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April 1980

RKER 80.045
EVALUATION OF SOURCE ROCK PROPERTIES OF
SEDIMENTS PENETRATED BY WELL
NARIMBA - 1, AUSTRALIA

by
TH.E. FELDER



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may be placed on open file after 26 August 1980
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ORR

KONINKLIJKE / SHELL EXPLORATIE EN PRODUKTIE LABORATORIUM
RIJSWIJK, THE NETHERLANDS

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SEDIMENTS PENETRATED BY WELL

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Investigation

95.14.74

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KONINKLIJKE / SHELL EXPLORATIE EN PRODUKTIE LABORATORIUM
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I INTRODUCTION

A source rock evaluation study has been carried out on a suite of cutting samples from the Australian well Narimba - 1 (offshore Tasmania, Bass Basin).

The location of this well is shown on a sketch map on figure 1.

The samples, covering the interval 5000 - 10 930 ft, are mainly of Eocene age (Eastern View Group and "Upper Eocene Shale").

Source rock evaluation commonly comprises determination of:

1. the presence (or absence) of hydrocarbons source material in the rock samples;
2. the quality of the organic matter as well as the distribution of its specific constituents;
3. the degree of organic metamorphism (= level of maturity).

A source rock is identified by measuring the amount of temperature reactive ("live") organic matter present, i.e. the amount of organic matter that yields hydrocarbons upon pyrolysis. The method excludes any ("dead") organic matter such as inertinites.

In addition, the total organic carbon content can be determined which gives the sum of "live" and "dead" organic carbon. Rocks containing less than 0.5 % organic carbon are not considered to have a potential for commercial oil accumulations.

The source rock indications (SRI), which are a measure of the amount of pyrolysable organic matter, are determined on the original samples and in certain cases also after extraction with organic solvents. A systematically lower value after extraction is due to the presence of extractable hydrocarbons. These may consist of trapped oil, oil generated in situ by a source rock, or e.g. gasoil used in the drilling fluid.

In general, samples with source rock indications of 30 or less do not represent (immature or mature) source rocks. Values between 30 and 100 generally indicate marginal source rocks, while values above 100 commonly indicate good source rocks.

Intervals or samples with high source rock indications are investigated under a microscope to ensure that the high values indicate genuine source rock properties and are not due to contaminants of an organic nature such as lost circulation material.

The quality of a source rock for oil/gas generation depends on the type of organic matter present. Five categories of organic matter can be distinguished, viz.: humic, mainly humic, mixed, mainly kerogenous, kerogenous. This classification

is based on the hydrogen content of the organic matter.

Source rocks with organic matter of kerogenous, mainly kerogenous and/or mixed type generate predominantly oil. Organic matter of humic type generates gas only. Strata with organic matter of mainly humic quality generate either gas, or gas and oil.

In addition to the type and the concentration of the organic matter, the source rock quality is also characterised by the distribution of the typical organic constituents, or macerals¹, in the sediments. The maceral distribution can be used to further qualify the source rock, especially when mainly humic quality is found. For this purpose a microscopic investigation on polished rock fragments is carried out.

The maturity of source rocks is expressed in terms of degree of organic metamorphism. With increasing degree of organic metamorphism the organic matter is gradually carbonised while generating hydrocarbons. With increased carbonification the light reflectance of vitrinite, one of the coal macerals, increases. The degree of organic metamorphism can be assessed by measuring this reflectance.

- 1) maceral: an organic constituent which can be recognised with the microscope (with objectives 25x to 50 x).

II RESULTS

The analytical results are tabulated in table I and are shown as well on the geochemical log (enclosure 1). They may be commented as follows:

a) Source rock indications (SRI)

From the samples 5000 - 6000 ft only insignificant or very marginal SRI values were obtained.

The samples 6050 - 10 930 ft show genuine SRI values, mainly larger than 200 units (often even >900 units). From the following samples only marginal SRI values (that is below 100 units) were obtained: samples 6850, 9150, 10 000, 10 050 and 10 550 ft.

b) Type of organic matter

The type of organic matter of the interval with high SRI values was determined as "mainly humic".

c) Organic carbon content

The high organic carbon contents (up to approx. 39 % in sample 9300 ft) reflect the lithology with abundant coals and coaly shales.

d) Maceral descriptions

Sample 6050 ft: Few SOM; (sapropelic organic matter);
Vitrinite common;
Few sporinite and liptodetrinite;
Rare resinite;
Rare sclerotinite and fusinite;
Micrinite common.
Vitrinite grades into SOM.
SOM partly converted.

Sample 6300 ft: SOM common;
Abundant vitrinite;
Few sporinite;
Rare cutinite and resinite;
Liptodetrinite common;
Few exsudatinite;
Rare sclerotinite and fusinite.
Vitrinite grades into SOM.
SOM partly converted.

- Sample 7050 ft: Few SOM;
Abundant vitrinite;
Sporinite and liptodetrinite common;
Few resinite;
Rare cutinite;
Rare sclerotinite and fusinite;
Micrinite common.
Vitrinite grades into SOM.
SOM partly converted.
- Sample 8150 ft: SOM common;
Abundant vitrinite;
Few sporinite, resinite and liptodetrinite;
Rare cutinite;
Few exsudatinite;
Rare sclerotinite and fusinite;
Micrinite common.
Vitrinite grades into SOM.
SOM partly converted.
- Sample 9210 ft: SOM common;
Vitrinite common;
Rare sporinite and liptodetrinite;
Few exsudatinite;
Rare fusinite;
Micrinite common;
Vitrinite grades into SOM.
SOM partly converted.
- Sample 10580 ft: SOM common;
Abundant vitrinite;
Micrinite common.
Vitrinite grades into SOM.
SOM completely converted.

All the samples are severely oxidised, probably due to drying of the sample material at too high temperatures in the area.

e) Vitrinite reflectance measurements

As the vitrinite particles are partly oxidised the reflectance measurements mentioned below are rather too high.

Sample 6050 ft	VR = 0.57 ± 0.05
6300 ft	0.56 ± 0.03
7050 ft	0.55 ± 0.04
9210 ft	0.67 ± 0.04
10580 ft	0.85 ± 0.08

Sample 8150 ft does not contain any suitable vitrinite.

III DISCUSSION AND CONCLUSIONS

High source rock indications and considerable organic carbon contents indicate the presence of source rocks in the interval 6050 - 10930 ft.

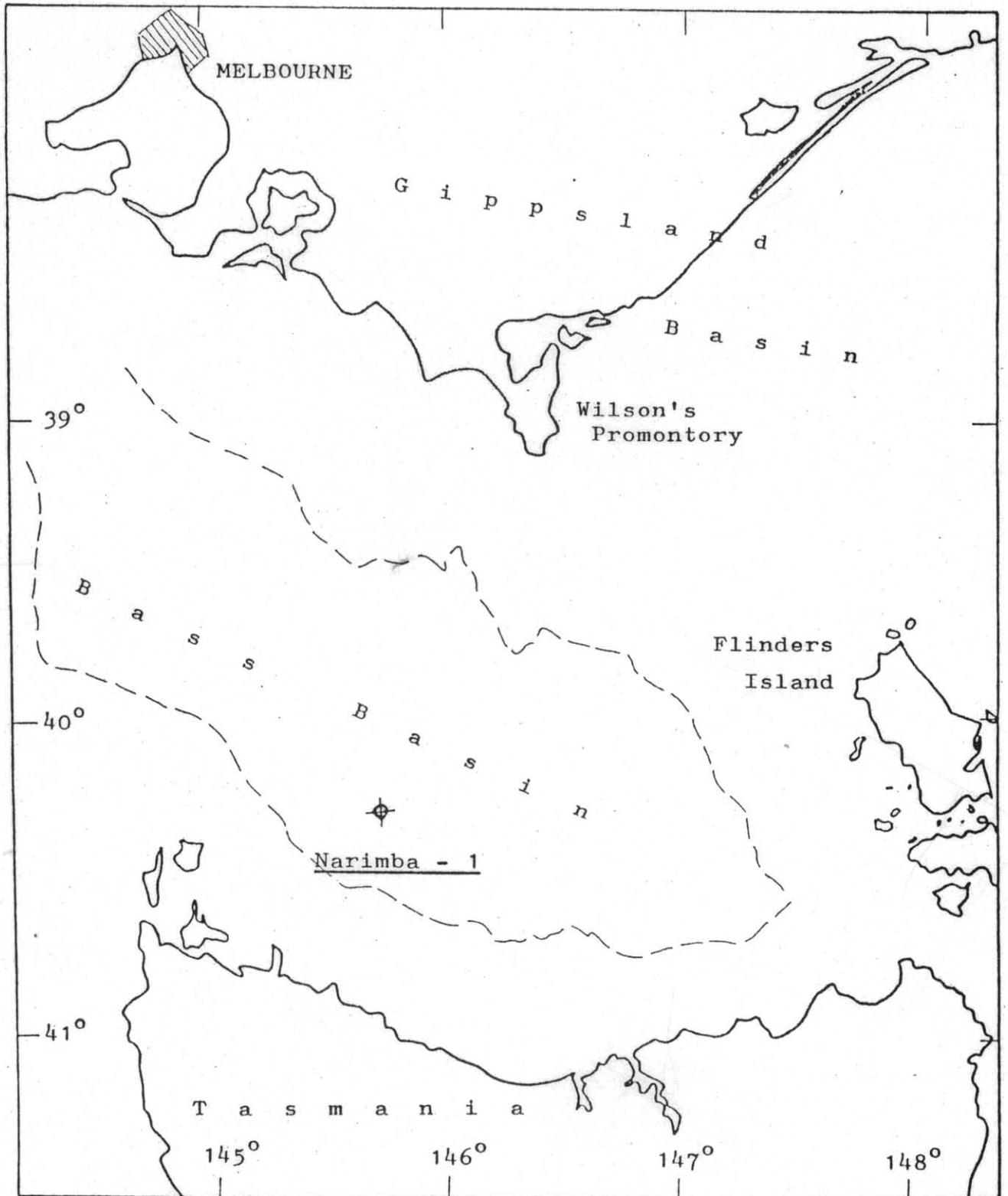
The type of organic matter ("mainly humic") reflects the maceral composition with vitrinite and sapropelic organic matter as its major components.

This composition enables the generation of gas and oil. The best oil source rock material was found in samples 8150 and 10580 ft.

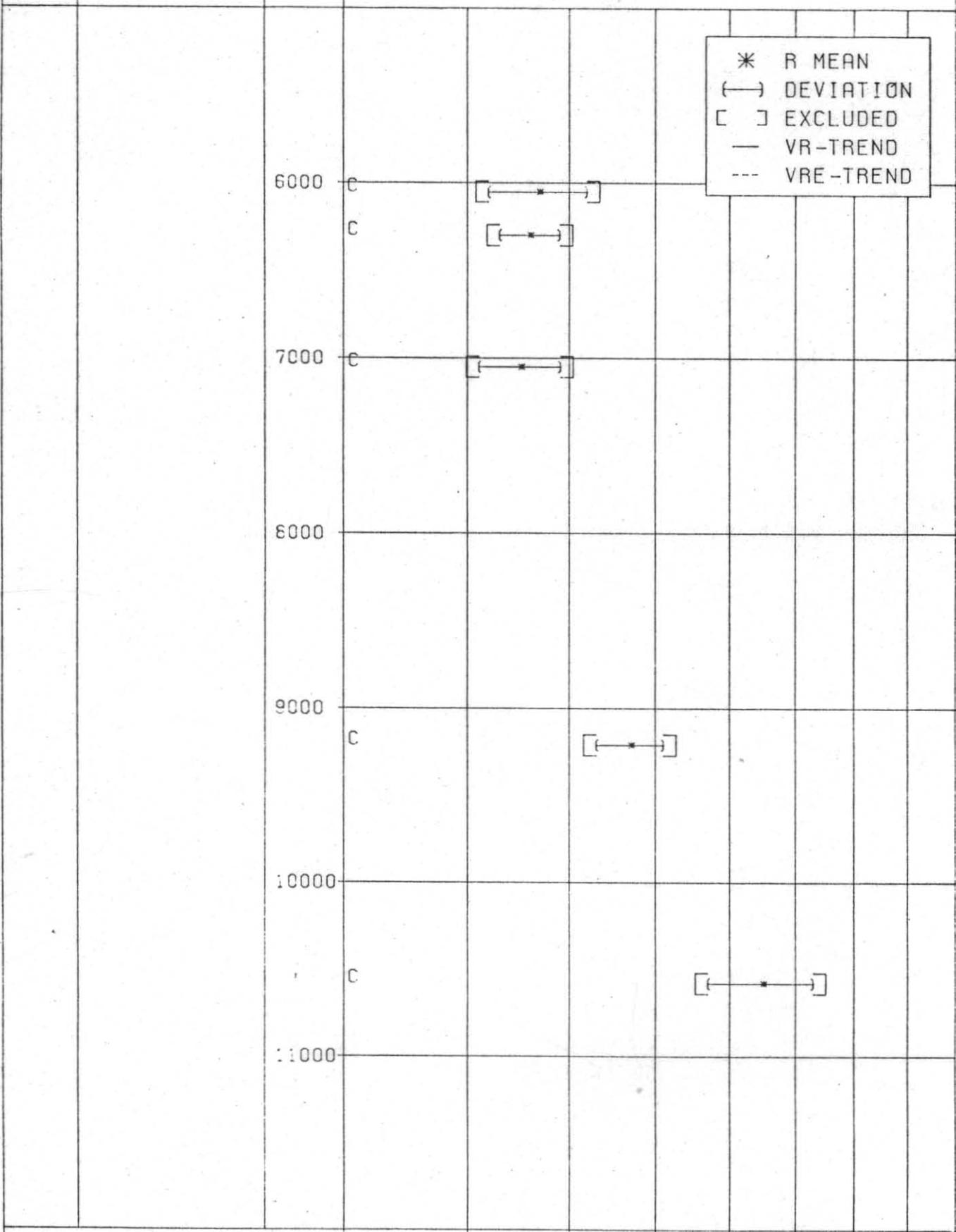
The vitrinite reflectance measurements as presented on figure 2 are not very reliable because the vitrinite particles are partly oxidised. The measured values are rather too high.

The occurrence of resinites and cutinites in the samples above 8200 ft as well as the presence of extractable hydrocarbons indicate that the source rocks are immature to just mature for oil generation.

Thus, it might be concluded that the section 6050 - 10930 ft contains immature to just mature source rocks for gas and oil.



AGE	FORMATION	DEPTH FEET BDF.	WELL : NARIMBA-1	346011
			COUNTRY : AUSTRALIA	



VR. (E) : 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1

VITRINITE REFLECTANCE (OR EQUIVALENT) AS A FUNCTION OF DEPTH

FIG. 2

5 cm

TABLE I (PART 1)

WELL:

NARIMBA-1

DEPTH	TYPE OF SAMPLE	SOURCE	SOURCE	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
		ROCK INDICATION	ROCK INDICATION		
F		BEFORE EXTR.	AFTER EXTR.		
5000	C	15	-		-
5050	C	17	-		-
5100	C	17	-		-
5150	C	15	-		-
5190	C	10	-		-
5250	C	10	-		-
5310	C	15	-		-
5370	C	15	-		-
5430	C	15	-		-
5480	C	10	-		-
5540	C	37	-		-
5600	C	25	-		-
5660	C	15	-		-
5720	C	47	35		-
5760	C	40	35		-
5800	C	40	30		-
5860	C	20	-		-
5920	C	15	-		-
5950	C	40	40		-
6000	C	20	-		-
6050	C	510	450	MH	-
6100	C	470	455		11.1
6150	C	315	280		-
6200	C	230	225		-
6270	C	> 900	> 900		-
6300	C	> 900	> 900	MH	-
6400	C	> 900	795		-
6730	C	> 900	> 900		-
6810	C	395	335		-
6850	C	105	95		-

TABLE I (PART 2)

WELL:

NARIMBA-1

DEPTH	TYPE OF SAMPLE	SOURCE ROCK INDICATION	SOURCE ROCK INDICATION	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
		BEFORE EXTR.	AFTER EXTR.		
6900	C	170	165		-
6950	C	530	520		-
7000	C	240	190		-
7050	C	> 900	> 900	MH	-
7100	C	110	100		-
7200	C	> 900	> 900		-
7250	C	740	555		-
7300	C	820	605		-
7300	C	> 900	> 900		-
7400	C	> 900	> 900		-
7500	C	> 900	685		-
7550	C	385	325		-
7600	C	> 900	> 900		-
7650	C	> 900	760		-
7700	C	130	115		-
7750	C	150	120		-
7800	C	> 900	> 900		-
7850	C	> 900	> 900		-
7900	C	> 900	> 900		-
8020	C	> 900	> 900		-
8150	C	> 900	> 900	MH	19.1
8230	C	205	190		-
8300	C	180	165		-
8350	C	275	265		-
8400	C	225	225		-
8450	C	385	375		-
8500	C	> 900	> 900		-
8600	C	760	725		-
8650	C	155	155		-
8700	C	150	140		-

TABLE I (PART 3)

WELL:

NARIMBA-1

DEPTH	TYPE OF SAMPLE	SOURCE	SOURCE	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
		ROCK INDICATION	ROCK INDICATION		
F		BEFORE EXTR.	AFTER EXTR.		
8750	C	130	115		-
8800	C	265	225		-
8890	C	> 900	> 900		-
8920	C	355	250		-
9020	C	600	545		-
9050	C	> 900	> 900		-
9100	C	150	110		-
9150	C	70	40		-
9210	C	> 900	> 900	MH	-
9300	C	> 900	> 900		39.1
9300	C	> 900	> 900		37.2
9400	C	155	120		-
9460	C	> 900	> 900		-
9510	C	> 900	> 900		-
9580	C	> 900	665		-
9600	C	> 900	> 900		-
9650	C	605	410		-
9800	C	> 900	> 900		-
9850	C	415	220		-
9900	C	525	275		5.1
9950	C	460	225		-
10000	C	165	90		-
10050	C	50	20		-
10110	C	> 900	> 900		-
10170	C	> 900	> 900		-
10280	C	> 900	645		-
10300	C	675	465		-
10450	C	315	190		-
10520	C	405	335		-
10550	C	85	70		-

TABLE I (PART 4)

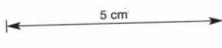
WELL: NARIMPA-1

DEPTH	TYPE OF SAMPLE	SOURCE ROCK INDICATION	SOURCE ROCK INDICATION	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
F		BEFORE EXTR.	AFTER EXTR.		
10580	C	> 900	> 900	MH	-
10650	C	> 900	> 900		-
10700	C	> 900	> 900		-
10750	C	290	195		-
10800	C	> 900	> 900		33.8
10930	C	> 900	> 900		-

TYPE OF SAMPLE C = CUTTINGS, R = CORE, S = SIDEWALL SAMPLE

CONTAMINATION : W = WALNUT FRAGMENTS OR SOME SIMILAR PRODUCT,
E = CELLOPHANE SHREDS, F = FIBRES, P = PLASTIC OR PAINT AND
C = CONTAMINATED BUT KIND NOT SPECIFIED

A DASH (-) INDICATES TEST NOT MADE, ASTERISKS INDICATE THE
ORGANIC CARBON CONTENT IS THE AVERAGE FOR THE SAMPLES CONCERNED



GEOCHEMICAL LOG

SCALE 1:5000

WELL

NARIMBA-1

LOCATION

REGIO IDENTIFIER

AGE	FORMATION	DEPTH IN F	LITHOLOGY	DOM	SOURCE ROCK INDICATION OF ORIGINAL SAMPLE						TYPE OF SAMPLE	SOURCE ROCK INDICATION OF SAMPLE AFTER EXTRACTION WITH CHLOROFORM						CONTAMINATION	DEPTH IN F	ORG. CARBON (PCT. WT)	TYPE OF ORGANIC MATTER
					100	200	300	400	500	600		100	200	300	400	500	600				
OLIGOCENE-MIOCENE	'UPPER EOCENE SHALE'	4500															4500				
		5000																5000			
		5500															5500				
		6000															6000	11.1	MAINLY HUMIC		
		6500															6500		MAINLY HUMIC		
		7000															7000		MAINLY HUMIC		
EOCENE	EASTERN VIEW GROUP	7500															7500				
		8000															8000	19.1	MAINLY HUMIC		
		8500															8500				
		9000															9000				
		9500															9500	39.1 37.2	MAINLY HUMIC		
		10000															10000	5.1			
		10500															10500		MAINLY HUMIC		
		11000															11000	33.8			

VALUES SMALLER THAN 30 ARE CONSIDERED NOT TO BE OF SIGNIFICANCE

THE INTERVAL 6050-10930 FT CONTAINS IMMATURE TO MATURE SOURCE ROCKS FOR GAS AND OIL

NUMBER OF SAMPLES ANALYSED 96

NUMBER OF SAMPLES ANALYSED 80

346016

- LEGEND**
- TYPE OF SAMPLE ○ = CORE, ▽ = SIDEWALL SAMPLE
 - CONTAMINATION C = UNSPECIFIED, H = WALNUTS, E = CELLOPHANE, F = FIBRES, P = PLASTIC OR PAINT

ANALYTICAL/DRILL
EXPLORATION & PRODUCTION LABORATORY

GEOCHEMICAL LOG OF
NARIMBA-1
AUSTRALIA

REF: 80-086/046 DATE: APRIL 1980
ENCL: 1 DRUM: 00 + 1

OR-0340 C.