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SHELL - AUSTRALIA E. & P. OIL AND GAS

SOURCE ROCK ANALYSIS. G.B. TUNA-1.

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SOURCE ROCK ANALYSIS OF SAMPLES FROM WELL TUNA A-1 , AUSTRALIA

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2)

CONTENTS

I INTRODUCTION

A source rock evaluation has been carried out on cores and cutting samples from well Tuna A-1 , Gippsland Basin , Australia.

The approximate location of the well is shown in Figure 1.

The samples are taken from interval 3000 to 11947 ft (TD) , i.e. Tertiary - Upper Cretaceous (Gippsland Limestone - Latrobe Group).

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 <u>quality</u> 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 macerals[1], 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).

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II RESULTS

The results are listed in Table I (source rock indications , type of organic matter , total organic carbon content) , Table II (maceral descriptions , comment lines) and Figure 2 a,b (vitrinite reflectance histograms).
The results are summarised in Enclosure 1 (geochemical log).

III DISCUSSION

Based on organic carbon content and/or source rock indications , 60 out of the 69 samples investigated from interval 5190 to 10760 ft and samples 11000 , 11330 and 11622 ft are marginal to excellent source rocks.

Nine samples have been selected for maceral analysis and for six samples the type of organic matter has been determined in order to establish the type of source rock.
The results indicate that these samples are source rocks for gas.

However , considering the amount and habitat of the SOM (sapropelic organic matter) and the large amount of liptinites in samples 5375 (core) and 6340 ft (cuttings) , interval 5190 to 6930 ft contains source rocks also for oil.

Although the habitat of the SOM in samples 9140 and 10550 ft is less favourable , they are still to be considered as source rocks for gas and some oil.

The vitrinite reflectance has been measured on samples 8670 and 9140 ft and reveals values of 0.68 (DOM 62) and 0.72 (DOM 63) respectively , indicating that the samples are nearly to just mature for oil generation.

IV CONCLUSIONS

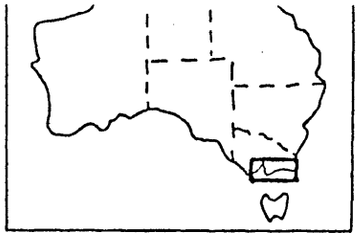
Interval 5190 to 10760 ft contains marginal to excellent source rocks for gas , while the top of this interval (5190 to 6930 ft) embraces source rocks also for oil.

As already mentioned , the lower part of interval 5190 to 10760 ft locally also contains source rocks for gas and some oil.

Finally , samples 11000 , 11330 and 11622 ft are marginal to fairly good source rocks for gas.

Situation Map

Scale 1 : 2 000 000



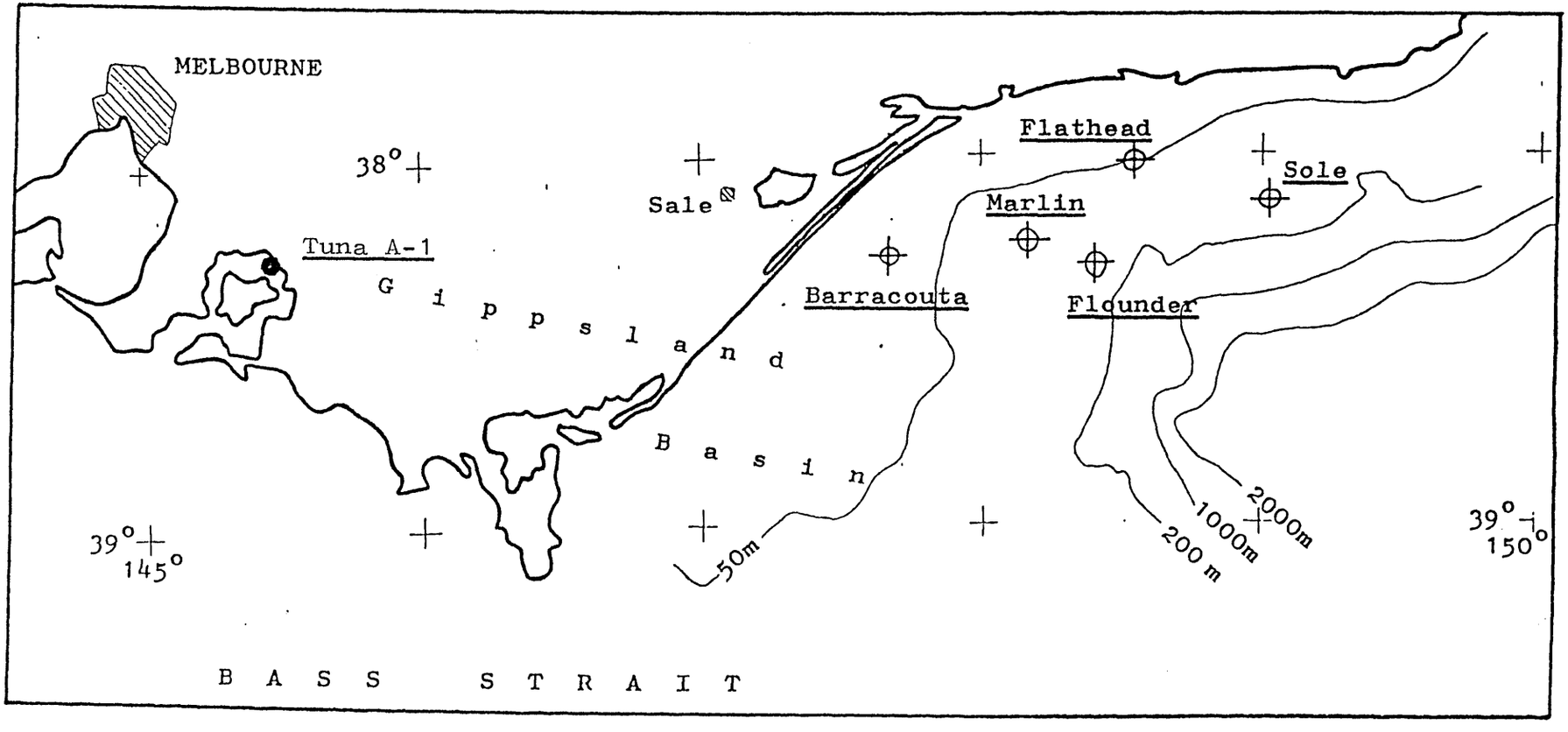


Figure 1

VITRINITE REFLECTANCE

COUNTRY	: AUSTRALIA	MEAN	: 0.68
WELL/OUTCROP	: TUNA-A1	DEVIATION	: 0.03
DEPTH/SAMPLE NR.	: 8670 FT	MODE	: MULTI
SAMPLE TYPE	: CUTTING SAMPLE	MEASUREMENTS	: 24

ANALIST: HDY D.D.: 11-MAY-82

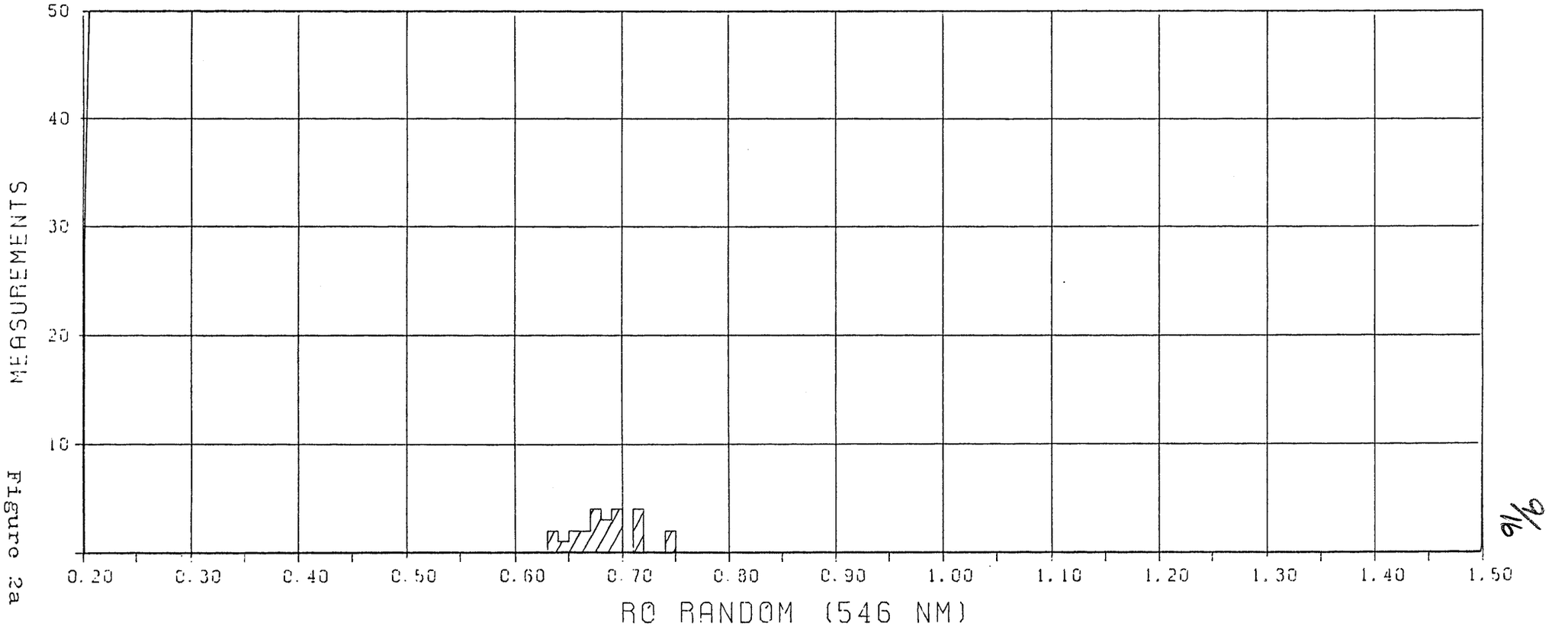


Figure 2a

VITRINITE REFLECTANCE HISTOGRAM

VITRINITE REFLECTANCE

COUNTRY	: AUSTRALIA	MEAN	: 0.72
WELL/OUTCROP	: TUNA-A1	DEVIATION	: 0.02
DEPTH/SAMPLE NR.	: 9140 FT	MODE	: 0.71
SAMPLE TYPE	: CUTTING SAMPLE	MEASUREMENTS	: 25

ANALIST: HDY D.D. : 11-MAY-82

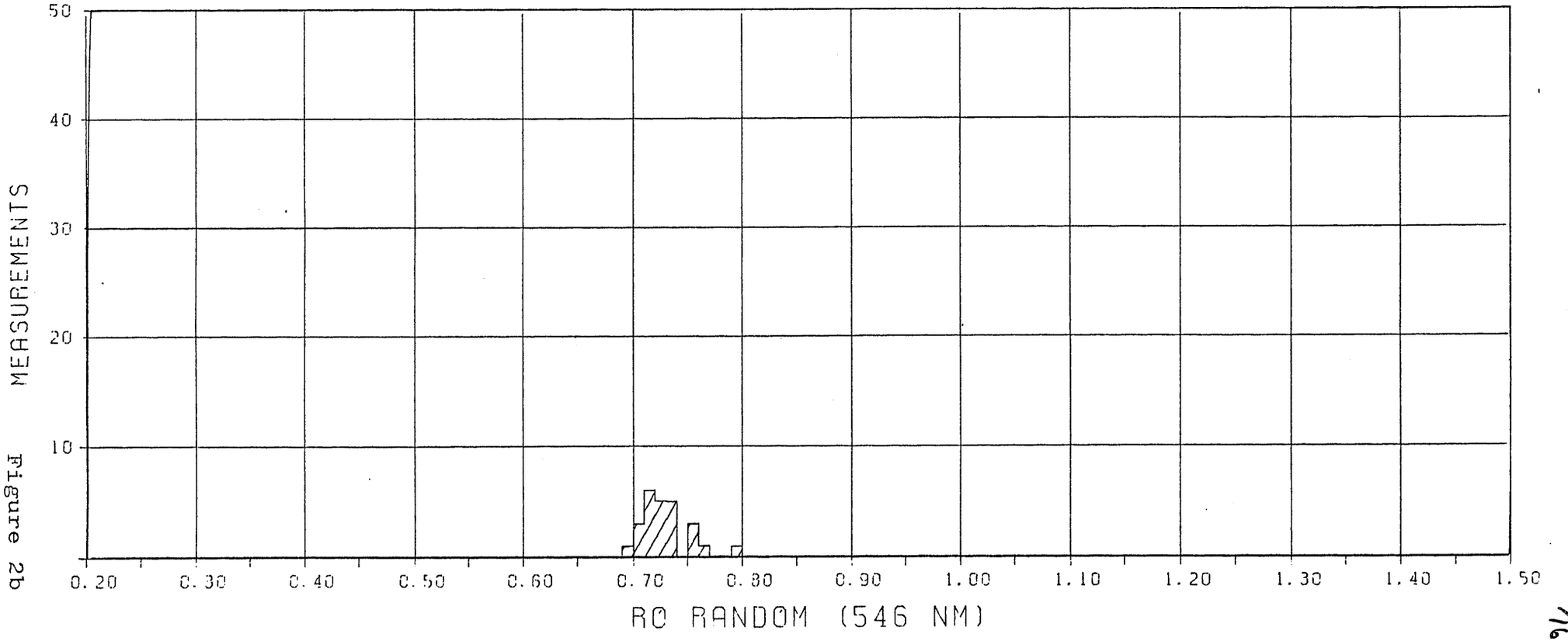


Figure 2b

VITRINITE REFLECTANCE HISTOGRAM

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TABLE I (PART 1) WELL: TUNA-A1

DEPTH F	TYPE OF SAMPLE	SOURCE ROCK INDICATION BEFORE EXTR.	SOURCE ROCK INDICATION AFTER EXTR.	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
3000	C	5	-		-
3100	C	5	-		-
3190	C	5	-		-
3300	C	5	-		-
3400	C	5	-		-
3500	C	5	-		-
3600	C	5	-		-
3700	C	5	-		-
3795	R	5	-		-
3800	C	5	-		-
3900	C	5	-		-
4000	C	5	-		-
4100	C	5	-		-
4200	C	5	-		-
4418	R	5	-		-
4620	R	5	-		-
4620	C	5	-		-
4700	C	5	-		-
4950	C	5	-		-
5050	C	5	-		-
5190	C	490	485		-
5300	C	165	155		-
5375	R	> 900	> 900	MH	25.9
5390	R	50	50		-
5400	C	195	195		-
5460	C	105	105		-
5560	C	110	105		-
5640	C	500	490		-
5700	C	555	545		-
5780	C	195	205		-

TABLE I (PART 2) WELL: TUNA-A1

DEPTH F	TYPE OF SAMPLE	SOURCE ROCK INDICATION BEFORE EXTR.	SOURCE ROCK INDICATION AFTER EXTR.	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
5870	C	205	205		-
6000	C	220	230		-
6140	C	240	240		-
6199	R	5	-		-
6230	C	220	240		-
6340	C	790	790	MH	18.1
6410	C	240	205		-
6474	R	65	65		-
6720	C	465	465		-
6770	C	340	310		-
6840	C	130	145		-
6930	C	45	45		-
7439	R	75	75		1.8
7960	C	45	45		-
8010	C	165	175		-
8080	C	50	45		-
8150	C	100	90		-
8300	C	150	150		-
8420	C	180	175		-
8470	C	135	135		-
8530	C	175	170		-
8600	C	305	305		-
8670	C	310	310	MH	5.4
8671	R	145	140		-
8774	R	40	40		-
8810	C	205	205		-
8960	C	175	175		-
8990	C	165	165		-
9030	C	130	130		-
9140	C	360	360	MH	6.9

TABLE I (PART 3) WELL: TUNA-A1

DEPTH F	TYPE OF SAMPLE	SOURCE ROCK INDICATION BEFORE EXTR.	SOURCE ROCK INDICATION AFTER EXTR.	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
9200	C	65	65		-
9250	C	110	110		-
9359	R	165	130		-
9360	C	20	20		-
9300	C	135	135		-
9420	C	55	55		-
9500	C	30	25		-
9590	C	35	35		-
9640	C	90	90		-
9700	C	75	80		-
9780	C	155	150		-
9850	C	60	70		-
9910	C	50	65		-
9950	C	40	50		-
10000	C	15	-		-
10080	C	150	135		-
10129	R	5	-		-
10150	C	15	-		-
10200	C	15	-		-
10250	C	10	-		-
10300	C	15	-		-
10350	C	75	85		-
10400	C	50	50		-
10450	C	140	135		-
10550	C	270	270	MH	5.6
10600	C	180	175		-
10660	C	75	80		-
10710	C	90	85		-
10760	C	105	100		-
10904	R	15	-		-

TABLE I (PART 4) WELL: TUNA-A1

DEPTH F	TYPE OF SAMPLE	SOURCE ROCK INDICATION BEFORE EXTR.	SOURCE ROCK INDICATION AFTER EXTR.	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
10910	C	15	-		-
10960	C	15	-		-
11000	C	75	70		-
11050	C	15	-		-
11100	C	20	-		-
11150	C	25	-		-
11210	C	10	-		-
11260	C	5	-		-
11330	C	55	65		-
11390	C	20	-		-
11440	C	25	-		-
11500	C	15	-		-
11537	R	5	-		-
11550	C	10	-		-
11622	R	155	150	H	2.0
11640	C	5	-		-
11700	C	5	-		-
11750	C	15	-		-
11800	C	5	-		-
11890	C	5	-		-

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

MACERAL DESCRIPTION OF 9 SAMPLES FROM WELL TUNA-A1

DEPTH IN FT	SAMPLE TYPE	ORGANIC																					INORG.			
			VITR.			LIPTINITE											INERT.									
											ALGAE															
		SAPROPALIC ORG. MATTER	TELOCOLLINITE	TELINITE	DESMOCOLLINITE	SPORINITE	CUTINITE	RESINITE	LIPTODETRINITE	BOTRYOCOCCUS	TASMANITES	OTHER ALGAE	MICROPLANKTON	EXSUDATINITE	SCLEROTINITE	FUSINITE	MACRINITE	MICRINITE	UNDIFFINED MINERALS	FRAMBOIDAL PYRITE	AGGREGATES OF PYRITE	CRYSTALS OF PYRITE
5375.0	CORE	+	-		+	+	/	/	+							-		+	*	-	-	/
6340.0	CTGS	+	/		+	+	/	/	+					-		/		+	*	/	-	/
7439.0	CORE	-			+	-	-	-	/					-		/			*		-	-
8670.0	CTGS	/	/		+	/	-	-	+					/		/		+	*	-	-	/
8671.0	CORE	-			+	/	-	-	/					-		/		/	*	-		-
9140.0	CTGS	+	/		+	/	-	-	/					/		/		+	*	-	-	/
9359.0	CORE	/			+	-	-		/					/		/		+	*	/	-	/
10550.0	CTGS	+	/		+	/	-	-	/					-		+		+	*	-	-	/
11622.0	CORE	-			+									/		/			*	-		

LEGEND	
*	: ABUNDANT
+	: COMMON
/	: FEW
-	: RARE

TABLE II

COMMENT LINES

5375.0 F : Sample slightly oxidised
Vitrinite grades into SOM
Initial conversion SOM

6340.0 F : Vitrinite shows oxidation features
Initial conversion SOM
Sample partly oxidised
Vitrinite grades into SOM

7439.0 F : No comments

8670.0 F : Sample oxidised
Vitrinite shows oxidation features
Few solid hydrocarbons
Vitrinite grades into SOM
Few good source rock particles

8671.0 F : Pyrite shows oxidation features
Initial conversion SOM
Sample partly severely oxidised

9140.0 F : Vitrinite shows oxidation features
Sample partly severely oxidised
Few solid hydrocarbons
SOM partly converted
Vitrinite grades into SOM

9359.0 F : Vitrinite shows oxidation features
Vitrinite grades into SOM
Sample partly oxidised
SOM partly converted

10550.0 F : Vitrinite shows oxidation features
SOM partly converted
Sample partly oxidised

11622.0 F : No comments

SOM = Sapropelic organic matter

TABLE II