPTION
BOGGY CREEK #1

NO.	DEPTH (m)	REC. mm.	DESCRIPTION
10	1683m	-	No Recovery
11	1675m	20	**Sandstone:** medium grey, friable, medium-very coarse pebbly in part, dominantly medium-coarse subangular-subrounded, trace dispersive clay matriz, rare disseminated cryptocrystalline pyrite, very good porosity. **NB: Gas extracted from the SWC bottle & injected into the chromatograph, gave 15ppm C1.**
12	1668m	0.5	**(Recovery not acceptable)** **Calcareous Sandstone:** off white to very light yellow orange, friable, fine-med, subangular-subrounded, well sorted, abundant calcarous clay matrix, very good porosity, interbedded with SIltstone: medium-dark grey, hard-very hard blocky, extremely calcareous, rare lithics.
13	1579m	27	**Claystone:** dark green grey, firm, hard in part, abundant fine-medium glauconite pellets, rare fine mica & detrital carbonaceous matter.
14	1487m	25	**Claystone:** dark grey, firm, blocky, commonly argillaceous, trace very fine carbonaceous detritus.
15	1343m	25	**Sandstone:** light-medium grey, friable-firm, very fine-fine, subangular-subrounded, dominantly subrounded, well sorted, common abundant silty clay matrix, rare lithics & carbonaceous detritus, poor porosity, no shows.
16	1247m	30	**Sandstone:** medium grey, friable, fine, subangular-subrounded, well sorted, rare dispersive argillaceous matrix, rare fine mica & carbonaceous flakes, fair-good porosity, no shows.
17	1193m	35	**Sandstone:** as per SWC #16 with traces medium grey-green grey lithics, poor-fair porosity, no shows.
18	1109m	22	**Claystone:** medium-dark grey-brown grey, firm, dispersive in part, commonly silty, moderately carbonaceous, rarely micaceous.
19	981.5m	35	**Claystone:** dark brown grey, dark green grey in part, firm, blocky in part, commonly silty, rarely-moderately arenaceous, rare mica, trace dark grey-green lithics, rarely carbonaceous.

SIDEWALL CORE DESCRIPTION
BOGGY CREEK #1

NO.	DEPTH (m)	REC. mm.	DESCRIPTION
20	939.5m	27	**Sandstone:** light-medium brown, friable, fine-coarse, dominantly medium, subangular-subrounded poor-fairly sorted iron stained quartz, no apparent matrix, good-very good porosity, no shows.
21	931m	32	**Sandstone:** medium-dark brown grey, friable, fine-medium with occasional rounded pebble, subangular-subrounded, fairly sorted, partially iron stained quartz, trace-rare medium brown grey argillaceous matrix, good porosity, no shows.
22	914.5m	35	**Pebbly Clayed Sandstone:** dark brown to dark grey brown, firm, grains consisit of medium-coarse iron stained quartz pebbles & abundant medium pebble sized iron oxide/hydroxide pellets, abundant chamositic and limonitic clay matrix, non-poor porosity, no shows.

NB: SWC #22 appears to belong to an unconformity surface and/or part of a lateritic provile.

NO.	DEPTH (m)	REC. mm.	DESCRIPTION
23	857m	40	**Claystone:** dark brown-dark brown grey, firm, blocky in part, moderately micaceous, rarely silty, rarely carbonaceous.
24	753m	40	**Claystone:** medium-dark brown grey in part, firm, blocky in part, rarely carbonaceous & micaceous moderately silty in part grading to **Siltstone:** medium-dark brown, firm, blocky in part & interlaminated with; **Sandstone:** light grey, friable-firm, very fine-fine subangular-subrounded, well sorted, minor clay matrix, poor porosity, no shows.

A. Tabassi
07/01/92

ISOTOPIC ANALYSIS

ISOTOPIC ANALYSIS OF GAS FROM BOGGY CREEK -1 WELL OTWAY BASIN

by

B.J. BURNS

JULY 1992

REPORT NO. JET0165-02

JOHNSTONE ENVIRONMENTAL TECHNOLOGY
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ISOTOPIC ANALYSIS OF GAS FROM THE BOGGY CREEK -1 WELL OTWAY BASIN

Introduction

Two gas samples were recovered from the Waarre Formation in the Boggy Creek -1 well, DST 1662-1673m, and were analysed for their molecular and isotopic composition. The isotopic analyses were carried out by the CSIRO's Division of Exploration Geoscience at North Ryde and the molecular composition was determined at Gas & Fuel's own laboratory. The results are set out in Table 1.

Both gas samples were characterised by an extremely high content of carbon dioxide (> 85%) and in order to analyse the C_3-C_4 hydrocarbon components it was necessary to preconcentrate the samples by passing the gas through a solution of potassium hydroxide (KOH) to absorb and remove the carbon dioxide and then concentrate the hydrocarbon components on Porapak prior to preparative gas chromatographic separation and isotopic analysis. CSIRO carried out a comparison run on one of the samples with no carbon dioxide absorption in order to check for possible isotopic fractionation during the potassium hydroxide step and it should be noted that there was a 0.2‰ decrease in the ethane value and a 0.3‰ increase for propane. This variation is of some concern because the maturity calculation used below is sensitive to small variations in the isotopic values. However, given the very small amount of C_2-C_4 hydrocarbons present in the Boggy Creek gas, some preconcentration is necessary, and this may be the best that can be expected with these samples.

In Table 1 the hydrocarbon components have also been separately normalised to remove the dominating effects of the non-hydrocarbon fraction.

RESULTS

If only the hydrocarbon components are considered, both of the Boggy Creek gases are only moderately 'wet' with just under 2% of C_2-C_4 components. However, the presence of heavier hydrocarbons up to hexane and heptane is an encouraging indication that the source rocks are capable of generating other oily components.

Using the method developed by James (1983), the relative separation between the carbon isotope values of adjacent hydrocarbon components has been measured, and then "fitted" to the plot in Figure 1. [For the second Boggy Creek gas the average of the two runs has been used.] From this plot, it is evident that both of the Boggy Creek gas samples have a 'best fit' corresponding to a maturity level equivalent to a vitrinite reflectance of Rv = 0.84-0.85%, that is, in the early generation phase.

However, it is also evident that for both samples the ethane and propane isotopic values are unusually close. In a 'normal' gas there is a gradual decrease in isotopic value from methane to butane but in Boggy Creek -1 the propane value is actually greater than that for ethane. This type of reversal has been observed in other gases that have undergone some degree of bacterial degradation, whereby the bacteria preferentially attack the various n-alkanes (particularly the propane and butane) and, in so doing, cause a shift in the carbon isotopic values. The most common requirements for bacterial degradation to occur in a reservoir are (i) a reservoir temperature less than 75-80°C and, (ii) an influx of meteoric water to bring the bacteria into contact with the hydrocarbons and to provide dissolved oxygen. In the case of the Waarre reservoir in the Boggy Creek structure, the DST temperature was 68.3°C and the formation water. (from logs) is moderately saline (approx. 18,000 ppm chloride). The true reservoir temperature is expected to be slightly higher than 68.3°C because rapid expansion of the gas during testing would tend to cool the borehole in the vicinity of the reservoir. Hence the true reservoir temperature is likely to be right on the borderline for present-day biodegradation but would indicate that degradation could have occurred in the past when the reservoir temperature was lower. The molecular composition data (Table 1) indicate that biodegradation has NOT been extensive (if at all) because the Normal-Butane and Normal-Pentane components are still present in equal or greater quantities than their corresponding Iso- forms (bacteria preferentially attacking the Normal- alkanes).

The carbon dioxide isotopic value ($\delta^{13}C$ = -6.4‰) is typical of gas which has been derived from volcanic origin or the thermal decomposition of carbonates deep within the crust. The presence of moderate amounts of helium (0.09-0.12 %) would also support an igneous origin for these non-hydrocarbon gases. Given the proximity of the Late Tertiary Newer Volcanics, and the presence of the deeply penetrating Boggy Creek Fault, it is almost certain that the carbon dioxide and hydrocarbon components of the gas have been derived from <u>different</u> sources and have migrated independently into the Boggy Creek structure. On the current data, it is not possible to say which gas migrated into the structure first.

Conclusions

1. Assuming that the isotopic values, as measured, have not been unduly effected by fractionation during the preconcentration step, the maturity of the Boggy Creek -1 gas is equivalent to a virtinite reflectance level of Rv = 0.84-0.85 % which is in the early maturation stage.

2. The carbon dioxide is not from the same source as the hydrocarbons and has most likely been derived from the Late Tertiary volcanics.

3. The hydrocarbon fraction of the gas is only moderately 'wet' although the presence of hydrocarbon components greater than hexane is an indication that the higher molecular weight oily components are being generated.

References

JAMES, A.T., 1983. Correlation of natural gas using the carbon isotopic distribution between hydrocarbon components. AAPG Bulletin, 67, 1176-1191.

Table 1

Molecular and Isotopic Analysis
Boggy Creek -1, DST 1662-1673m

Component	Sample 1 RLT-C-012 Concentration Mole %	Normalised HC %	Sample 2 RST-C-004 Concentration Mole %	Normalised HC %	Sample 2 RST-C-004 Repeat
Methane	9.03	97.89	10.9	98.30	
Ethane	0.14	1.52	0.146	1.32	
Propane	0.032	0.35	0.028	0.25	
Iso-Butane	0.004	0.04	0.003	0.03	
Normal-Butane	0.006	0.07	0.004	0.04	
Iso-Pentane	0.001	0.01	0.001	0.01	
Normal-Pentane	0.001	0.01	0.001	0.01	
Hexanes	0.003	0.03	0.001	0.01	
Heptanes +	0.008	0.09	0.005	0.05	
Carbon Dioxide	88.70		86.10		
Oxygen + Argon + Nitrogen	2.00		2.60		
Helium	0.09		0.12		
ISOTOPE RESULTS					
Methane δ13C (PDB)	-35.6		-35.4		
Ethane δ13C (PDB)	-22.8		-22.8		-23.0*
Propane δ13C (PDB)	-23.0*		-22.8*		-22.5*
Normal-Butane δ13C (PDB)	-21.1*		-20.9*		
Carbon Dioxide δ13C (PDB)	-6.4		-6.4		
Carbon Dioxide δ18O (SMOW)	-11.7		-13.3		

* = Preconcentrated through KOH to remove carbon dioxide

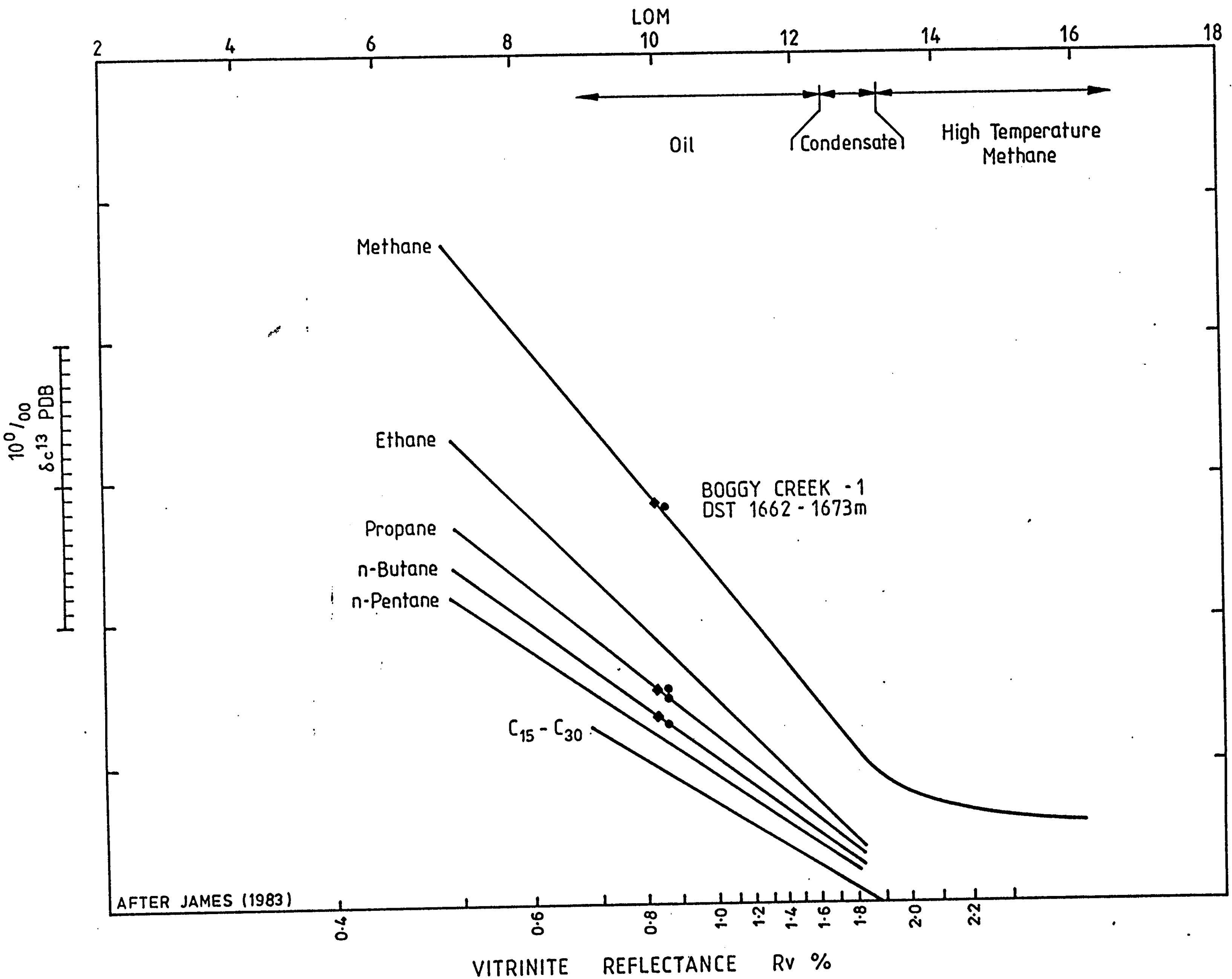

FIGURE 1 GAS ISOTOPE MATURITY - BOGGY CREEK -1 WELL, OTWAY BASIN