B. L. RAYNER

OLANGOLAH-1 WELL COMPLETION REPORT (OTWAY BASIN, P.E.P. 100)

1982

WCR

OLANGOLAH-1

W774

OIL and GAS DIVISION

- 2 DEC 1982

OLANGOLAH - 1

WELL COMPLETION REPORT

(OTWAY BASIN, P.E.P.100)

BY

B.L. RAYNER.

GAS AND FUEL EXPLORATION N.L.

SEPTEMBER, 1982.

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FIGURES

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APPENDIX VI.

GEOCHEMICAL EVALUATION OF OLANGOLAH #1 CUTTINGS

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July, 1982

CONTENTS

TABULATED DATA

WELLNAME = OLANGOLAH NO. 1 DATE OF JOB = JULY 1982

ROCK-EVAL PYROLYSIS DATA

DEPTH(m)	TMAX	S1	S2	S3	S1+S2	S2/S3	PI	PC	TOC	HI	OI
200.0	nd	nd	nd	nd	nd	nd	nd	nd	0.35	nd	nd
300.0	nd	nd	nd	nd	nd	nd	nd	nd	0.54	nd	nd
400.0	521	0.01	0.02	0.09	0.03	0.22	0.33	0.00	0.61	3	14
500.0	nd	nd	nd	nd	nd	nd	nd	nd	0.69	nd	nd
600.0	515	0.02	0.10	0.36	0.12	0.28	0.17	0.01	1.55	6	23
800.0	418	0.01	0.05	0.01	0.06	5.00	0.17	0.00	0.86	5	1
900.0	324	0.02	0.03	0.01	0.05	3.00	0.40	0.00	0.67	4	1
1000.0	nd	nd	nd	nd	nd	nd	nd	nd	0.19	nd	nd
1100.0	nd	nd	nd	nd	nd	nd	nd	nd	1.15	nd	nd
1200.0	418	0.02	0.04	0.06	0.06	0.67	0.33	0.00	0.96	4	6
1300.0	nd	nd	nd	nd	nd	nd	nd	nd	0.99	nd	nd
1400.0	347	0.01	0.02	0.01	0.03	2.00	0.33	0.00	0.62	3	1
1500.0	nd	nd	nd	nd	nd	nd	nd	nd	0.69	nd	nd
1600.0	295	0.03	0.04	0.05	0.07	0.80	0.43	0.01	0.73	5	6
1700.0	nd	nd	nd	nd	nd	nd	nd	nd	0.65	nd	nd
1800.0	260	0.01	0.01	0.04	0.02	0.25	0.50	0.00	0.50	2	8
1900.0	288	0.01	0.01	0.01	0.02	1.00	0.50	0.00	0.53	1	1
2000.0	217	0.02	0.01	0.01	0.03	1.00	0.67	0.00	0.43	2	2
2100.0	nd	nd	nd	nd	nd	nd	nd	nd	0.50	nd	nd
2200.0	260	0.01	0.03	0.01	0.04	3.00	0.25	0.00	0.54	5	1
2300.0	nd	nd	nd	nd	nd	nd	nd	nd	0.76	nd	nd

KEY

TOC = Total organic carbon (soluble + insoluble)

PI = Production Index

PC = Pyrolysable Carbon

HI = Hydrogen Index

OI = Oxygen Index

HC = Hydrocarbon

nd = No data

THEORY AND METHOD

THEORY AND METHOD

1. PREPARATION OF SAMPLES

The samples provided for this study were all cuttings. Each sample was air dried, crushed to 1/8" chips using a jaw crusher, and finally crushed to 0.1mm using a Cross Beta grinding mill.

2. TOC DETERMINATIONS

The total organic carbon value (TOC) was determined on the unextracted sediment sample. The value was determined by treating a known weight of sediment with dilute HCl to remove carbonate minerals, and then heating the residue to approximately 1700 °C (Leco Induction Furnace) in an atmosphere of pure oxygen. The carbon dioxide produced was absorbed on a "Carbosorb" tower. The weight of carbon dioxide produced was then used to calculate %TOC in the sediment.

3. ROCK-EVAL PYROLYSIS

Rock-Eval pyrolysis is carried out by placing approximately 100mg of the crushed sample into a crucible and then subjecting it to the following pyrolysis cycle:

Stage (i) - Sample purged with helium for 3.5 minutes outside of heated part of pyrolysis furnace;

Stage (ii) - Sample heated at 300°C for 3 minutes to liberate free petroleum (S_1 peak);

Stage (iii)- Sample heated from 300°C to 550°C at 25°C/minute to produce petroleum from kerogen (S_2 peak). The furnace is maintained at 550°C for one minute. Carbon dioxide produced during this pyrolysis up to 390°C (550°C in the case of the carbonate-free sediment) is absorbed on a special column;

Stage (iv) - During cool-down period the carbon dioxide produced during pyrolysis is measured (S_3 peak).

The units used for Rock-Eval data are as follows:

S_1, S_2, S_3 = kg/tonne of rock
T_{max} = °C
Hydrogen Index = mg HC/g TOC
Oxygen Index = mg CO_2/g TOC

Rock-Eval data is most commonly used in the following manner:

(i) S_1 - indicates the level of oil and/or gas already generated by the sample.

(ii) S_1+S_2 - referred to as the genetic potential this parameter is used for source rock evaluation according to the following criteria:

<2	kg/tonne	Poor
2-6	kg/tonne	Moderate
>6	kg/tonne	Good

(iii) $S_1/(S_1+S_2)$ - this parameter is the production index which is a measure of the level of maturity of the sample.

(iv) T_{max} - the temperature corresponding to the S_2 maxima. This temperature increases with increasingly mature sediments.

(v) HI, OI - the hydrogen ($[S_2 x100]/TOC$) and oxygen ($[S_3 x100]/TOC$) indices when plotted against one another provide information about the type of kerogen contained in the sample and the maturity of the sample.

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COMMENTS AND CONCLUSIONS

X

DISCUSSION

General

A series of 21 canned cuttings samples from the Olangolah #1 exploration well were provided for geochemical analysis. After careful drying the samples were crushed to 0.1mm. An aliquot of each sample was then treated with dilute acid to remove carbonate minerals and analysed for its total organic carbon (TOC) content. Finally, both the crushed but otherwise untreated sediment and the crushed, acid-treated sediment from eleven representative samples were analysed by the Rock-Eval pyrolysis technique. Based on the TOC and Rock-Eval data it was not considered worthwhile subjecting these samples to any further geochemical analysis.

Although the geochemists responsible for the development of the Rock-Eval technique suggest that the analysis can be carried out on crushed but otherwise untreated sediment, it has now been established that in many cases analysis of this type of sample results in unreliable S_3 data due to a contribution to this peak from carbon dioxide resulting from carbonate mineral decomposition. It has consequently been suggested that Rock-Eval pyrolysis should be carried out on carbonate-free (acid-treated) sediment. However it is our experience that analysis of the carbonate-free sediment often provides unreliable S_1 and S_2 data. Therefore, the S_1 and S_2 data presented in this report was obtained by pyrolysis of crushed but otherwise untreated sediment whereas the S_3 data was obtained by pyrolysis of carbonate-free sediment. This approach provides the most meaningful Rock-Eval data.

Source Rock Richness

The basic requirement for sediments to be considered a petroleum source is that they contain sufficient organic matter to allow the generation of commercial quantities of petroleum. Since the type of organic matter contained in sediments strongly influences their petroleum generating potential then the minimum level of organic matter required to classify sediments as source rocks also depends upon the source type. However, several prominent geochemists have suggested that generally this minimum TOC value can be set at 0.5% and therefore we use the following criteria for source rock classification based on %TOC:

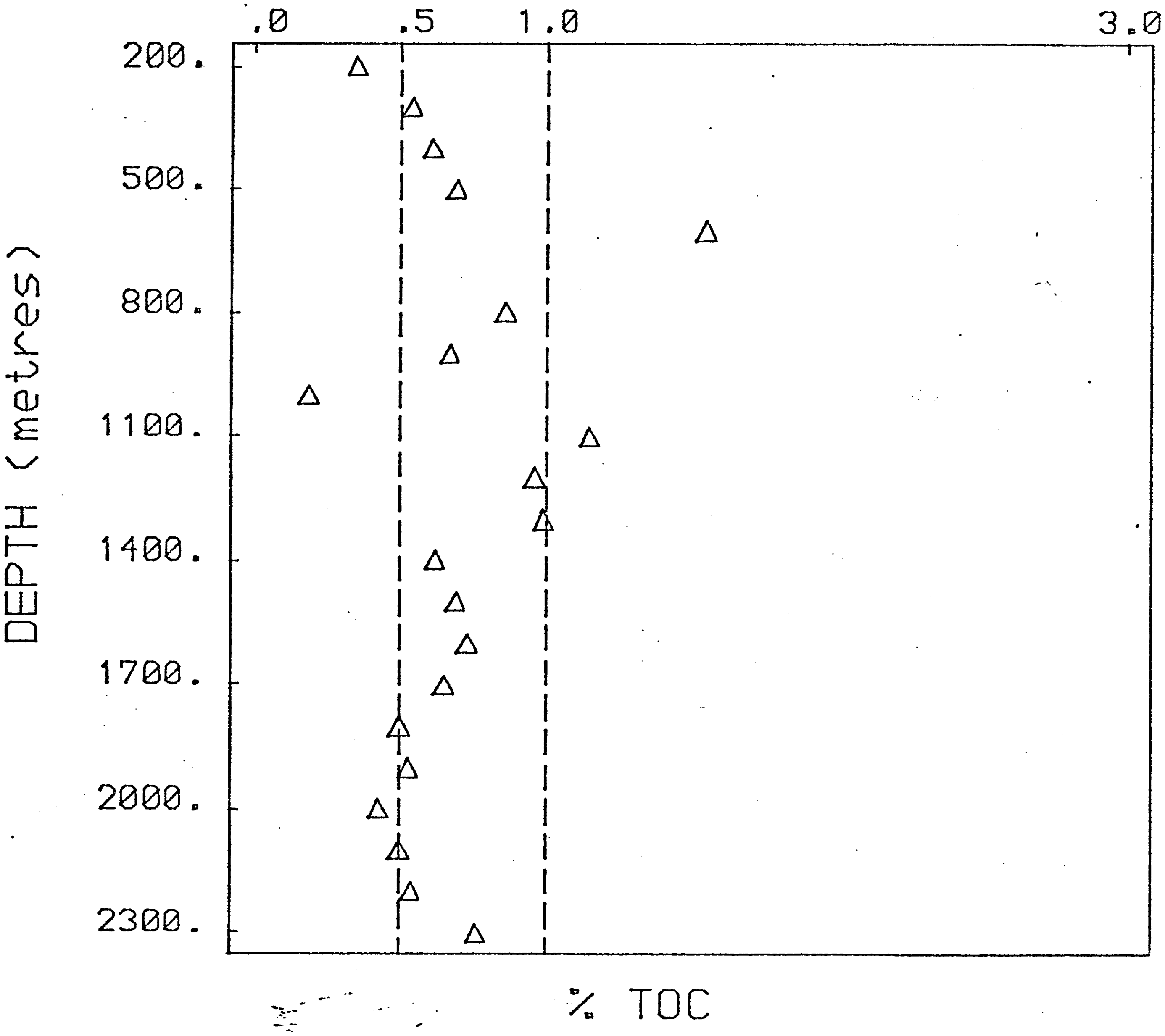
<0.5%	Poor
0.5 -1.0%	Moderate
>1.0%	Good

On this basis the 600m and 1100m samples are good source rocks; the 200m, 1000m and 2000m samples are poor source rocks; and the other 16 samples are all moderate petroleum sources (see plot over the page). Since these samples are generally at least moderate source rocks based on TOC data a more detailed investigation of their source rock suitability was carried out by subjecting eleven representative samples to Rock-Eval pyrolysis.

The most meaningful source rock classification is carried out on the basis of the potential yield (S_1+S_2) data. Unlike the TOC data this parameter at least partially accounts for variation in source type. The criteria used for source rock assessment based on the Potential Yield data are as follows:

<2.0 kg/tonne	Poor
2.0 - 6.0 kg/tonne	Moderate
>6.0 kg/tonne	Good

PLOT OF TOTAL ORGANIC CARBON VERSUS SEDIMENT BURIAL DEPTH



Clearly, based on this parameter these samples are very poor source rocks for either oil or gas. In fact their potential yield values are abnormally low considering their level of TOC. There are two likely reasons for this characteristic:

(i) the samples contain extremely poor quality organic matter; or
(ii) they have been subjected to extreme conditions of maturation.

The only evidence as to the most likely of these two possibilities is the oxygen index (OI) data. Overmature sediments have very low OI values (similar to those observed for these samples) whereas poor quality organic matter has values up to 150 depending on its level of maturity. On this basis it seems likely that the poor pyrolysis yield for these samples is largely due to the samples having been overmatured.

It should be noted that these sediments may have generated and expelled some petroleum before being overmatured, in which case they cannot be totally excluded as a petroleum source.

Sediment Maturity

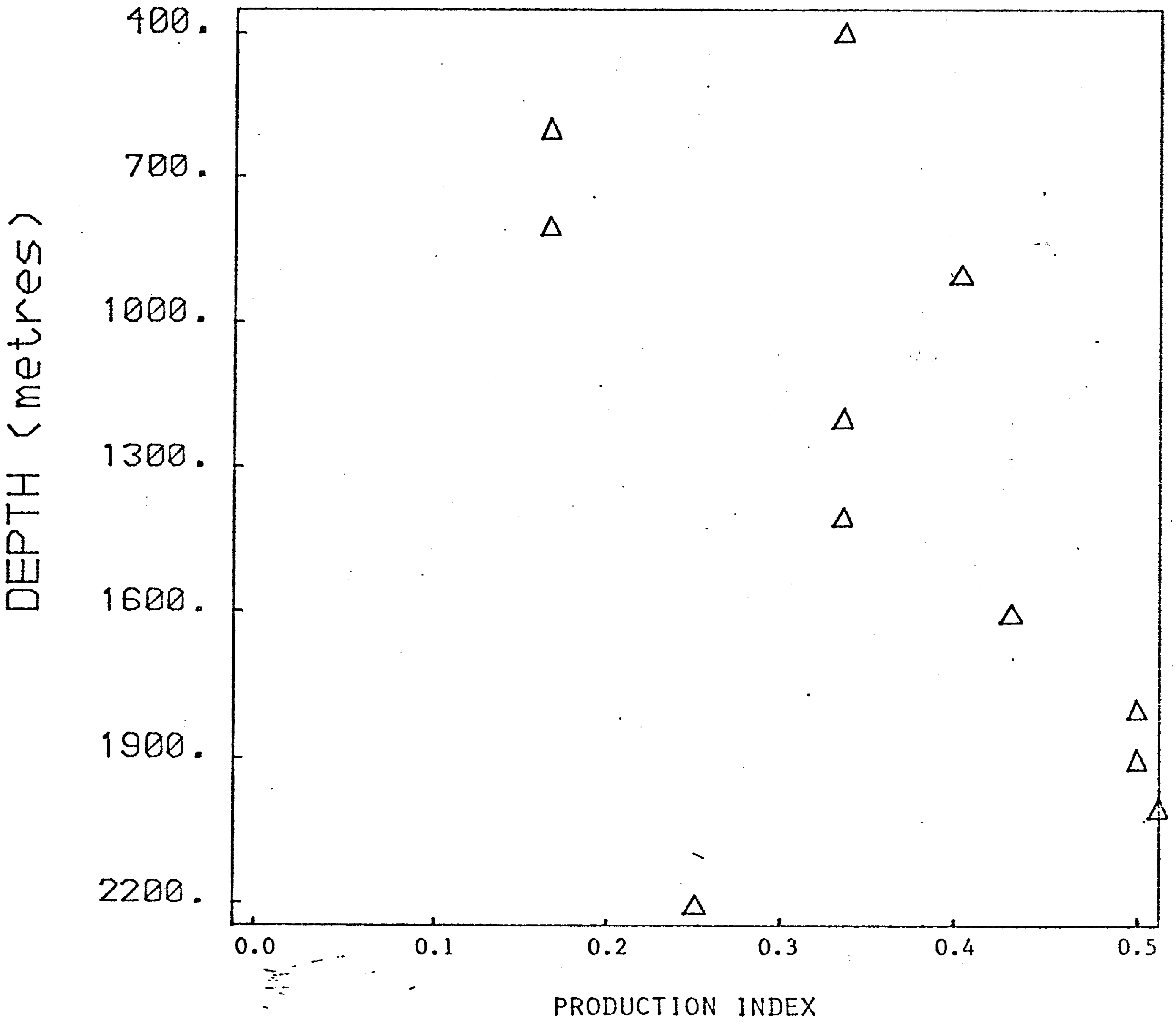
It has already been suggested on the basis of OI data that these samples are probably overmature. In this section, however, the more conventional Rock-Eval maturation parameters are discussed. These parameters are the T_{max} value and production index (PI). Detailed study of samples from the Paris Basin has shown that a T_{max} value of 430-435°C represents a maturity level equivalent to the onset of oil generation whereas T_{max} of about 460°C corresponds to the peak of oil generation. For oil prone sediments the PI value varies from about 0.1 at the onset of oil generation to 0.5 at peak oil generation. For gas prone sediments, the PI data shows only a small change with increasing maturity.

Due to the very small S_2 values the T_{max} data is totally unreliable and in fact is so scattered that our normal plot of T_{max} versus depth included only two data points on scale. Consequently, we have not presented this plot in this report. Although the plot of Production Index versus depth (shown over the page) included all data points on scale we are not prepared to place any emphasis on any trend in this data because the very low S_1 and S_2 values make this data fairly unreliable. Thus the conventional Rock-Eval maturation parameters are of little use in this study.

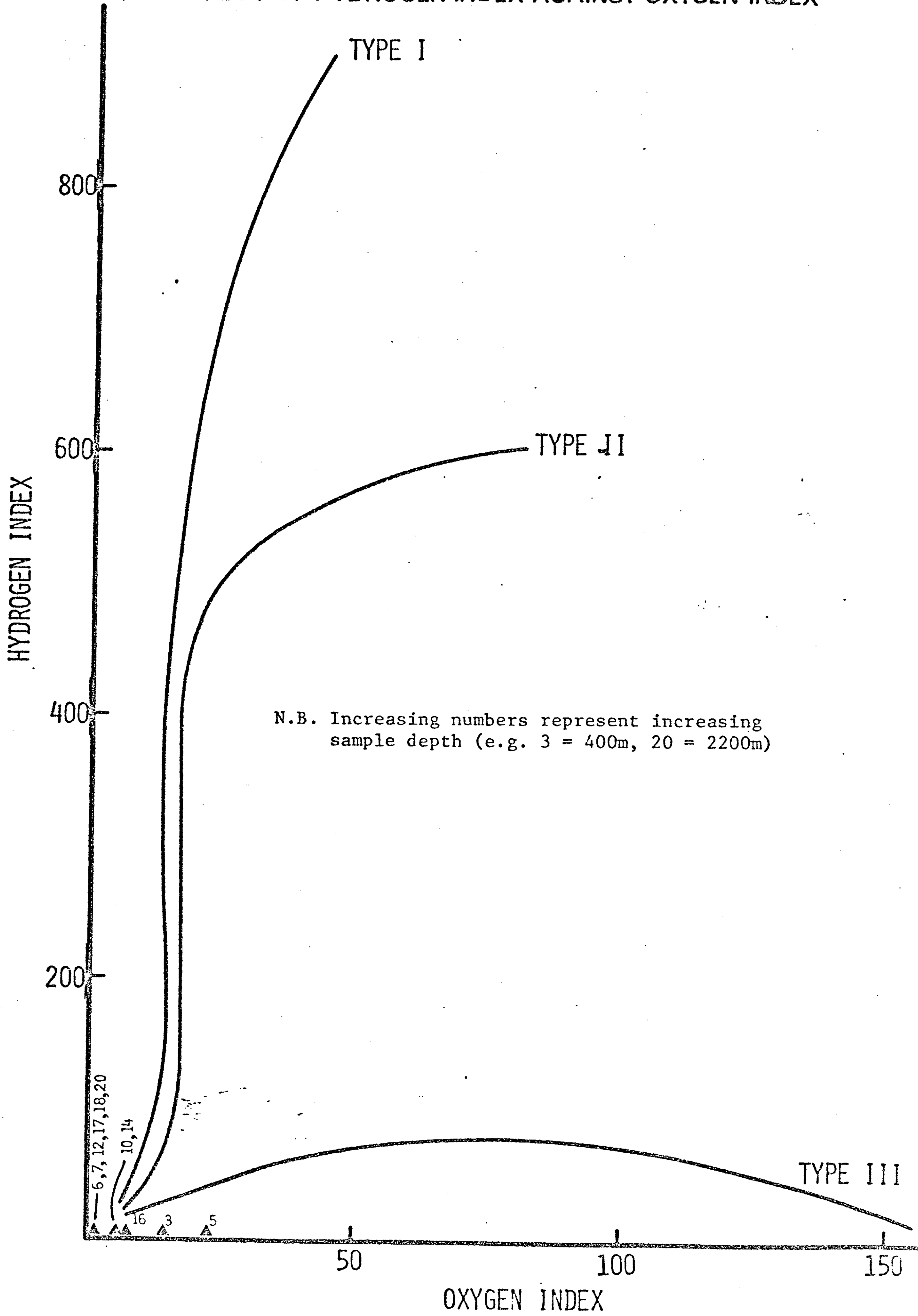
Source Type

A plot of hydrogen index versus oxygen index is shown over the page. The location of the data points on this plot suggests that these sediments are very mature and thus we cannot comment on their kerogen type.

PLOT OF PRODUCTION INDEX VERSUS SEDIMENT BURIAL DEPTH



PLOT OF HYDROGEN INDEX AGAINST OXYGEN INDEX



N.B. Increasing numbers represent increasing sample depth (e.g. 3 = 400m, 20 = 2200m)

CONCLUSIONS

(i) The samples are generally moderately endowed with organic carbon, although this is apparently residual carbon;

(ii) The level of free petroleum (S_1) and pyrolysable petroleum (S_2) in these sediments is extremely low;

(iii) The poor potential yield (S_1+S_2) data is most likely due to the sediments having been overmatured, as evidenced by the low hydrogen index and oxygen indes values;

(iv) It is possible that these sediments generated and expelled oil and/or gas prior to being overmatured. Of course such petroleum may have suffered the same fate as the source sediments;

(v) Conventional Rock-Eval maturation and source typing parameters are of little use in this study.

APPENDIX IX.

OLANGOLAH NO. 1

Organic petrology of a suite of samples from Olangolah No. 1

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A report prepared for
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August 1982

Olangolah No. 1

Contents

Organic petrology of a suite of samples from Olangolah No. 1

Introduction

Ten cuttings and one junk basket samples were received from Gas and Fuel Exploration N/L for petrological examination of the contained organic matter. These samples covered a depth interval from 195m to 2200m and are believed to be from the Eumeralla Formation.

Short descriptions of the organic matter in each sample, together with vitrinite reflectance data and descriptions of rock-types, are given in Appendix 1. This report draws together the petrological and other data for the suite of samples and develops an interpretation of the source-potential of, and the extent to which hydrocarbons are likely to have been generated from, the sequence drilled at the location of Olangolah No. 1. Estimates of the thermal history and the possible timing of maturation are also made.

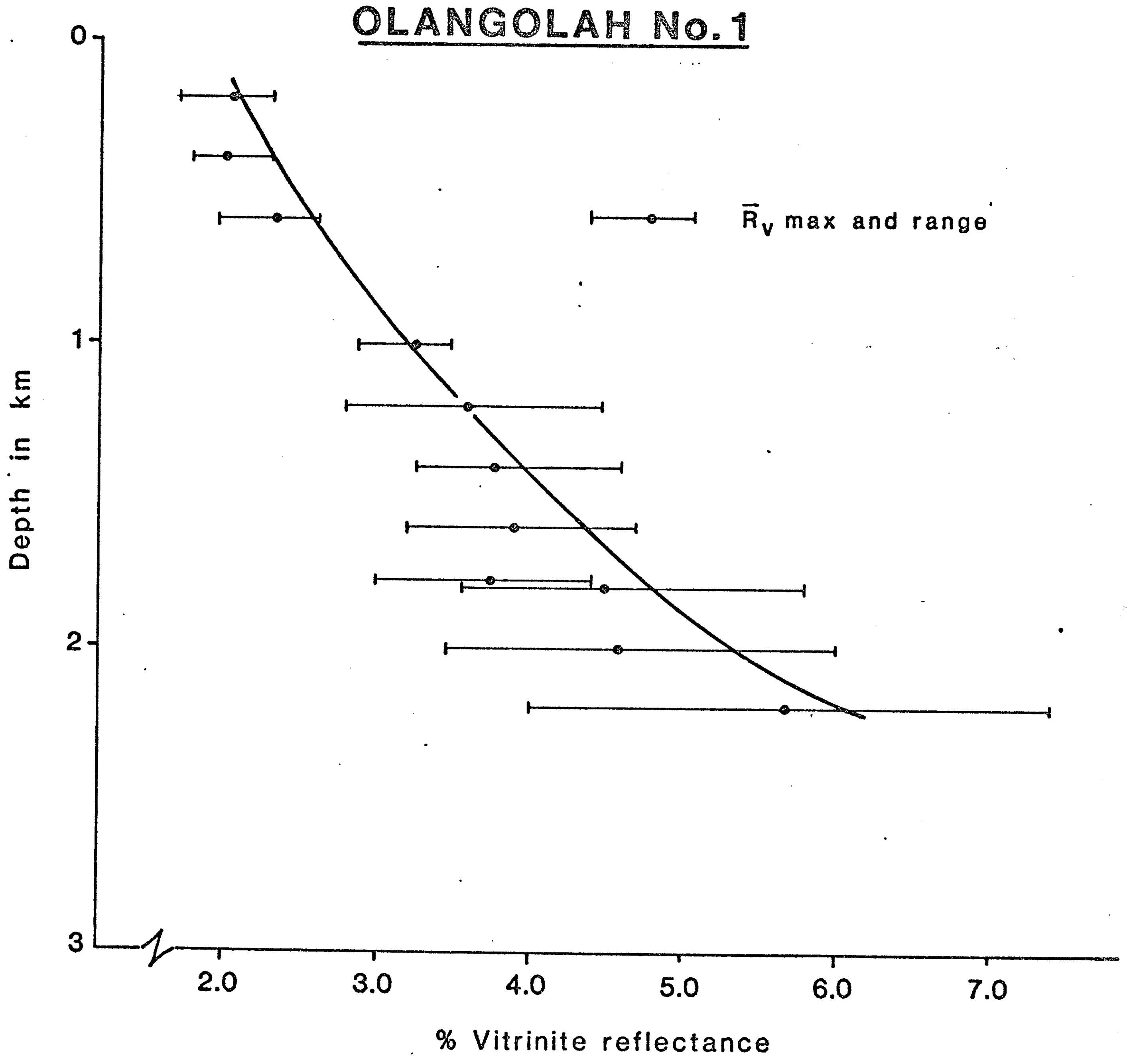
Experimental Methods

Samples were mounted in cold-setting polyester resin and polished "as received", so that whole-rock samples rather than concentrates of organic matter were examined. This method is preferred to the use of demineralised concentrates because of the greater ease, with whole-rock samples, of identifying first generation vitrinite. The whole-rock method also permits the examination of maceral associations and is useful in establishing the R_{max} and true R_{min} values.

Vitrinite reflectance measurements were made using immersion oil of refractive index 1.518 (at 546nm and 23°C) and spinel and garnet standards of 0.42%, 0.917% and 1.726% reflectance. Fluorescence-mode observations were made to provide a check that the anthracitic vitrinite was not a reworked population. For fluorescence-mode, a 3mm BG 3 excitation filter was used with a TK400 dichroic mirror and a K490 barrier filter. A Leitz MPV 1.1 photometer mounted on a Leitz Orthoplan was used for photometric work. A separate Opak illuminator is normally used for examination in fluorescence-mode.

Vitrinite Reflectance

The sample set provides good control over the variation of the vitrinite reflectance as a function of depth, even though the range of reflectance from each sample is relatively high. The ranges obtained may be partly due to the presence of cavings, but with high rank samples, the R_{max} values may be difficult to find and the distinction of vitrinite from inertinite is not always unequivocal, especially in sections parallel to bedding. In defining the vitrinite population, measurements were made first on the more highly bireflecting phytoclasts — that is vitrinite sectioned perpendicular to, or nearly perpendicular to, bedding. All eight samples were found to contain vitrinite. Twenty readings were obtained for all samples except for that from 1000m where only ten readings were obtained. In all samples, the vitrinite population was relatively well defined. The results for the samples fall on a smooth trend. They provide a good indication of the level and the rate of change (with


OLANGOLAH No.1
$\overline{R}_V$ max and range
Depth in km
0
1
2
3
2.0
3.0
4.0
5.0
6.0
7.0
% Vitrinite reflectance

depth) of maturation (Fig. 1, p 4). The best estimate of maturation (solid curve on Fig. 1) is drawn to take account of the possibility of cavings and the probability that measurement errors will be biased towards lower readings rather than high readings.

The level of maturation is very high with all samples being beyond the oil dead-line ($\bar{R}_{max}$ 1.3%) and beyond the normal limit of commercial gas production ($\bar{R}_{max}$ 2.0%). The three shallowest samples lie slightly below the reflectance trend for the deeper samples but indicate that the upper part of the section is overmature. The relatively smooth form of the reflectance profile, and the high bireflectances found for much of the vitrinite (Plates 1, 2 and 3, and 4 and 5), indicate a normal coalification history rather than very localized contact metamorphism. However, it is clear that the temperatures involved must have been unusually high (see also the section on Thermal History). Slight evidence of a mosaic texture was found in the sample from 600m, but evidence of contact metamorphism is generally lacking. Petrologically the vitrinite resembles the meta-anthracites of the Cooper Basin (Kantsler et al 1978) rather than those described by Creaney (1980). Bireflectance exceeds 2.0% in many of the samples and appears to be typical of that for normally coalified vitrinite.

The reflectance gradient is high with the reflectance increasing at an average of 1.82%/km. This is an average for the depth interval sampled and the tangents to the curve give lower values in the upper part of the section and higher values in the lower part of the section. The reflectance gradient is not, however, unusually high for overmature sections.

Organic Matter Type

Dispersed organic matter (d.o.m.) ranges from rare to abundant (less than 0.1% to >2.0%) but is typically sparse (0.5% to 2.0%). Vitrinite is typically more abundant than inertinite but, at high ranks, these macerals cannot always be reliably distinguished. Vitrinite occurs as small to moderately large phytoclasts (Plates 1 to 5). No fragments derived from coal seams were found. Exinite is also difficult to distinguish but some of the phytoclasts with very high values for R_{max} and bireflectance may be cutinite (Plate 6). The lack of exinite fluorescence is due to the high rank of the sequence. Relatively little variation was found in organic matter type.

Mineral matter fluorescence is weak to absent. Small amounts of chalcopyrite were noted in one of the samples. Pyrite is present in most samples, none appears to have been altered to pyrrhotite.

Thermal History

The sequence must have suffered early, rapid coalification under a significant cover of younger sediments. The duration of coalification is not known but was probably much less than the total age of the sequence. Estimates of palaeotemperatures using the total age of the sediment will give minimum estimates. The estimates in Table 1 were made using the Bostick recalibration of the Karweil nomogram (Appendix 2). The Karweil nomogram is not well calibrated for such high rank coals, but the data in Table 1 give

Table 1. Model temperatures for Olangolah No. 1.

Depth m	Vitrinite Reflectance	Assumed age	Model Temperatures	
			T_{ISO}	T_{GRAD}
150	2.0	120my	130	208
1900	5.1	120my	240	384
2200	6.2	120my	>240	>384

an indication of the order of the magnitude of temperatures involved.

The duration of coalification must have been much less than the total age of the sediments, so that the estimates in Table 1 are likely to be systematically low. The palaeo-geothermal gradient probably exceeded 100°C/km. The depth of cover which has been removed was probably in excess of 1.5km and less than 2.5km. Assumptions concerning the timing of coalification do not greatly affect the estimate of cover loss.

These inferred temperatures contrast markedly with reported well temperatures for the Otway Basin (typically less than 130°C) and with model tempertures based on vitrinite reflectance (maximum value 152°C for T_{GRAD}). The reflectance profiles for some other wells may be consistent with a loss of cover in excess of 1km. Thus, it is probable that the area in which Olangolah No. 1 was drilled was subject to very high temperatures soon after deposition of the sedimentary sequence drilled. Subsequent uplift and erosion has been similar to, or marginally greater than, that in other parts of the onshore Otway Basin notwithstanding the very high rank of near-surface samples.

Hydrocarbon Generation

The source-potential of the sequence ranged from poor to moderately good prior to coalification. The proportion of exinite cannot be estimated accurately so that it is difficult to be definitive concerning the relative importance of oil generation as compared with gas during maturation. The overmature to highly overmature nature of the sequence means that the hydrocarbon potential at Olangolah is restricted to dry gas. Hydrocarbon generation must have occurred early in the history of the sequence. Such timing is commonly considered to give enhanced migration efficiency, and early reservoiring can result in the preservation of porosity and permeability in sandstones at unusually high levels of maturity.

Levels of maturation in the Otway Basin are typically much lower than those found in Olangolah. For example, the depth to the 0.7% reflectance level is typically in excess of 2000m. The high rank found at Olangolah is likely to affect a significant area. Hydrocarbons generated within this area will have largely been driven out of the high rank part of the section. Some zones of anomalously high rank are associated with an aureole of hydrocarbon accumulation. Two of the best known are the Bramsche Massif in W. Germany (Teichmüller and Teichmüller, 1968) and the Nappamerri trough in the Cooper Basin of South Australia (Kantsler and Cook, 1979/1982). If these analogies hold, a potential exists for the existence of hydrocarbon accumulations between the location of Olangolah and areas showing maturation levels more typical of the Otway Basin. Wet gas index should increase away from the high rank areas and some potential exists for oil accumulation peripheral to the zone of high rank.

Conclusions

The section at Olangolah is overmature. The coalification appears to be a response to a regional rise in temperature rather than to contact metamorphism, but the maturation level for Olangolah is clearly anomalous as compared with reported data for the Otway Basin. The original source-potential of the sequence ranged from poor to moderately good. Exinite cannot be reliably distinguished but is probably present. Potential exists for the occurrence of hydrocarbon accumulations between the location of Olangolah and the typical low levels of maturation found in the Otway Basin. Coalification probably occurred at an early stage with temperatures in the lower part of the sequence probably exceeding 300°C and reaching approximately 200°C in the upper part of the sequence.

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Plate Captions

V - vitrinite

R.L. reflected white light

Fl. fluorescence mode

PLATES

The Plates have been printed from photomicrographs using 35 mm transparencies. All the photomicrographs were taken using oil immersion. Magnification is indicated by the field width given in the Plate captions. Polarized light was not used for all of the photographs and Plate 1 was taken using partially crossed polars.

Plate 1. Ctgs. 600m

Large phytoclast of vitrinite.
$\bar{R}_v$max 2.35%.

Partially crossed polars, R.L., field width 0.27mm.

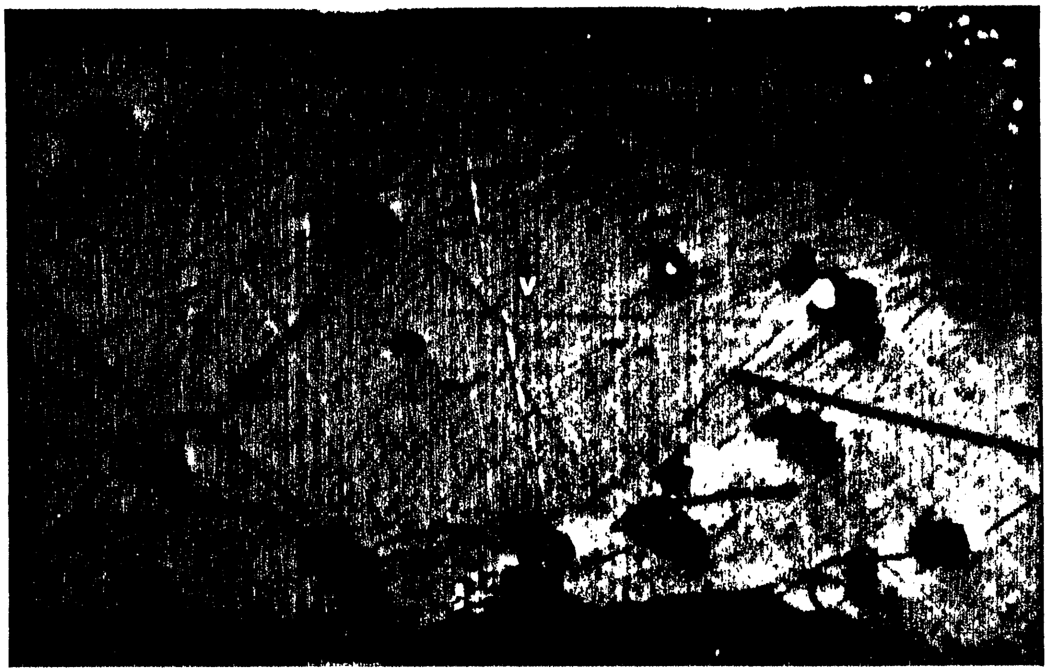
Plate 2. Ctgs. 1200m

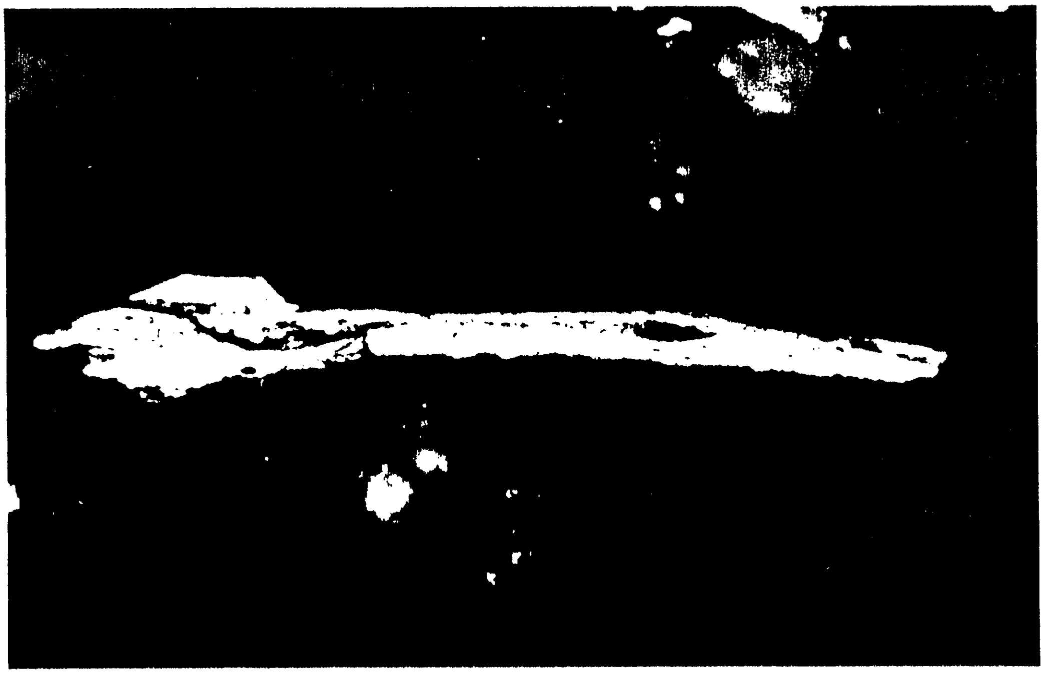
Vitrinite phytoclast photographed in plane polarized light with the polarization direction of the analyser running "E-W".
$\bar{R}_v$max 3.60%.

R.L., field width 0.27mm.

Plate 3.

As for Plate 2, but with the analyser rotated 90° to give illumination in the Rmin position.





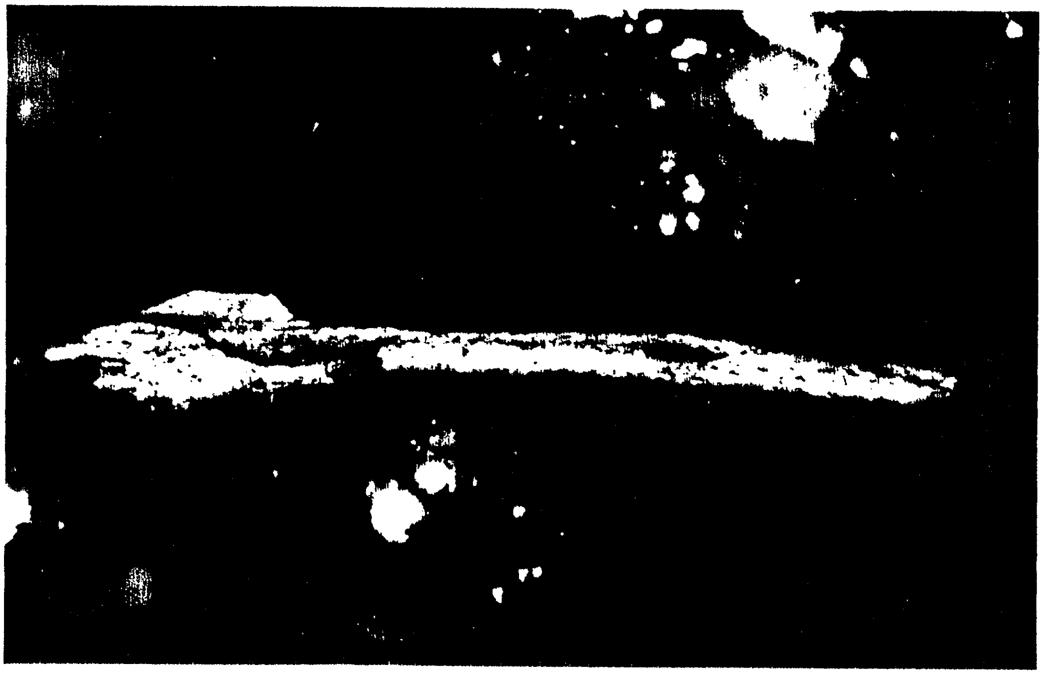


Plate 4. Ctgs 1400m

Vitrinite phytoclast photographed in the illumination conditions used for measurement of Rmax. Polarizer direction and Rmax direction are both "NE-SW".
Rmax 3.78%.
$\bar{R}_v$max 4.04%.

R.L., field width 0.27mm.

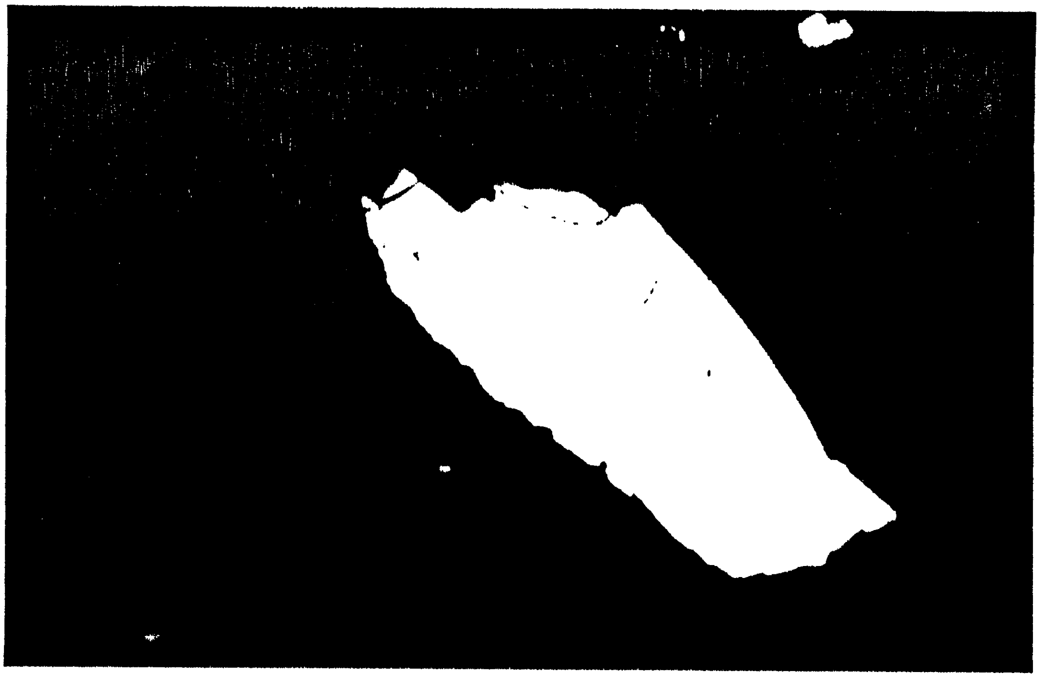
Plate 5.

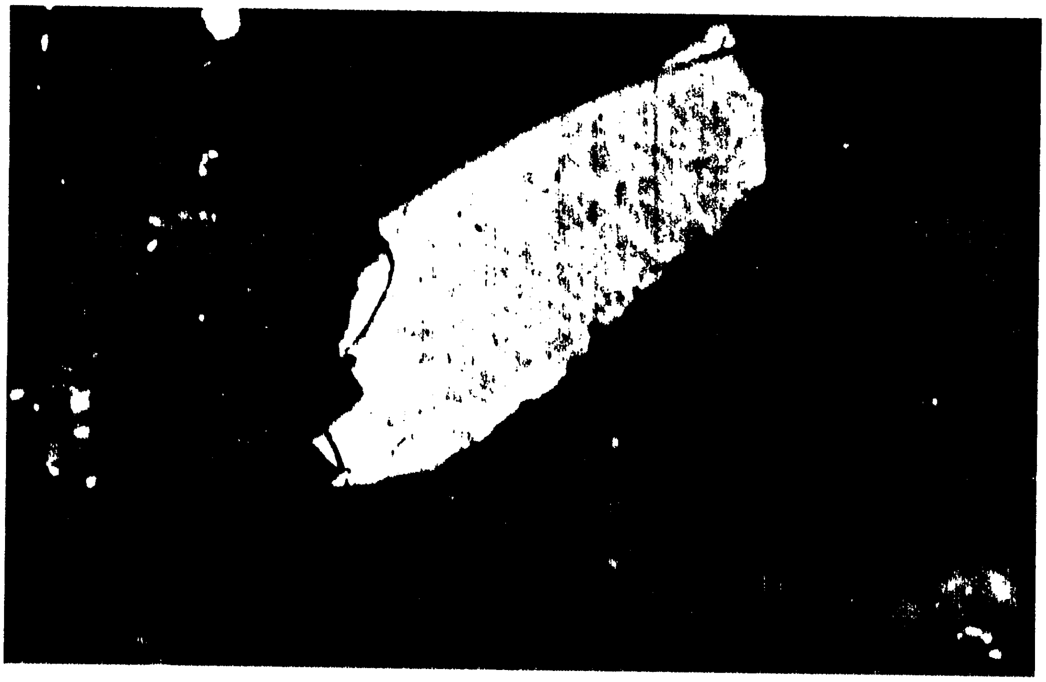
As for Plate 4, but stage rotated through 90° to the measurement position for Rmin. Rmin 1.72%. More surface texture can generally be distinguished in the Rmin position.

Plate 6. Junk basket 1765m

Phytoclast possibly derived from plant cuticle. The form and extreme bireflectance suggest that the phytoclast may be cutinite, but its optical properties are very similar to those of vitrinite. Rmax 4.40%, Rmin 1.28%

$\bar{R}_v$3.76%.





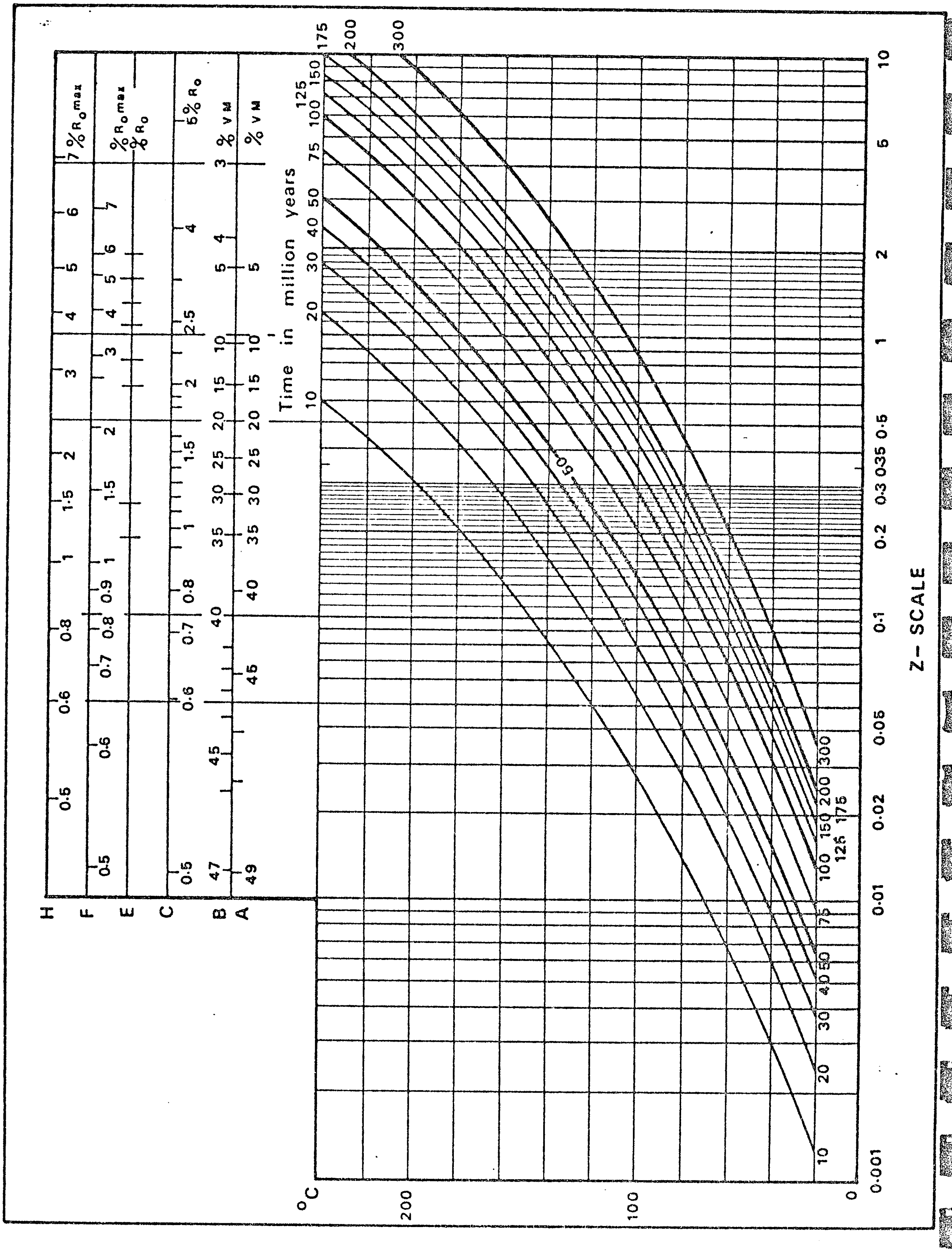
OLANGOLAH No. 1

K.K. No.	Depth	$\bar{R}_o$max	Range	N	Exinite Fluorescence (Remarks)
16025	195 Ctgs	2.05	1.73-2.47	11	No fluorescing exinite. (Calcareous siltstone and sandstone with d.o.m. rare to sparse, V>I. Vitrinite rare.)
16026	400 Ctgs	2.01	1.82-2.35	16	No fluorescing exinite. (Calcareous siltstone, claystone, and sandstone. D.o.m. rare to sparse, V>I, vitrinite rare. Rare chalcopyrite present.)
16027	600 Ctgs	2.35	1.97-2.63	20	No fluorescing exinite. (Claystone and siltstone with rare coal or thick vitrinite layers. D.o.m. rare but sparse vitrinite, chiefly as isolated grains derived from thick layers of massive telocollinite. V>>?I. Slight evidence of very fine-mosaic structure present in the vitrinite. No other evidence of contact alteration.)
15902	1000 Ctgs	3.26	2.90-3.50	10	No fluorescing exinite. (Claystone with abundant carbonate, d.o.m. rare, V>I, E not distinguished. Vitrinite and inertinite are both rare. Pyrite rare, some iron oxide minerals present.)
15903	1200 Ctgs	3.60	2.80-4.44	20	No fluorescing exinite. (Claystone with d.o.m. sparse, V>I. Vitrinite sparse, inertinite rare. The bireflectance of the vitrinite ranges up to 2.11%.)
15904	1400 Ctgs	3.78	3.25-4.60	20	No fluorescing exinite. (Similar to 15903, d.o.m. sparse V>I. Vitrinite sparse, small phytoclasts.)
15905	1600 Ctgs	3.90	3.20-4.70	20	No fluorescing exinite. (Silstone and claystone, d.o.m. sparse, V>I. Vitrinite and inertinite sparse.)
15754	1765 Junk basket	3.76	3.00-4.40	20	No fluorescing exinite. (Silty mudstone with abundant d.o.m., macerals difficult to distinguish due to very high rank, probably V>I>E. The vitrinite has a high bireflectance, R_{min} approx 1.9%, and the highest reflectance values were probably measures on cutinite. The level of maturity indicated is higher than that usually associated with adequate permeability for gas production.)
15906	1800 Ctgs	4.50	3.57-5.80	20	No fluorescing exinite. (Siltstone, sandstone and claystone, d.o.m. common, V>I, vitrinite common, inertinite sparse. Pyrite sparse to common.)
15907	2000 Ctgs	4.56	3.47-6.00	20	No fluorescing exinite. (Claystone and siltstone with abundant carbonate, d.o.m. rare to sparse, V>I.)
15908	2200 Ctgs	5.69	4.00-7.40	20	No fluorescing exinite. (Siltstone, claystone and sandstone, d.o.m. common V=I, vitrinite and inertinite both sparse. Bireflectance of vitrinite high, up to 4.18%.)

Appendix 2 Thermal History Models

The Karweil nomogram (Fig 2-1) can be used to determine the third variable if two of the three variables — rank, temperature and time of coalification — are known. Thus, using Scale C, a reflectance of 2%, and an age of 120 million years, gives a coalification temperature of 130°C. A z value of 0.7 corresponds to the reflectance value of 1%. The z value is a measure of coalification work and is an additive quantity. The temperature of 130°C is that which, if operative over the period of 120 million years, would give z value of 0.7. Given the form of the equation relating time, temperature and z, it is possible to recalculate the isothermal temperatures to fit a model of an initial temperature of 10°C and constantly rising temperature. The final or gradthermal temperature T_{grad} is effectively given by T_{iso} X 1.6. The factor (1.6) is not a constant and does vary with the value of T_{iso} but the variation is small in relation to other possible errors. The Karweil nomogram is known to be wrong in detail but has given model temperatures which have proved useful in terms of testing assumptions concerning thermal history in a number of sedimentary basins. Scales C ($R > 0.6$) and H ($R < 0.6$) are normally used by the author and a recalibration of the scales is being undertaken. The value of model temperatures lies chiefly in their use in a qualitative way to compare the model temperature data from a set of wells with present well temperatures.

Figure 2-1



KARWEIL DIAGRAM (AFTER BOSTICK)