

1985/19. Source rocks from Squid #1, Bass Basin

P.W. Baillie

Abstract

Source rock studies indicate that the Eastern View Coal Measures encountered during the drilling of Squid #1 contain moderate to good source rocks with gas prone terrestrial kerogen Type II/III, but that the section drilled is immature.

INTRODUCTION

Squid #1 and #1 Sidetrack were drilled in the Bass Basin on behalf of a consortium headed by Weaver Oil and Gas Corporation, Australia. The well was located at 40°11'53.344"S, 146°18'27.340"E and penetrated 2925 m of the Tertiary sequence before being plugged and abandoned as a dry hole without hydrocarbons.

Rock Eval pyrolysis is a firmly established routine technique for determining type and maturation of organic matter (Tissot and Welte, 1984). Yields from pyrolysis are related to both the amount of organic matter and its richness, or hydrogen content.

Rock Eval and vitrinite reflectance data are included without comment as part of Appendix 4 in the Well Completion Report for Squid #1 and #1 ST (Weaver, 1985). It is the purpose of this report to analyse this data.

RESULTS

Data are presented in tabular form (Table 1) and also plotted against depth (fig. 1).

The potential of a source to yield hydrocarbons to a reservoir is a function of the amount of organic matter in the rock (Powell, 1985) and its ability to yield hydrocarbons. Total Organic Carbon (TOC; %) is a measure of organic matter, and a value of 0.5% is usually taken as a lower limit for source beds (Tissot and Welte, 1984). Minimum values are of significance because a critical level of hydrocarbons has to be reached before expulsion from a source rock is possible.

The yield of free hydrocarbons in the rock is S1 (kg/tonne). The yield of pyrolysable hydrocarbons from kerogen is known as S2 (kg/tonne) and oxygen-containing volatiles are represented by S3, the yield of carbon dioxide (kg/tonne) from pyrolysis of kerogen.

The type of kerogen is characterised by two indices: the hydrogen index (HI; S2/organic carbon) and the oxygen index (OI; S3/organic carbon).

S1 + S2 is an evaluation of the genetic potential of the rock and the following classification is used by Tissot and Welte (1984):

- <2 kgt⁻¹ (2000 ppm): poor source rock,
- 2-6 kgt⁻¹ (2000-6000 ppm): moderate source rock,
- >6 kgt⁻¹ (6000 ppm): good source rock

T_{max} is recorded at the maximum temperature of hydrocarbon generation during pyrolysis.

The transformation rates or productive index (PI; S1/S1 + S2) is a

valuable index of maturation and can also be used for a quantitative evaluation of any hydrocarbons generated.

A direct indication of thermal maturation is provided by vitrinite reflectance. The following stages are generally recognised (\bar{R}_o is mean reflectance in oil, and for the purposes of this report can be considered equivalent to \bar{R}_{max}):

- $\bar{R}_o < 0.5$ to 0.7% : diagenesis stage, rock immature,
- 0.5 to $0.7\% < \bar{R}_o < 1.3\%$: catagenesis stage, main zone of oil generation ("Oil Window"),
- $1.3\% < \bar{R}_o < 2\%$: catagenesis stage, zone of wet gas and condensate,
- $\bar{R}_o > 2\%$: metagenesis stage, dry gas (CH_4) zone.

DISCUSSION

A plot of source rock types using hydrogen and oxygen indices (Tissot and Welte, 1984) of the Squid rocks (fig. 2) indicates that the rocks contain Type II/III kerogen which is consistent with a terrestrial origin for the Eastern View Coal Measures.

Of more interest is a plot of HI against T_{max} . Isoreflectance lines have been superimposed on the plot (Gorter, 1984). This plot, together with vitrinite reflectances obtained (Table 1), clearly indicates that the section penetrated by Squid is immature and reinforces the current exploration philosophy in Bass Basin, i.e. to test Palaeocene and Late Cretaceous sections.

Notwithstanding the overall immaturity, good source rocks are present in the section penetrated by Squid, particularly in the sections 1900-2000 m and 2400-2550 m. Given the total thickness and age of the Eastern View Coal Measures in the whole of Bass Basin, these results are promising and indicate that suitable source rocks are probably present in sections within the catagenesis zone and that significant hydrocarbons may have been generated in some parts of the Basin.

REFERENCES

GORTER, J.D. 1984. Source potential of the Horn Valley Siltstone, Amadeus Basin. *APEA J.* 24:66-90.

POWELL, T.G. 1985. Applying geochemical concepts to Play Analysis and basin evaluation. *PESA J.* 6:25-39.

TISSOT, B.P.; WELTE, D.H. 1984. *Petroleum formation and occurrence.* Springer-Verlag : Berlin.

WEAVER OIL & GAS. 1985. Squid No. 1 and No. 1 ST Well Completion Report. *Unpubl.Rep.Weaver Oil & Gas Corporation, Australia.*

[11 April 1985]

Table 1. ROCK-EVAL AND VITRINITE REFLECTANCE DATA FROM SQUID #1.

Depth (m)	T _{max}	S1	S2	S3	S1+S2	P1	TOC	HI	OI	R _{max}
1840 - 1855	427	1.05	5.57	2.49	6.62	0.16	4.37	127	56	
1930 - 1945	424	0.46	1.53	1.40	1.99	0.23	1.34	114	104	
1945 - 1960	425	0.99	11.28	2.19	12.27	0.08	5.02	224	43	0.40
1975 - 1990	428	1.46	25.48	3.09	26.94	0.05	9.89	257	31	0.43
2020 - 2035	431	0.90	15.43	2.42	16.33	0.06	6.91	223	35	
2095 - 2110	536	1.29	2.93	1.70	4.22	0.31	9.38	31	18	
2200 - 2215	539	2.88	10.77	1.00	13.65	0.21	41.80	25	2	2.05*
2305 - 2320	428	0.32	0.44	0.95	0.76	0.42	0.69	63	137	
2365 - 2380	445	0.47	1.63	1.53	2.10	0.22	7.64	21	20	2.05*
2425 - 2440	428	13.13	146.11	2.16	159.24	0.08	44.61	327	4	0.55
2530 - 2545	432	3.06	36.47	1.09	39.53	0.08	12.47	292	8	0.55
2645 - 2660	429	1.37	10.57	0.77	11.94	0.11	3.24	326	23	
2750 - 2765	433	0.38	2.29	2.81	2.67	0.14	1.32	173	212	0.54
2900 - 2915	434	1.17	7.17	1.49	8.34	0.14	3.40	210	43	

* Thermally altered vitrinite

19-3

3/5

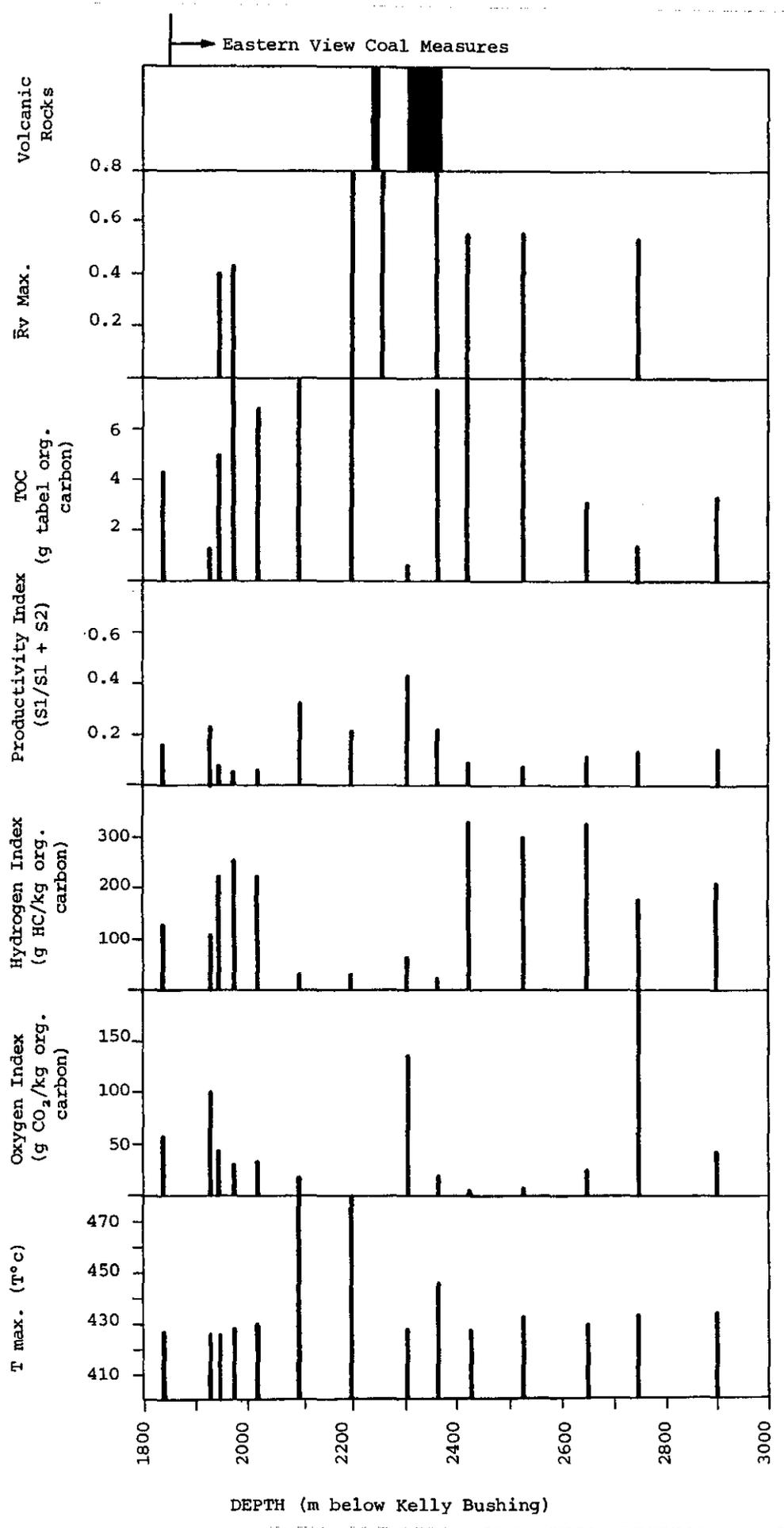


Figure 1.

5 cm

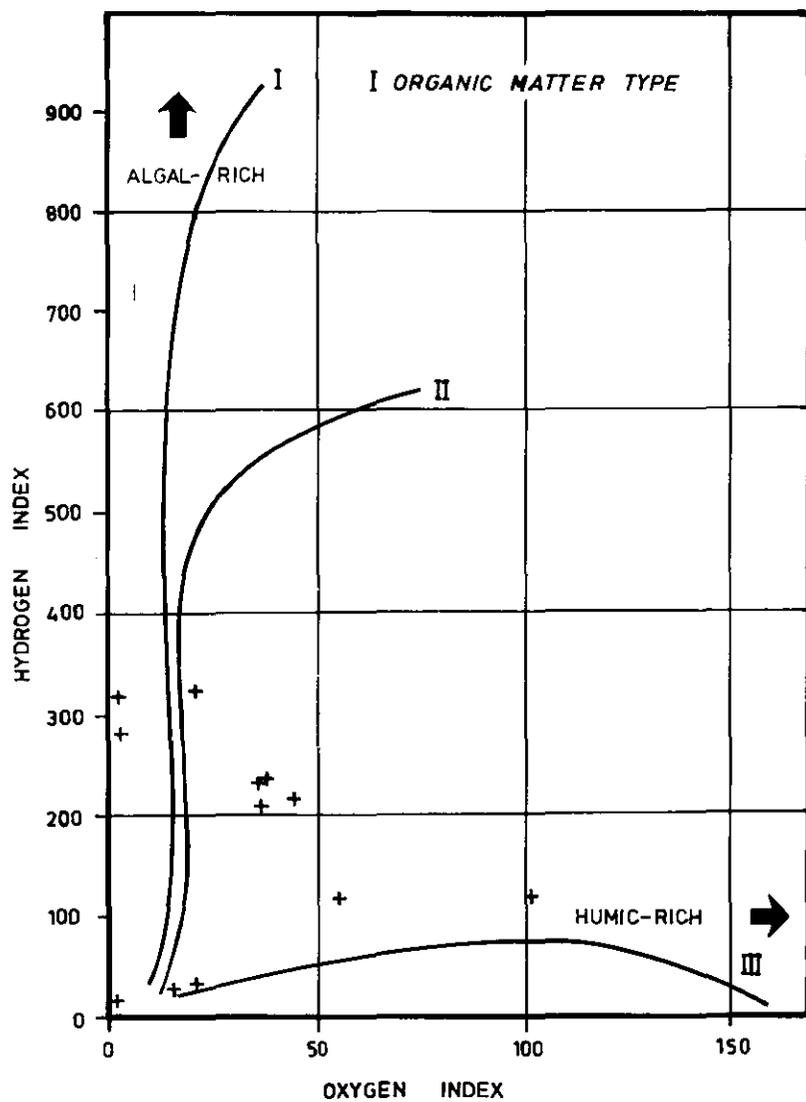


Figure 2. Hydrogen index v oxygen index

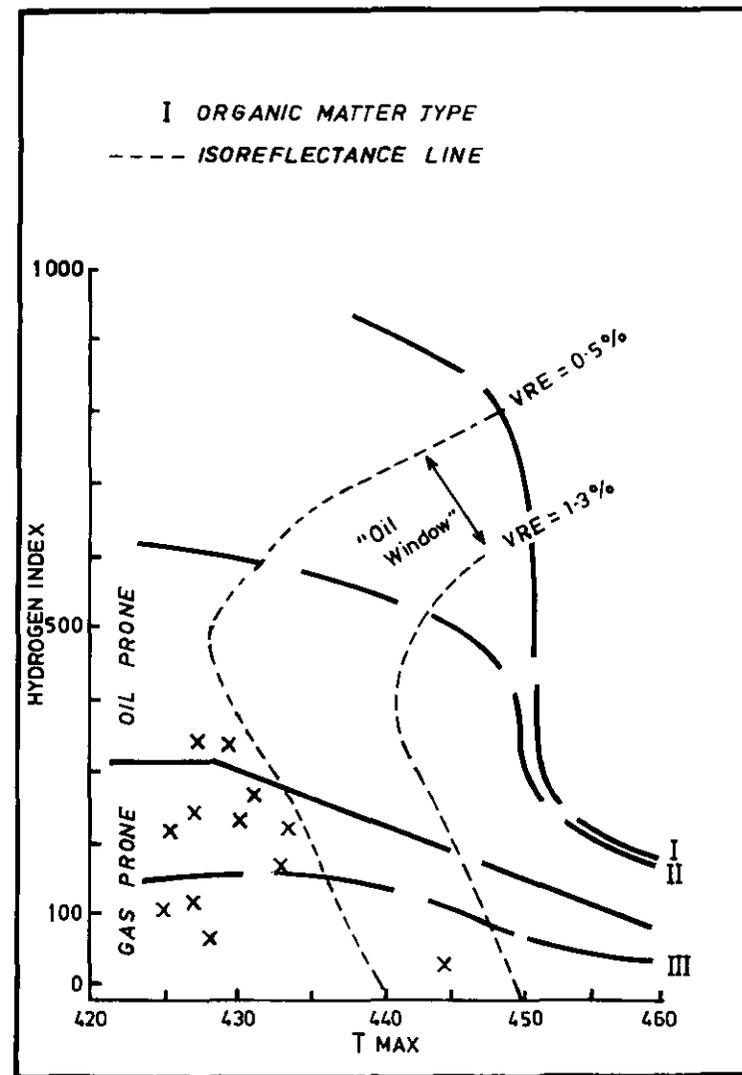


Figure 3. Geochemical crossplot based on Rock-Eval - Tmax v Hydrogen index

5 cm