THERMAL MATURATION ANALYSIS-AMOCO CATHEDRAL RIVER NO. 1

10,255 to 11,850'

TOTAL ORGANIC CARBON

ROCK-EVAL PYROLYSIS

VISUAL KEROGEN/VITRINITE REFLECTANCE

ROBERTSON RESEARCH (U.S.) INC.

REPORT NO. 823-7B

TOTAL ORGANIC CARBON AND ROCK-EVAL PYROLYSIS OF SEVENTEEN SAMPLES FROM THE CATHEDRAL RIVER WELL

by
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Project No. RRUS/823/T/7/2 (B)

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INTRODUCTION

Seventeen samples from the interval 10,255 to 11,850 feet of the Cathedral River well were forwarded for total organic carbon (TOC) and Rock-Eval pyrolysis, the latter to be run on every other sample regardless of the TOC value.

SUMMARY

The total organic carbon values range from 0.5 to 0.7 wt. %, indicating a marginal source quality. The pyrolysis data suggest that the level of maturity is near the end of the oil-generating window. The low S2 and S2/S3 values reflect the present state of the kerogen and are not necessarily indicative of the original generating capabilities. The T-max values for samples 10,255 and 10,450 feet are unreasonably low considering the trend of the remaining samples.

CATHEDRAL RIVER WELL

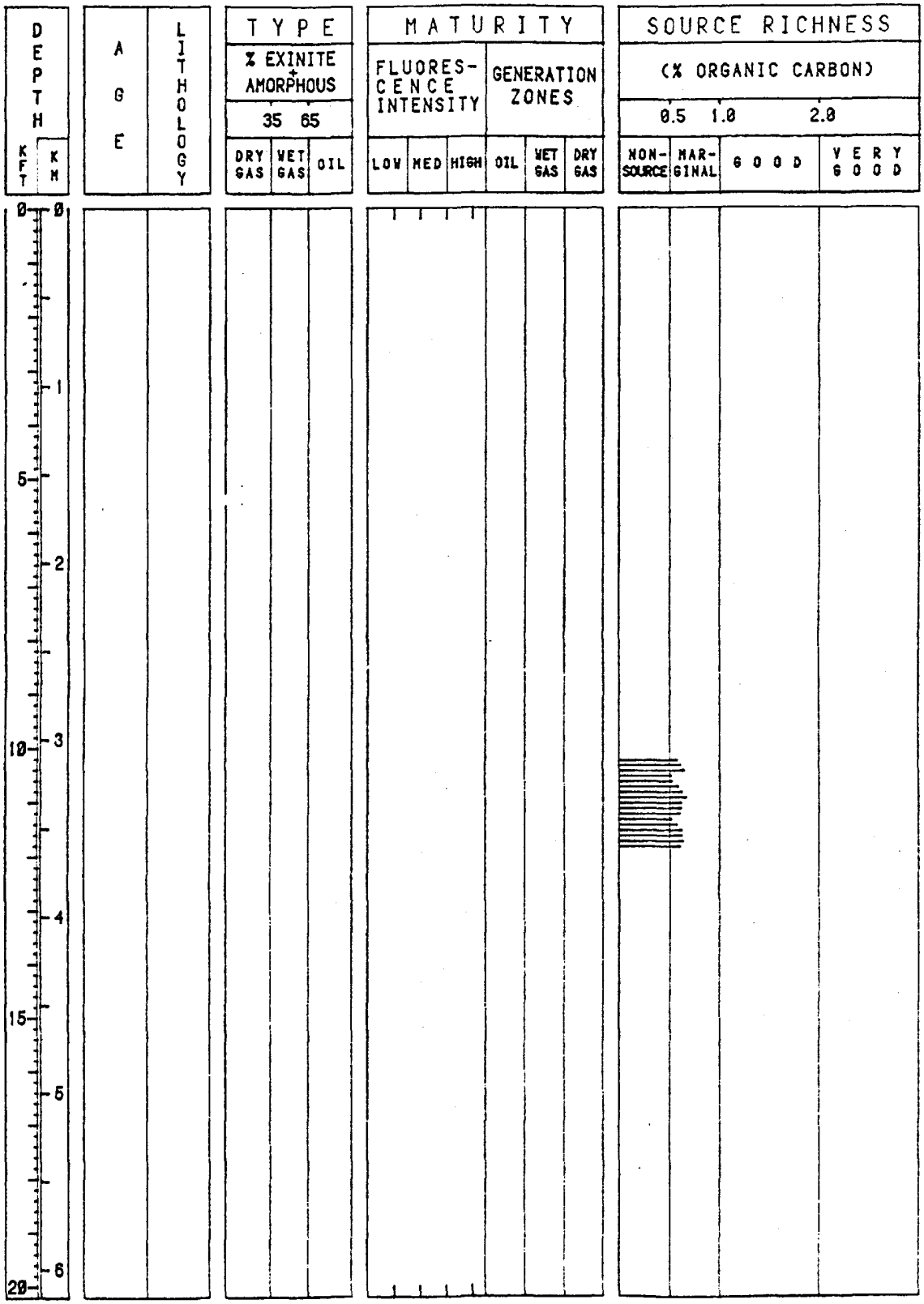

FIGURE 1: SUMMARY PLOTS SHOWING KEROGEN TYPES, MATURITY, AND SOURCE RICHNESS (SEE APPENDICES I AND III)

CATHEDRAL RIVER WELL

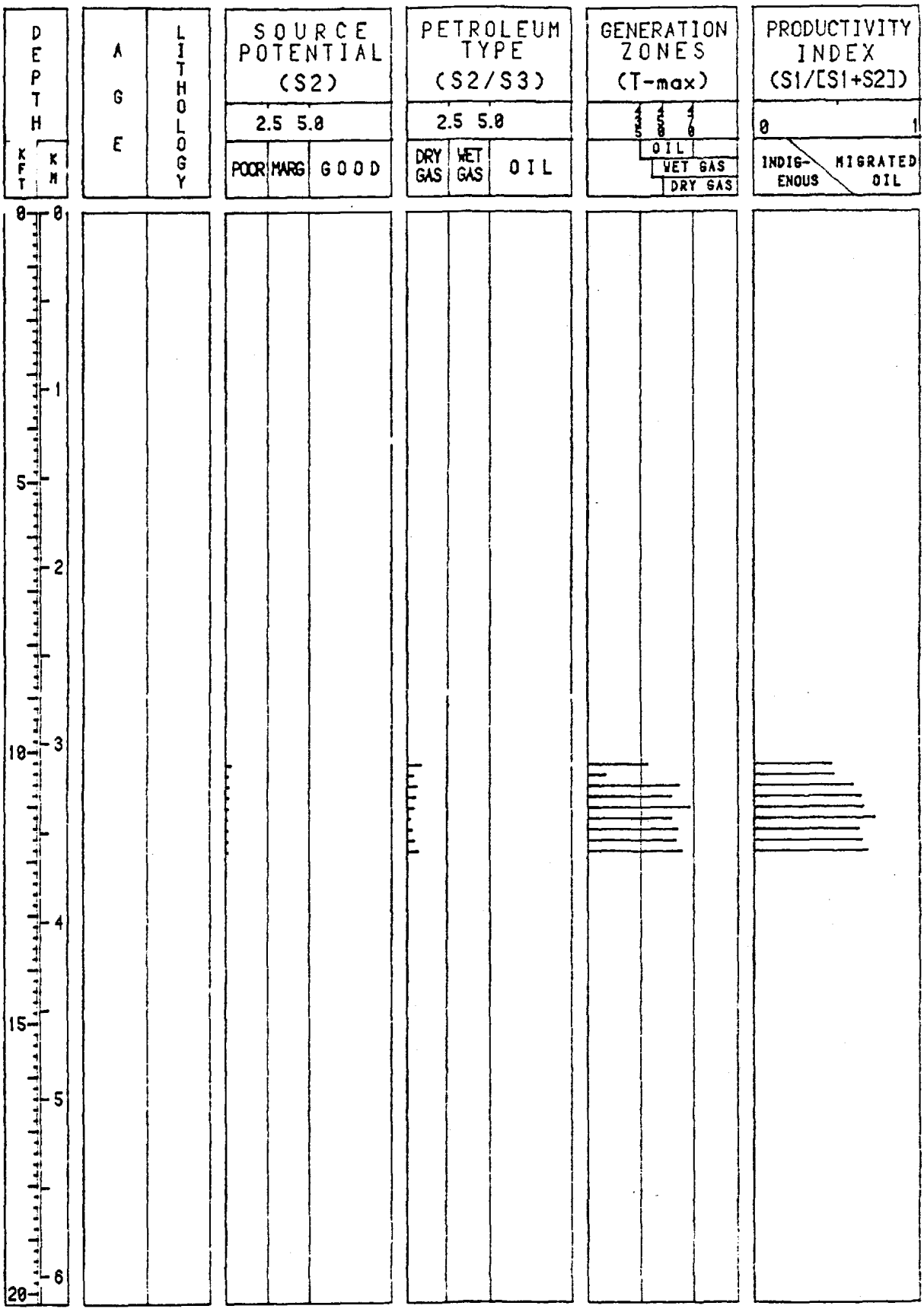

FIGURE 2: SUMMARY PLOTS OF ROCK-EVAL PYROLYSIS DATA (APPENDIX II)

CATHEDRAL RIVER WELL

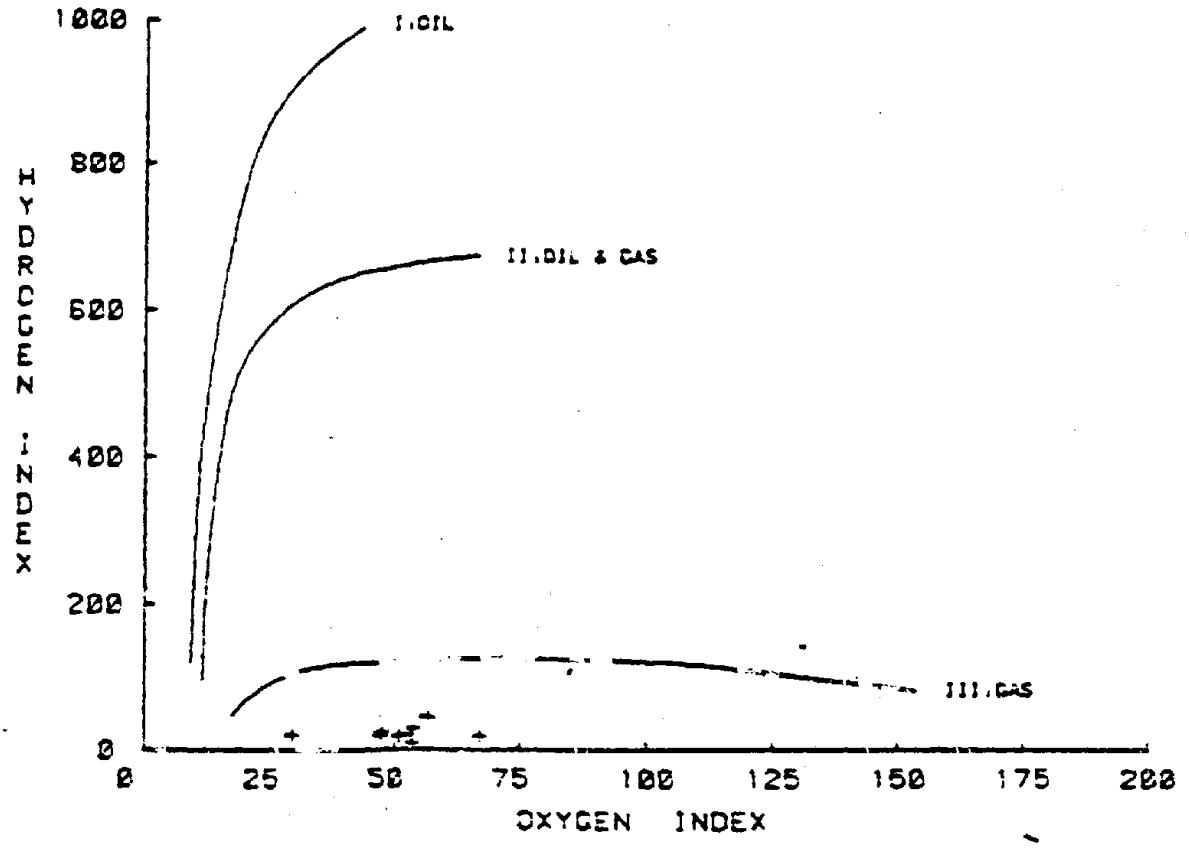

FIGURE 3: KEROGEN TYPE DETERMINATION FROM ROCK-EVAL. PYROLYSIS DATA (APPENDIX II).

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APPENDIX I

TOTAL ORGANIC CARBON DATA

Total organic carbon is determined by pulverizing the sample, treating a carefully weighed portion with warm hydrochloric acid to remove carbonate minerals, and analysing the residue for carbon content with a Leco carbon analyser. It is generally accepted that samples with less than about 0.5 percent TOC cannot yield sufficient petroleum to form commercial deposits and are therefore considered nonsources; samples with between 0.5 and 1.0 TOC are rated as marginal in source quality; and samples with more than 1.0 TOC are considered to be good in source quality.

TOTAL ORGANIC CARBON DATA

CATHEDRAL RIVER WELL

DEPTH (Feet)	TOC (%)	DEPTH (Feet)	TOC (%)
10255	0.57	11150	0.61
10350	0.61	11250	0.60
10450	0.64	11350	0.52
10550	0.51	11450	0.57
10650	0.52	11550	0.62
10750	0.56	11650	0.62
10850	0.62	11750	0.63
10950	0.66	11850	0.60
11050	0.61		

APPENDIX II

ROCK-EVAL PYROLYSIS DATA

Rock-Eval data are expressed as mg/g of rock and include four basic parameters: 1) S_1 represents the quantity of free hydrocarbons present in the rock and is roughly analogous to the solvent extractable portion of the organic matter; 2) S_2 represents the quantity of hydrocarbons released by the kerogen in the sample during pyrolysis; 3) S_3 is related to the amount of oxygen present in the kerogen; and 4) T-max, in °C, is the temperature at which the maximum rate of generation (of the S_2 peak) occurs and can be used as an estimate of thermal maturity.

In addition, the ratio S_2/S_3 provides a general indication of kerogen quality (type) and reveals whether oil or gas are likely to be generated. The ratio $S_1/(S_1+S_2)$, or the productivity index, is an indication of the relative amount of free hydrocarbons (in place or migrated) present in the sample. Hydrogen and oxygen index values are in mg of hydrocarbons (S_2 peak) or carbon dioxide (S_3 peak) per gram of organic carbon. When plotted against each other on a van Krevelen-type diagram, information on kerogen type and maturity can be obtained.

Data are interpreted in the following manner:

Source Potential - values of S2	<2.5	: poor
	2.5-5.0	: marginal
	>5.0	: good
Petroleum Type - value of S2/S3	<2.5	: dry gas
	2.5-5.0	: wet gas
	>5.0	: oil
Generation Zones - values of T-max	<435	: immature
	435-470	: oil
	450 +	: gas

Productivity Index - high values of S1/(S1+S2) indicate migrated hydrocarbons.

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ROCK-EVAL PYROLYSIS RAW DATA

CATHEDRAL RIVER WELL

Thermal maturation

DEPTH (FEET)	S1	S2	S3	S2/S3	S1/(S1+S2)	T-MAX
10255	0.211	0.247	0.322	0.765	0.461	439
10450	0.095	0.105	0.324	0.323	0.476	411
10650	0.208	0.141	0.278	0.508	0.596	460
10850	0.241	0.135	0.292	0.462	0.641	455
11050	0.208	0.110	0.322	0.343	0.653	467
11250	0.103	0.039	0.320	0.122	0.725	495
11450	0.161	0.096	0.380	0.251	0.627	459
11650	0.195	0.107	0.290	0.370	0.644	458
11850	0.228	0.107	0.174	0.616	0.680	462

Reactive Carbon

10255	8.035
10450	3.12
10650	6.7
10850	6.06
11050	5.2
11250	2.4
11450	4.5
11650	4.8
11850	5.5

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HYDROGEN AND OXYGEN INDICES FROM ROCK-EVAL PYROLYSIS DATA. WITH TOC DATA

CATHEDRAL RIVER WELL

DEPTH (FEET)	HYDROGEN INDEX (mg HC/g TOC)	OXYGEN INDEX (mg CO2/g TOC)	TOC (%)
10255	43	57	0.57
10450	16	51	0.64
10650	27	53	0.52
10850	22	47	0.62
11050	18	53	0.61
11250	7	53	0.60
11450	17	67	0.57
11650	17	47	0.62
11850	18	29	0.60

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APPENDIX III

REFLECTED LIGHT MICROSCOPY DATA

A sample of ground rock is treated successively with hydrochloric and hydrofluoric acids to concentrate the kerogen, freeze-dried, mounted in an epoxy plug, and polished. Kerogen type is identified with the aid of blue light fluorescence.

The visual kerogen analysis data sheet contains visual percentage estimates of each principle kerogen type, notes on vitrinite description, and kerogen fluorescence data.

The histograms show measured reflectance values of all vitrinite present and on all material with the visual appearance of vitrinite. Shaded values are those used to calculate the interpreted vitrinite reflectance maturities. Unshaded values are interpreted to be oxidized vitrinite, recycled vitrinite, or possibly misidentified material such as solid bitumen, pseudo-vitrinite, or semifusinite. Sometimes the samples analysed contain no vitrinite or have an insufficient number of readings to allow a reliable maturity determination to be made. Alternate maturity calculations are possible on a few samples. The histograms are identified by a sequence number and depth or notation.

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REFLECTED LIGHT
VISUAL KEROGEN ANALYSIS

PROJECT NO. RRUS 823/T/48/II

Amoco Cathedral River.

ORGANIC MATTER TYPE %

SAMPLE DESCRIPTION

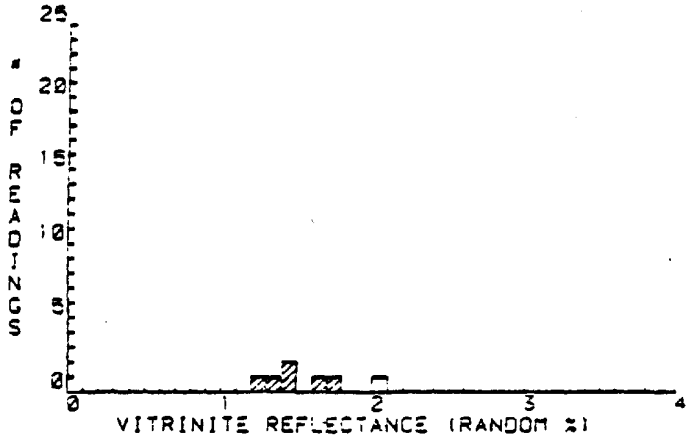
VITRINITE DESCRIPTION

FLUORESCENCE INTENSITY

O = NONE
T = TRACE
— = SMALL AMT.
M = MODERATE AMT.
+ = LARGE AMT.

SAMPLE	DEPTH (ft)	Ro MATURITY	AMORPHOUS	EXINITE	VITRINITE	INERTINITE	BITUMEN	AMT. ORGANIC MATTER	PYRITE	NORMAL	ROUGH, CORRODED	OXIDATION	COKE	EXINITE	BACKGROUND	REMARKS
1	10,650	1.47/45	0	45	10	+	M	-	M	M	M					

AMOCO CATHEDRAL RIVER



ID 1

DEPTH 10650.0 FT
3247.0 M

* = Ro MATURITY

# VALUES	6.00
MEAN	1.47
STD DEV	0.17
MEDIAN	1.47
MODE	1.45

HISTOGRAM 0-4 (0.1)

ORDERED REFLECTANCE VALUES:

*1.24
*1.33
*1.41
*1.47
*1.66
*1.71
2.08

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