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OTWAY BASIN

SOURCE ROCK STUDIES - DATA
(Reports for the period
October 1981 - July 1991)

Submitted by

various petroleum exploration companies plus
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1991

ENVELOPE 5876

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WELL REPORT NO. 10

Organic Petrology of the Sedimentary Sequence
at Robertson No. 1

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October 1986

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Introduction

Thirty samples from Robertson No. 1 were examined for the assessment of organic matter type and abundance and maturation level. Twenty eight samples are cuttings, two samples were taken from cores. The stratigraphic thickness covered by individual cuttings samples varies from 25 feet to 65 feet (8m to 20m). Robertson No. 1 intersects a 1400m (4646 feet) thick Lower Cretaceous sequence, overlain by sediments from the Tertiary Knight Group and Gambier Limestone. No Upper Cretaceous sediments are present at Robertson No. 1. The samples include three samples from the Tertiary, twenty four from the Lower Cretaceous and two from the ?Pre-Cretaceous. The deepest sample examined was taken from 'Basement'. The location of Robertson No. 1 is shown in Figure 1.

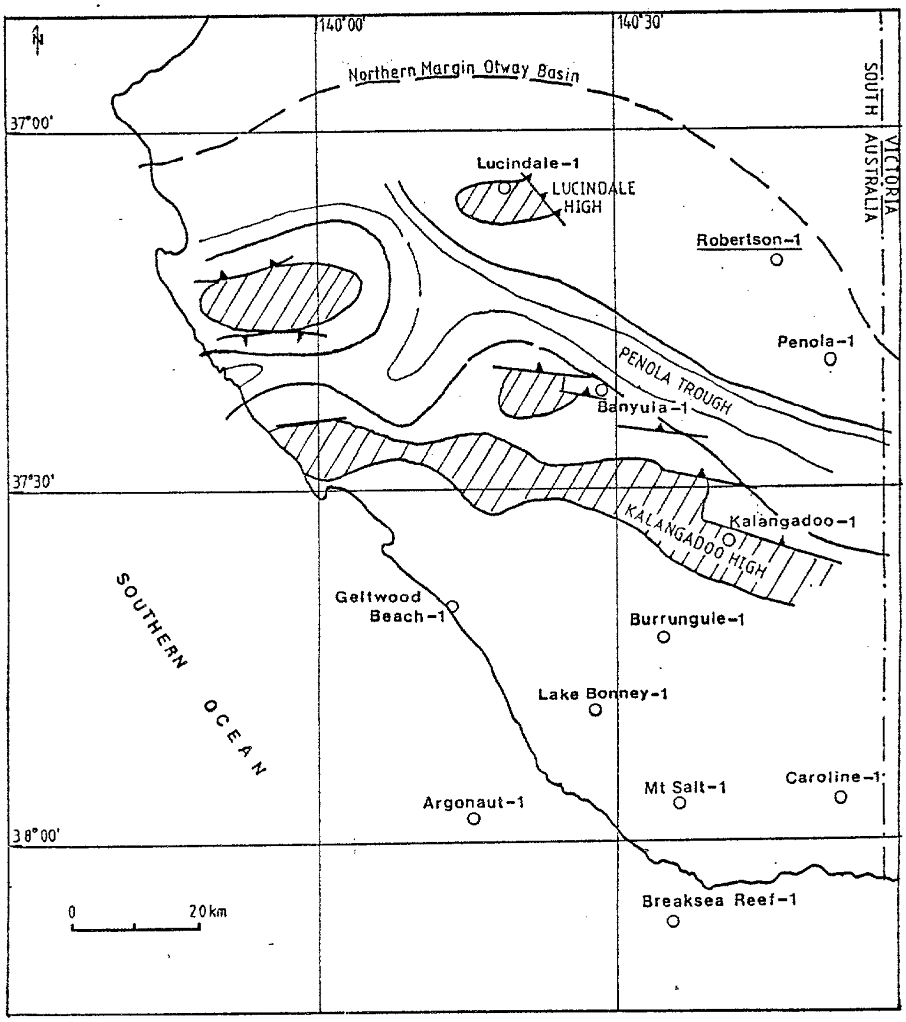

Figure 1: Location of Robertson No. 1.

Short descriptions of the organic matter type, rock-types and reflectance data are given in Appendix 1 and in Tables 1 and 2.

The 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. The samples were cut and polished perpendicular to the 'bedding' in the grain mount (the term bedding is here used for the layering associated with the settling of grains in the mounting process). Samples marked with an asterisk in Appendix 1 were polished parallel to 'bedding' due to an insufficient amount of sample.

Vitrinite reflectance measurements were made using immersion oil of refractive index 1.518 (at 546 nm and 23°C) and spinel and garnet standards of 0.42 %, 0.917 % and 1.726 % reflectance. For fluorescence-mode, a 3mm BG 3 excitation filter was used with a TK 400 dichroic mirror and a 490 barrier filter. A Leitz MPV 2 photometer mounted on a Leitz Orthoplan was used for photometric work. A separate Opak illuminator is used for examinations in the fluorescence mode.

The maximum reflectance of vitrinite ($R_v max$) was measured for all occurrences and the mean of the maximum reflectance values ($\bar{R}_v max$) is reported in Table 2 and is used in Figures 11 and 12. Additionally, the maximum reflectance of inertinite ($R_i max$) was measured where possible. This gives control on the vitrinite reflectance and indicates the maturation level of samples where vitrinite is absent (Smith and Cook, 1980).

For the examination of organic matter type and abundance, the percentage of each maceral group occuring as coal, shaly coal and dispersed organic matter (dom) is estimated using comparison charts (Appendix 2) for each grain encountered during a series of traverses of the grain mount. The number of grains examined is normally fifty. The abundance of each maceral group and, for dom, the total dom abundance, is recorded for each grain using a series of abundance categories (Appendix 2). The categories are rare (< 0.1 %), sparse (0.1 % - 0.5 %), common (0.5 % - 2 %), abundant (2.0% - 10%) and major (> 10%), approximately corresponding to the geochemical concepts of source rocks as poor, marginal, good, very good and prolific, based on T.O.C. values.

Organic Matter Type and Abundance

The relative abundance and maceral composition of dispersed organic matter (dom), coal and shaly coal is presented graphically in Figures 2 to 8. A summary of the organic matter type and abundance found in the major stratigraphic units is shown in Table 1 and Figures 9 and 10.

Figure 2 shows that low to moderate dom contents were observed in samples from the upper part of the Eumeralla Formation, whereas samples from the remaining Lower Cretaceous sequence contain moderately high amounts of dom. Very high dom content was found in one sample from the upper Pretty Hill Formation and in one sample from the ?Pre-Cretaceous. Very little dom is present in samples from the Tertiary. A comparison of Figures 3, 4 and 5 with Figure 2 shows that liptinite is the most abundant maceral in dom of the Eumeralla Formation. Inertinite is predominant over liptinite and vitrinite in most samples from the Pretty Hill Formation.

The abundance of coal and shaly coal is given in Figure 6. Two horizons containing abundant to major coal/shaly coal were observed within the Eumeralla Formation. In the Pretty Hill Formation, coal is absent or present in traces only, except for the uppermost sample which contains abundant coal and shaly coal. Figure 7 shows that vitrinite is the major component in coals from the Eumeralla Formation with inertinite contents ranging between about 20% and 30%. Coals from the upper part of the Eumeralla Formation contain very little liptinite, but considerable amounts of liptinite (10-18%) were observed in coals from the deeper part. Pretty Hill Formation coals typically show mono-maceral microlithotypes with vitrinite and inertinite being the dominant constituents. Figure 8 shows that liptinite content in shaly coal is considerably higher than in associated coals, whereas the percentage of inertinite is lower in most samples.

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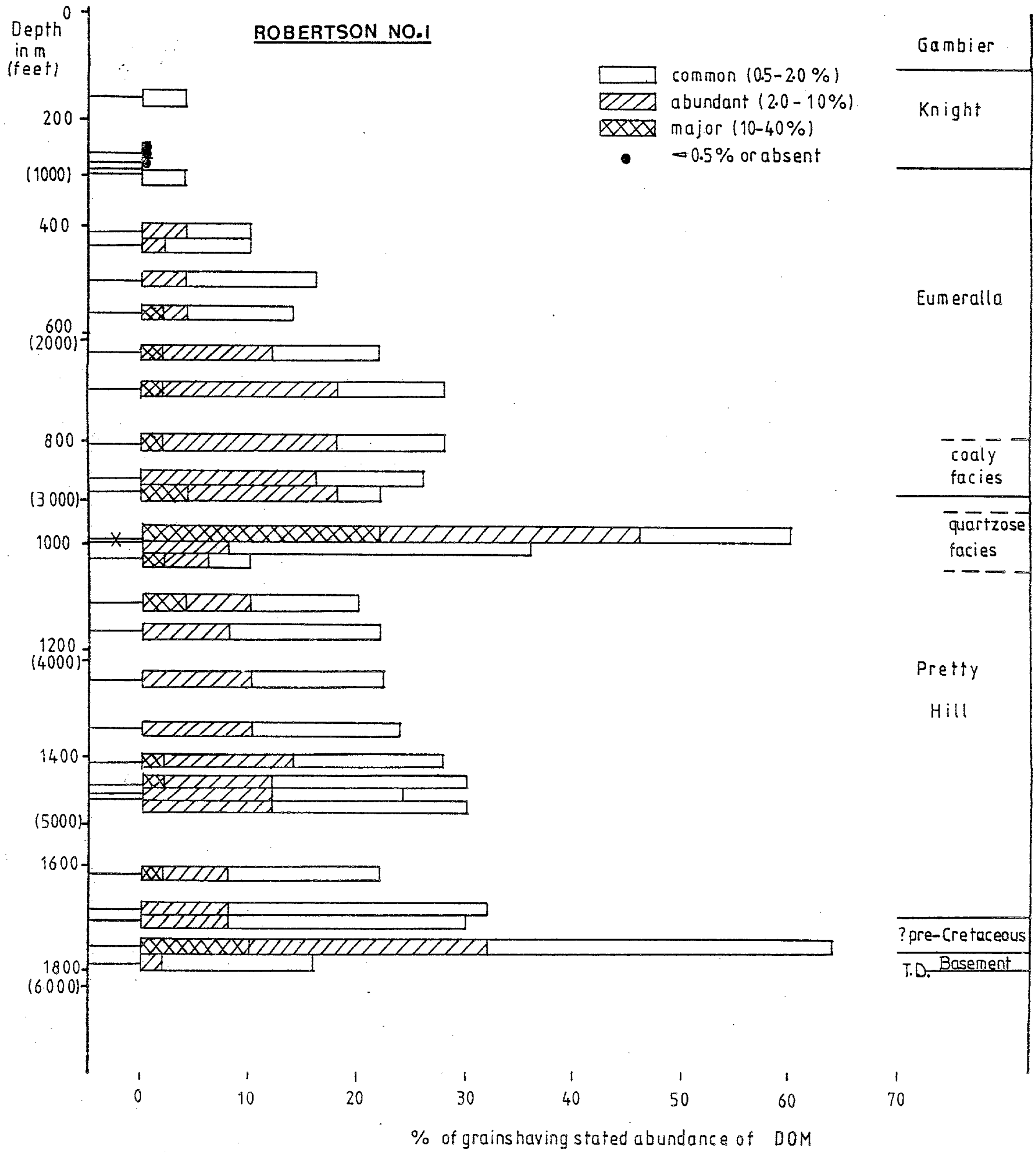

Figure 2: Abundance of DOM in Robertson No. 1.
(x - core sample)

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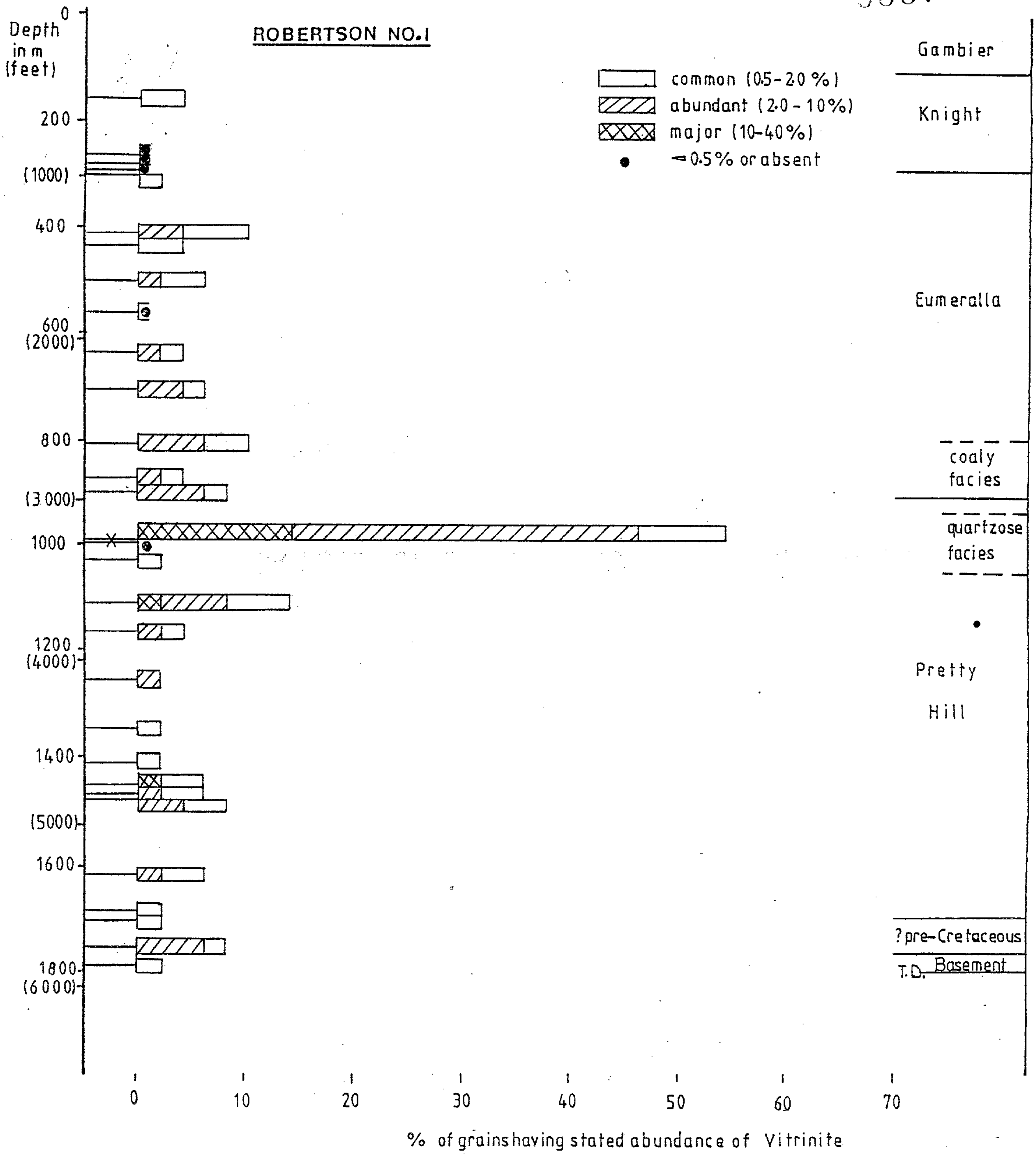

Figure 3: Abundance of Vitrinite in DOM in Robertson No. 1.
(X - Core samples)

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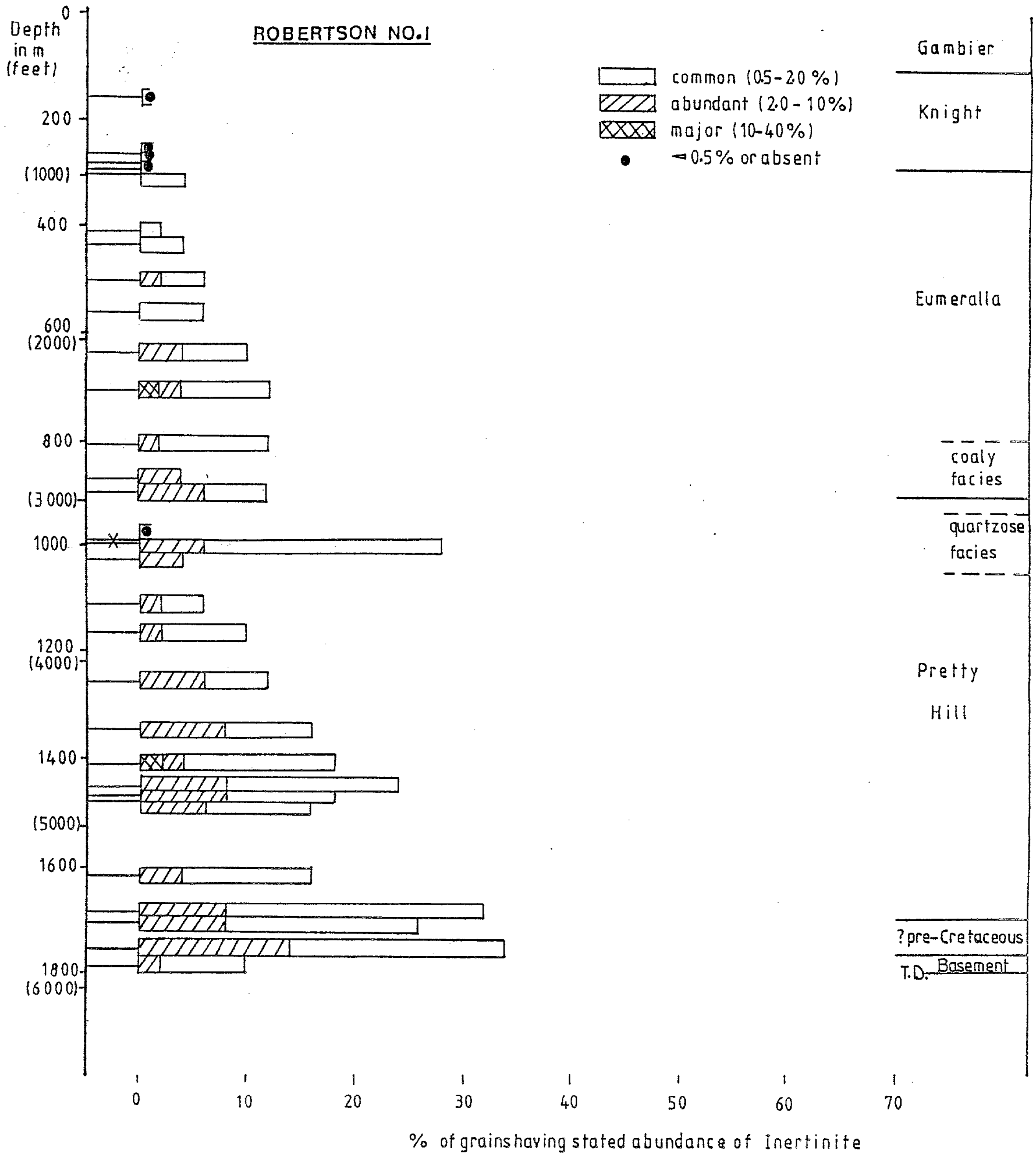

Figure 4: Abundance of inertinite in DOM in Robertson No. 1. (X - core samples)

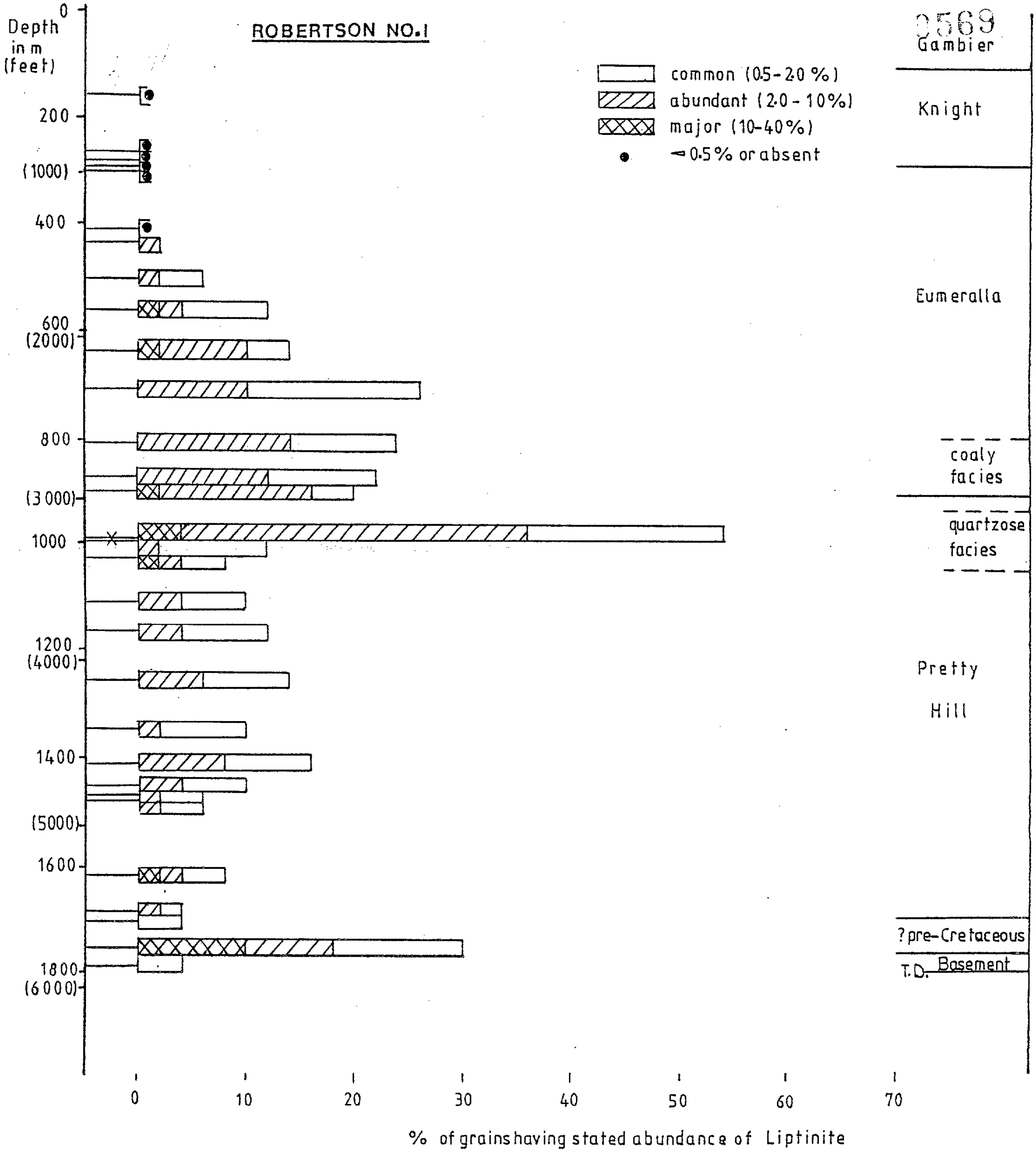

Figure 5: Abundance of Liptinite in DOM in Robertson No. 1.
(X - core samples)

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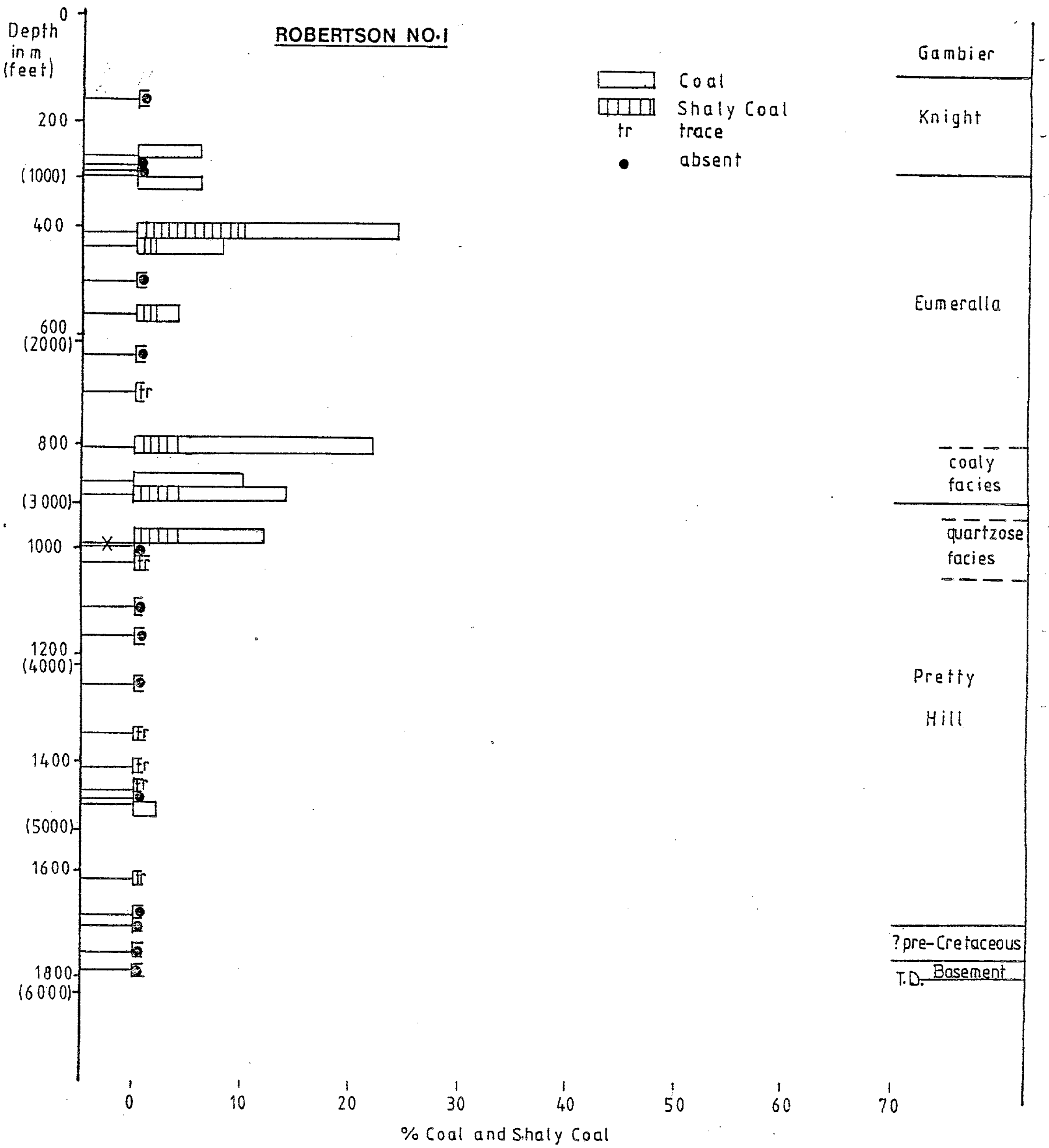

Figure 6 : Abundance of Coal and Shaly Coal in Robertson No. 1. (X - core samples)

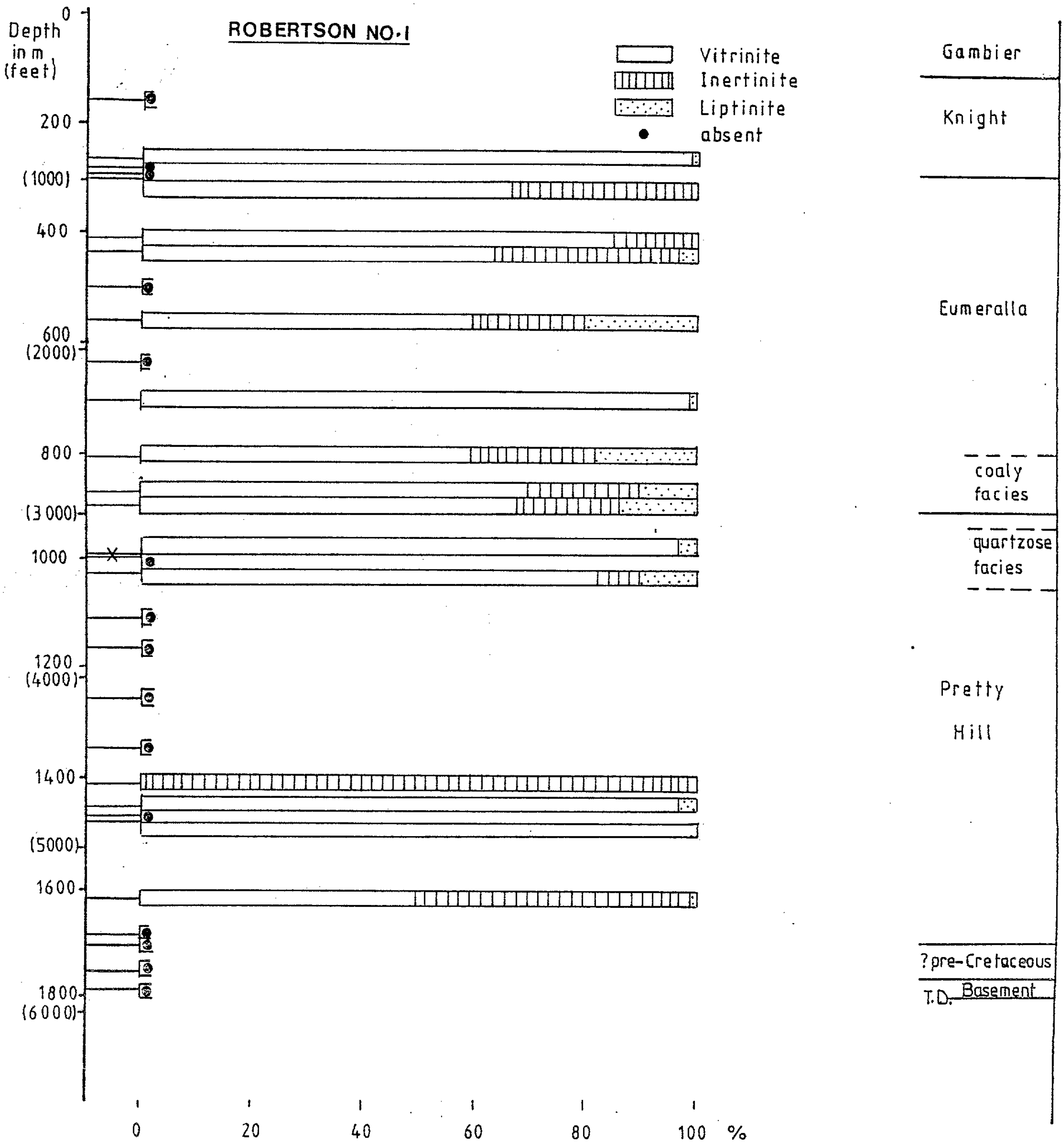

Figure 7: Maceral composition of Coal in Robertson No. 1.
(X - core samples)

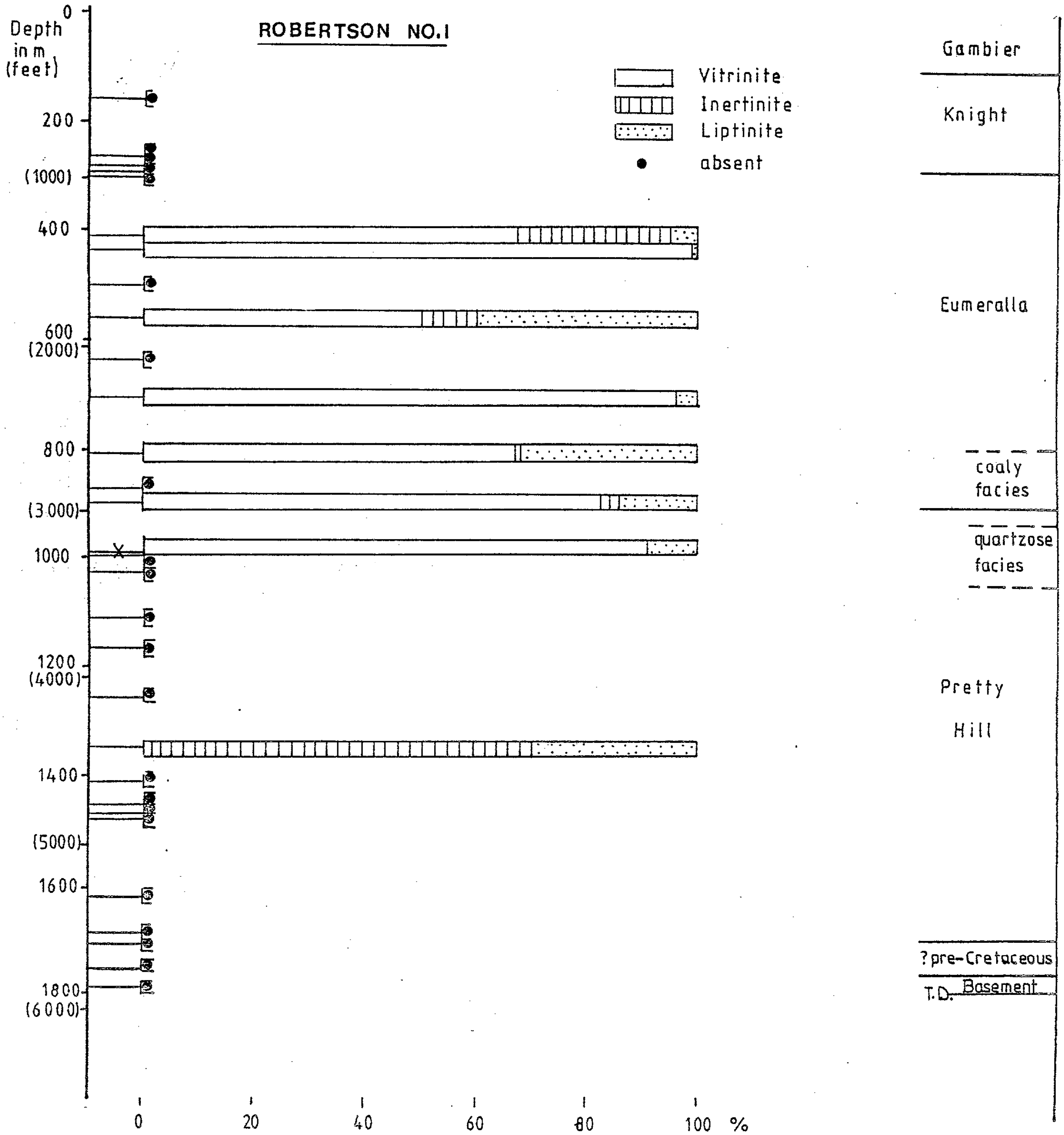

Figure 8: Maceral composition of Shaly Coal in Robertson No. 1. (X - core samples).

The Tertiary Knight Group was examined in three samples. The dominant sandstone lithology is virtually barren and dispersed organic matter mainly occurs in minor siltstone lithologies. Overall, dom is rare with liptinite being the most abundant maceral. Liptinite consists mainly of liptodetrinite, although minor amounts of sporinite, cutinite and resinite were identified. Abundant coal (vitrite) was observed in one sample from 259-274m (850-900ft) comprising ulminite, texto-ulminite and eu-ulminite as typical vitrinite macerals.

Eleven samples were examined from the Eumeralla Formation. Sandstone and sandy siltstone form the typical lithology and predominate over carbonate, coal, shaly coal and claystone. Dispersed organic matter is mainly confined to siltstones, sandy siltstones and claystones (where present). Although the number of samples taken from the Eumeralla Formation is relatively low, a subdivision of the sequence into an upper organic poor and a deeper organic rich part can be made. It should be noted, however, that the terms organic poor and organic rich are used in a relative sense. For example, the organic rich part of the section in Robertson No. 1 contains considerably less dom than that in Banyula No. 1 (Figure 9).

Overall, the upper part of the Eumeralla Formation (282m to about 600m/925 to 1969 feet) contains sparse dom comprising sparse liptinite and vitrinite as the most abundant macerals. Coal is abundant in this part of the section with vitrite and inertite (fusite) being the characteristic microlithotypes. Several samples also contain shaly coal which is typically richer in liptinite than the associated coals. Rare to sparse liptodetrinite is the dominant liptinite maceral, but minor to moderate amounts of sporinite and cutinite are also present. Suberinite and resinite occur mainly in samples containing coal, and rare phytoplankton (?acritarchs) is restricted to one sample from 497-506m (1630-1660ft).

Common dom comprising common liptinite and sparse inertinite and vitrinite was observed in the deeper part of the Eumeralla Formation (about 600m to 905m/1969ft to 2970ft). Abundant to major coal and abundant shaly coal are present in the 'coaly facies' which is part of the organic rich section. The coals are rich in vitrinite, but also contain significant amounts of inertinite (18-22%) and liptinite (10-18%). Clarite and duroclarite are the characteristic microlithotypes, but significant amounts of clarodurite and vitrite are also present. Durite, vitrinertite and fusite are of minor occurrence. Shaly coals contain significantly less inertinite, but liptinite contents are high. Clarite is the typical related microlithotype. Yellow to dull orange fluorescing sporinite, liptodetrinite and cutinite, and brown suberinite are the characteristic liptinite macerals in this part of the section. Rare to sparse resinite is present in all samples and is mainly confined to coal and shaly coal. Additionally, minor amounts of fluorinite and bitumen were observed in two samples, whereas rare ?telalginite is restricted to the deepest sample. Bright greenish yellow fluorescing oil droplets are typically present in coal and shaly coal and detrovitrinite shows brown fluorescence colours.

The vitrinite population found in the Eumeralla Formation shows a variety of maceral types. Detrovitrinite (attrinite, densinite, desmocollinite) is predominant over telovitrinite and is typically associated with suberinite, liptodetrinite, resinite and inertodetrinite. Telovitrinite occurs commonly as cell fillings surrounded by suberinized cell walls. Detrital carbonate and siderite, mostly occurring in siltstones, are ubiquitous in the deeper part of the section. Pyrite is rare to sparse overall, but is more abundant in the upper part of the sequence, where it commonly occurs in framboidal form.

Figure 9 shows a comparison of the organic matter type and abundance in the upper and the deeper part of the Eumeralla Formation in Robertson No. 1 with that in three wells previously examined. Figure 9a shows that in the upper part of the Eumeralla Formation dom contents are lower in Robertson No. 1 than in the other three wells. The abundance of coal and shaly coal, however, is considerably higher in Robertson No. 1. This is partly due to the presence of a coal rich horizon at 405-414m (1330-1360ft), but the low

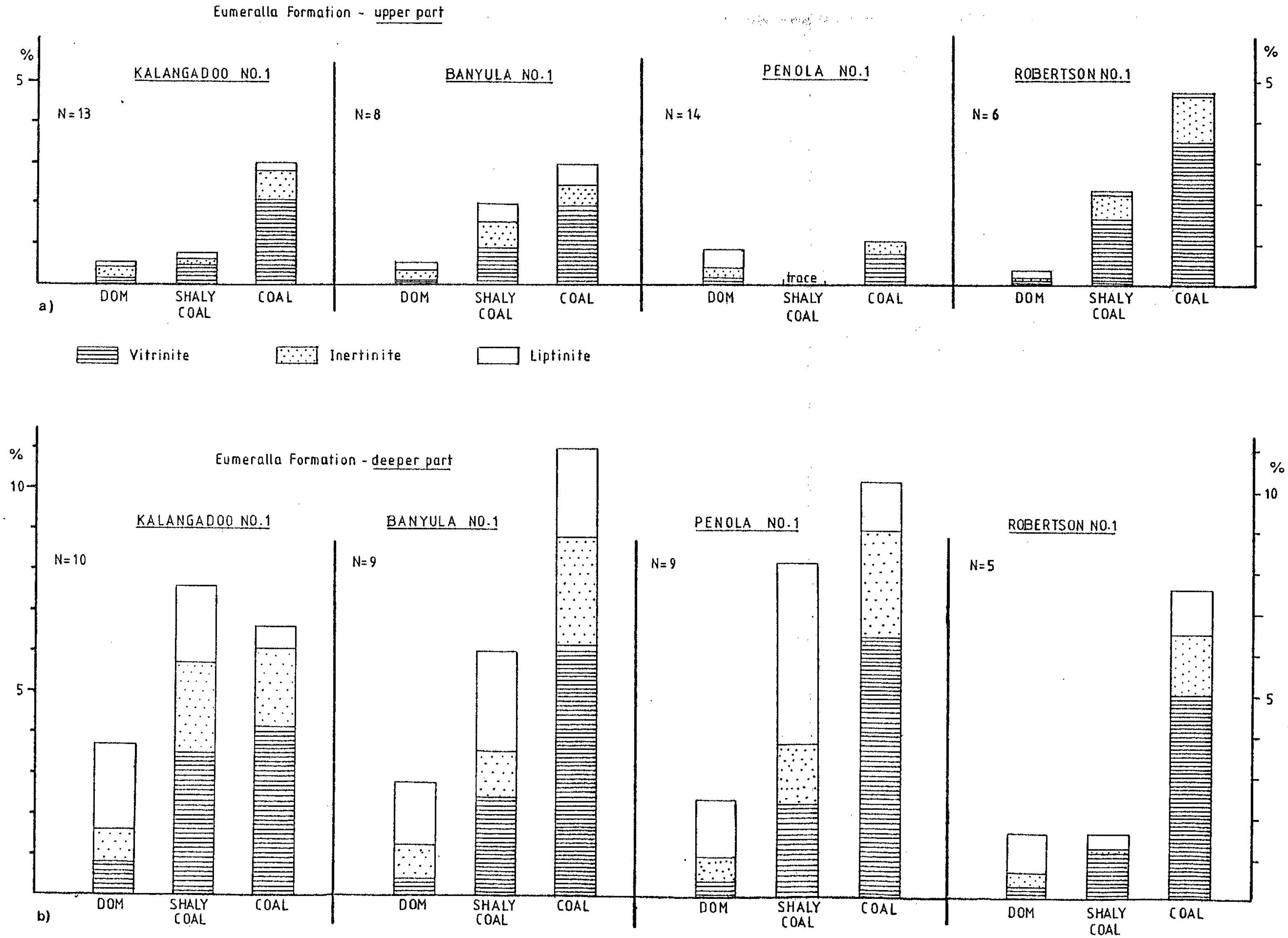

Figure 9: Average abundance of DOM, Shaly Coal and Coal in the Eumeralla Formation of four wells from the Penola Trough area.

number of samples examined from the upper part of the section may bias the average towards a higher value. Dom composition is similar in all four wells, whereas the liptinite content in Robertson No. 1 coals and shaly coals is lower than that in Kalangadoo No. 1 and Banyula No. 1 coals. Figure 9b shows that the overall content in organic matter of the deeper part of the Eumeralla Formation is signifcantly lower at Robertson No. 1 as compared with wells previously examined. But the maceral composition of dom, shaly coal and coal shows good agreement.

The Pretty Hill Formation was examined in thirteen samples. Sandy and calcareous siltstone and sandstone form the typical lithologies and predominate over carbonate and claystone. Dispersed organic matter is common in all samples, except for the uppermost sample, which contains abundant vitrinite and liptinite rich dom. Vitrinite in this sample occurs mostly as leaf tissue, thus being associated with cutinite and resinite. In the majority of the samples inertinite is predominant over liptinite and vitrinite. Overall, inertinite and liptinite are sparse to common and vitrinite is rare to sparse. Except for the uppermost sample, coal/shaly coal is a very minor component in the Pretty Hill Formation and was found in traces only. Vitrite, clarite and fusite are the typical microlithotypes, but minor amounts of durite and duroclarite are also present. Sporinite, cutinite and liptodetrinite are the characteristic liptinite macerals, but minor amounts of resinite were also observed. Rare suberinite is present in several samples, whereas bitumen is restricted to the sample from 1615-1624m (5300-5330ft). Figure 10 shows that samples from the Pretty Hill Formation at Robertson No. 1 contain less dom than those from three wells previously examined. Coal and shaly coal contents are significantly lower than in Kalangadoo No. 1 and Banyula No. 1, but are comparable to those found in Penola No. 1. The maceral composition of dom, shaly coal and coal in Robertson No. 1 is similar to that in Kalangadoo No. 1, whereas the organic matter in Banyula No. 1 and Penola No. 1 is richer in liptinite.

Two samples were examined from the ?pre-Cretaceous. The upper sample is comparable to samples from the Pretty Hill Formation in containing common dom comprising common inertinite, sparse

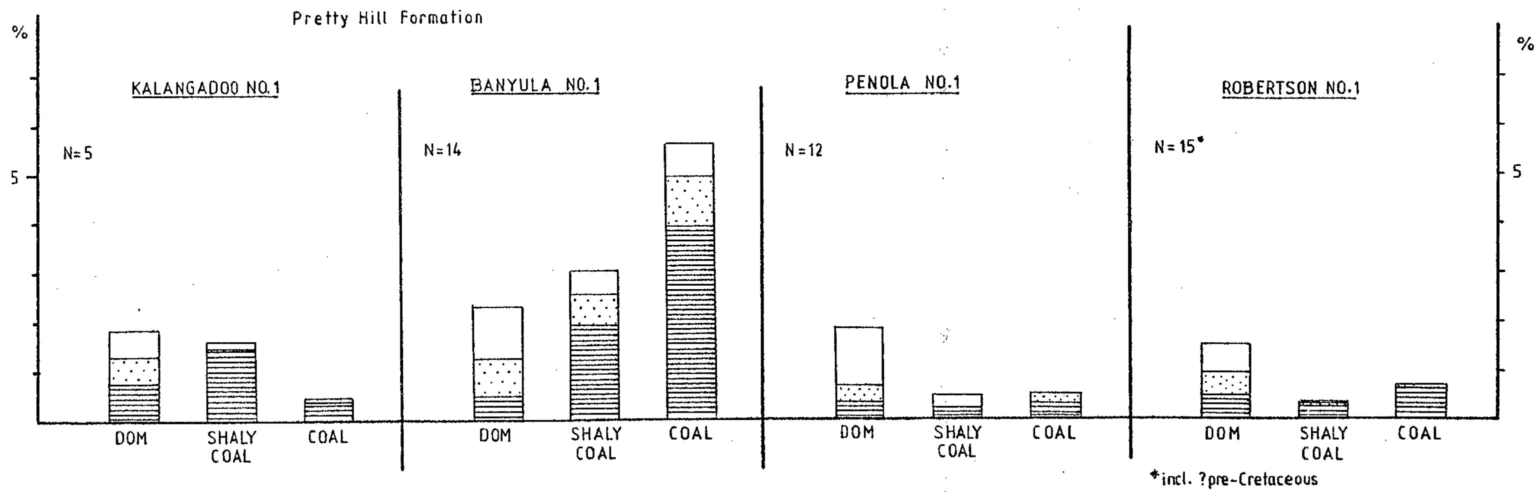

Figure 10: Average abundance of DOM, Shaly Coal and Coal in the Pretty Hill Formation of four wells from the Penola Trough area.

liptinite and rare vitrinite. In contrast to the overlying sediments, claystone forms the dominant lithology in this sample. Liptinite typically consists of liptodetrinite, sporinite and cutinite. The deeper sample is rich in organic matter and contains about 10 to 15% oil shale comprising bright greenish yellow fluorescing Botryococcus-related telalginite and bright yellow to yellow fluorescing lamalginite as the dominant constituents. According to its composition the oil shale can be classified as torbanitic lamosite. The alginite is typically associated with low reflecting vitrinite, but very minor amounts of sporinite are also present. Transitions between oil shales per se and siltstones containing sporinite, liptodetrinite and cutinite were observed. These transitional lithologies typically contain associations of alginite, sporinite and liptodetrinite. The sample covers a depth interval of 13m (40ft) suggesting that the oil shale horizon is relatively thin. Although this sequence is considered to be of possibly pre-Cretaceous age, similarities between the alginite rich horizon at Robertson No. 1 and the deepest part of the Banyula No. 1 section are present. Claystones in the samples overlying basement in Banyula No. 1 contain abundant ?lamalginite which is, however, not associated with Botryococcus-related telalginite as in Robertson No. 1.

Siltstone and sandstone relatively poor in organic matter form the typical lithology in the single sample from Basement. Overall, dom is sparse comprising sparse inertinite and rare liptinite and vitrinite. Liptinite typically consists of liptodetrinite, sporinite and cutinite. The occurrence of minor lamalginite in claystone can probably be attributed to cavings.

The type and composition of the organic matter found in the sequence drilled at Robertson No. 1 give some indications for the depositional environment of the sediments. The presence of oil shales containing major alginite in association with vitrinite strongly suggests a lacustrine environment for the ?Pre-Cretaceous sequence. Land plant derived organic matter is predominant in the Cretaceous section. Relatively poor preservation of the organic matter in the greater part of the Pretty Hill Formation, the predominance of inertinite in dom and the scarcity of coal

Table 1: Summary of organic matter type and abundance in samples from Kalangadoo No. 1, Banyula No. 1, Penola No.1, Robertson No. 1 and Lucindale No. 1.

Unit/ Formation	KALANGADOO-1		BANYULA-1		PENOLA-1		ROBERTSON-1		LUCINDALE-1	
	DOM	COAL	DOM	COAL	DOM	COAL	DOM	COAL	DOM	COAL
Knight Group	rare, V > L	abundant to major V >> L	rare V > I > L	abundant V >> L > I	very rare, V = I = L	rare, V >>L	rare, L > V > I	common, V >> L	very rare, L > V > I	absent
Curdies/ Paaratte	absent	common, V >> L > I	very rare, V = L	absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Belfast/ Waarre	common, I > V >> L	absent	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.
Eumeralla upper part	common, I > V > L	abundant, V > I > L shaly coal common, V > I > L	common, I > L > V	abundant, V > L = I shaly coal abundant, V > I > L	common, L > I > V	common, V > I >> L	sparse, L > V > I	abundant V > I > L shaly coal common, V > I > L	common, L > V > I shaly coal abundant, V > I = L	abundant, V > I > L
Eumeralla - deeper part	abundant, L > V > I	abundant, V > I > L shaly coal abundant, V > I > L	abundant, L > I > V	major, V > I > L shaly coal abundant, V > L > I	abundant, L > I > V	abundant, V > I > L shaly coal abundant, L > V > I	common, L > I > V	abundant, V > I > L shaly coal common, V > L > I		
Pretty Hill Formation	common, V > L > I	sparse, V only shaly coal common, V >> I > L	abundant, L > I > V	abundant, V > I > L shaly coal abundant, V > I > L	common, L > V > I	sparse to common, V > I > L shaly coal sparse, V > L >> I	common, L > V > I, I > L > V	sparse to common, V >> L > I shaly coal sparse, V >> L > I	common, L > I > V	common, V > I >> L shaly coal sparse, V > L > I

N.A. - not applicable

indicate a fluviatile environment for this sequence. The coal rich deeper part of the Eumeralla Formation was probably deposited in a lower energy lacustrine environment. Lacustrine to fluviatile environments are likely to have prevailed during depositon of the remaining Cretaceous sequence, although minor occurrences of ?acritarchs and other phytoplankton indicate some marine influence.

Vitrinite Reflectance

Reflectance measurements were taken from both dispersed organic matter and coal. Table 2 summarizes the reflectance data for Robertson No. 1. Figure 11 shows the mean maximum reflectance and the range of reflectance attributed to each of the horizons sampled. The reflectance profile shows the most probable average trend. For comparison, Figure 12 shows the reflectance data plotted on a semi-log scale.

Good control was obtained for the variation of vitrinite reflectance with depth. Variations in the type of vitrinite, the number of measurements, maceral associations and the possible presence of cavings may influence the results to systematically lower or higher values. The reflectance profile has been drawn to account for these factors. Data for the core sample from 993m (3258ft) were mainly obtained from leaf-derived tissue resulting in a systematically low $\bar{R}_v max$ value. Vitrinite associated with alginite in the sample from 1755m (5740-5780ft) shows a reflectance which is lower by 0.24% $\bar{R}_v max$ (see value marked with asterisk in Figures 11 and 12) than that in siltstones of the same sample containing no alginite. This supports the observations made by Hutton and Cook (1980) about the influence of alginite on the reflectance of vitrinite.

The vitrinite reflectance data indicate that the sediments at Robertson No. 1 are immature down to a depth of about 930m (3051ft). The remaining sequence is marginally mature to mature. The reflectance gradient is very low (0.17%/km) and shows no sharp increase near basement.

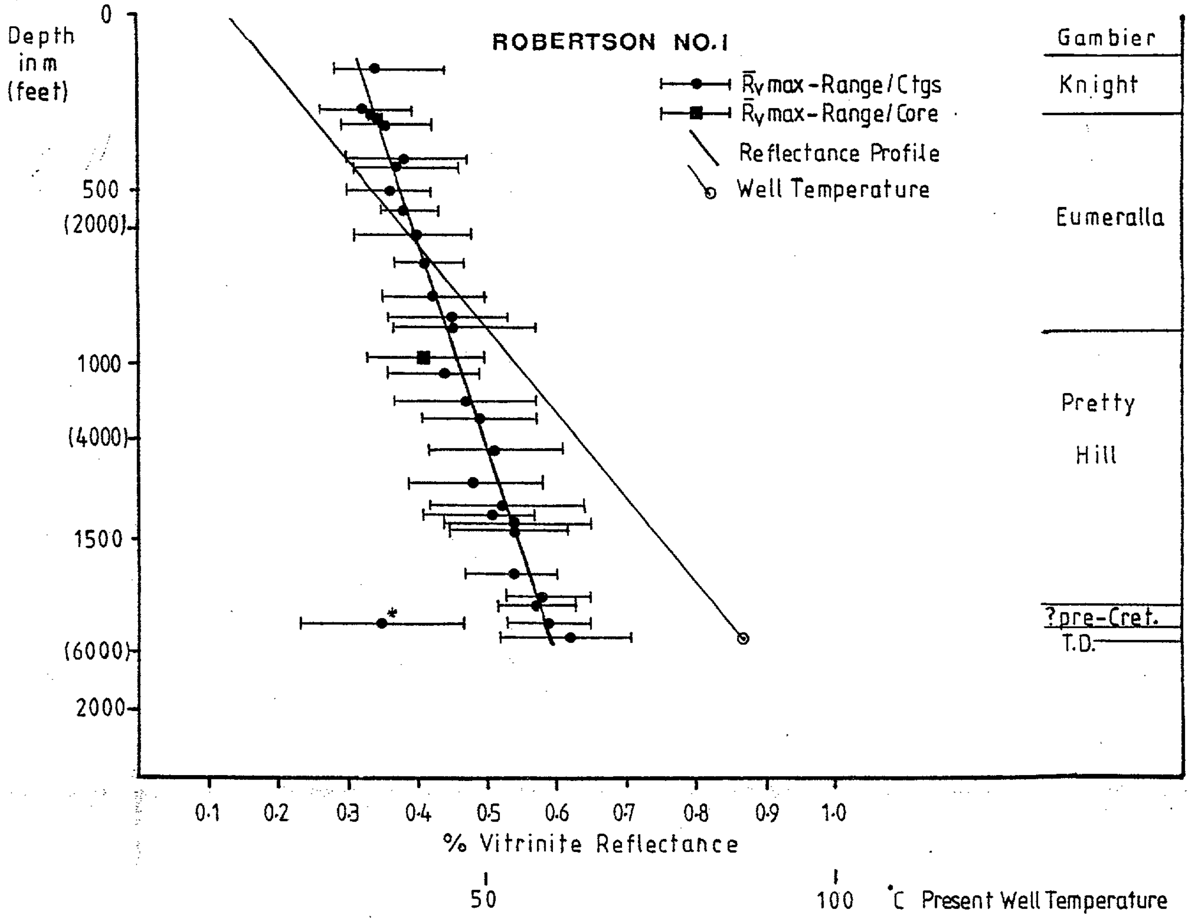

Figure 11: Reflectance Profile for Robertson No. 1 (*vitrinite associated with alginite).

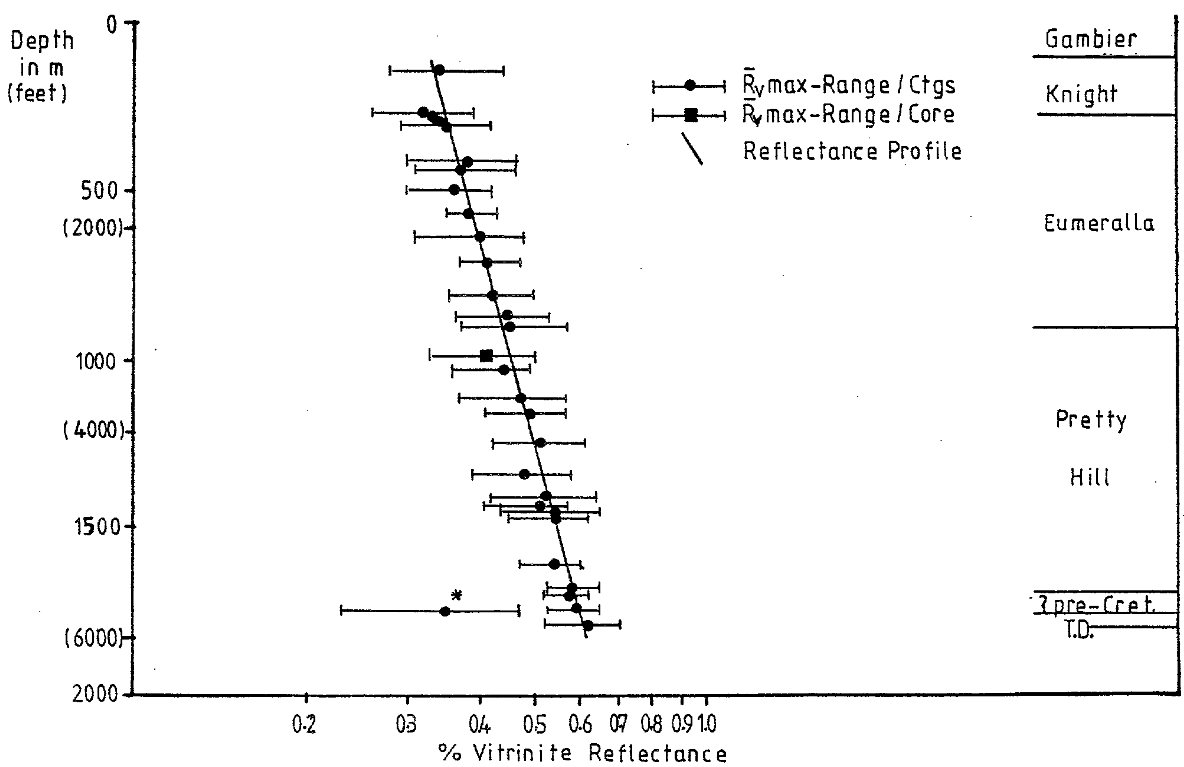

Figure 12: Reflectance Profile (semi-log) for Robertson No. 1 (*vitrinite associated with alginite).

Table 2: Maturation data for Robertson No. 1

Sample No.	Depth ft	Formation	Sample type	$\bar{R}_v$max %	Range	Number	Standard deviation	$\bar{R}_I$max %	Range	Number	Standard deviation
21576	490-520	Knight	Ctgs	0.34	0.28-0.44	20	0.040	0.72	0.71-0.73	2	0.014
21577	850-900	"	"	0.32	0.26-0.39	16	0.042	-	-	-	-
21578	900-930	"	"	0.33	-	1	-	-	-	-	-
21579	930-960	Eumeralla	Ctgs	0.34	0.33-0.35	2	0.014	-	-	-	-
21580	960-990	"	"	0.35	0.29-0.42	17	0.035	0.81	0.65-1.02	4	0.158
21581	1330-1360	"	"	0.38	0.30-0.47	25	0.040	0.82	0.67-1.03	2	0.255
21582	1420-1450	"	"	0.37	0.31-0.46	14	0.041	0.82	0.66-1.14	4	0.225
21583	1630-1660	"	"	0.36	0.30-0.42	9	0.034	0.74	0.59-0.99	6	0.163
21584	1830-1860	"	"	0.38	0.35-0.43	7	0.030	-	-	-	-
21585	2070-2100	"	"	0.40	0.31-0.48	10	0.050	0.91	0.65-1.25	5	0.243
21586	2300-2330	"	"	0.41	0.37-0.47	10	0.029	0.93	0.70-1.18	4	0.241
21587	2630-2660	"	"	0.42	0.35-0.50	25	0.044	0.92	0.68-1.22	5	0.210
21588	2850-2890	"	"	0.45	0.36-0.53	25	0.044	1.01	0.78-1.32	5	0.248
21589	2930-2970	"	"	0.45	0.37-0.57	25	0.055	1.02	0.74-1.35	5	0.238
21606	3258	Pretty Hill	Core	0.41	0.33-0.50	25	0.040	-	-	-	-
21607	3259.5	"	"	-	-	-	-	0.97	0.79-1.20	6	0.165
21590	3380-3410	"	Ctgs	0.44	0.36-0.49	5	0.052	1.01	0.85-1.14	5	0.126
21591	3640-3670	"	"	0.47	0.37-0.57	15	0.053	1.02	0.64-1.31	5	0.246
21592	3800-3840	"	"	0.49	0.41-0.57	5	0.059	1.14	0.65-1.50	5	0.320
21593	4100-4130	"	"	0.51	0.42-0.61	12	0.054	0.99	0.68-1.31	5	0.297
21594	4400-4440	"	"	0.48	0.39-0.58	6	0.072	1.11	0.84-1.36	5	0.250
21595	4620-4650	"	"	0.52	0.42-0.64	13	0.064	1.10	0.98-1.30	5	0.144
21596	4720-4785	"	"	0.51	0.41-0.57	20	0.043	1.27	0.94-1.77	8	0.284
21598	4795-4820	"	"	0.54	0.44-0.65	20	0.058	1.01	0.92-1.12	5	0.077
21599	4820-4860	"	"	0.54	0.45-0.62	25	0.049	1.18	0.84-1.59	6	0.312
21600	5300-5330	"	"	0.54	0.47-0.60	8	0.043	1.32	1.01-1.78	5	0.311
21601	5510-5570	"	"	0.58	0.53-0.65	8	0.044	1.17	0.87-1.60	5	0.289
21603	5570-5610	?Pre-	Ctgs	0.57	0.52-0.63	8	0.041	1.11	0.89-1.48	5	0.249
21604	5740-5780	Cretaceous	"	0.59	0.53-0.65	10	0.043	1.31	0.87-1.36	5	0.203
				0.35	0.23-0.47	5	0.086				
21605	5860-5900	Basement	Ctgs	0.62	0.52-0.71	6	0.075	1.14	1.02-1.30	5	0.102

Thermal History

The present geothermal gradient at Robertson No. 1 is 41°C/km. This value is considerably higher than those for Banyula No. 1 (24°C/km) and Kalangadoo No. 1 (27°C/km), but is close to those for Penola No. 1 (40°C/km) and Lucindale No. 1 (50°C/km). It is not certain how comparable the present downhole temperatures for the shallower wells are with those of Banyula No. 1 and Kalangadoo No. 1. It is likely that the calculated high geothermal gradients for the shallower wells are related to the thickness of sediment. Data relating to the thermal history of Roberston No. 1 are presented in Table 3, where they are also compared with data from previously examined wells.

The comparatively low thickness of the Lower Cretaceous sequence and the linear shape of the reflectance profile indicate an absence of an early heating event. Post-coalification cover loss may have occurred, as given reflectance levels at Robertson No. 1 are reached at shallower depths as compared with Banyula No. 1 and Kalangadoo No. 1. Calculated model temperatures and present well temperatures show the relationship $T_{pres} > T_{grad} > T_{iso}$ for the 0.50% reflectance level, indicating continuous burial with gradually rising temperatures. Thus, cover loss does not appear to have been associated with a drop in temperature at the location of Robertson No. 1. The reflectance/depth relationship, however, indicates that heat flow from uplifted basement may have been high as compared with the temperature regime at Banyula No. 1, which is located close to the centre of the Penola Trough. As pointed out in previous well reports, model temperatures for lower reflectance levels are given with reservation, as the Karweil diagram (Appendix 3), which is used for the calculations, is mainly designed for vitrinite reflectances higher than 0.50% $\bar{R}_v$max.

Figure 13 shows that for Robertson No. 1 the values of T_{pres} plotted against T_{grad} fall to the upper left of the 45° tie line and are comparable to values for similar reflectance levels from other wells from the Penola Trough area.

Table 3: Present well temperatures compared with isothermal and gradthermal model temperatures, and reflectance gradients at given reflectance levels.

Depth (m)	$\bar{R}_v$max %	% $\bar{R}_v$max/km	T_{pres} °C	T_{iso} °C	T_{grad} °C
Robertson No. 1					
635	0.40	0.17	39	-	-
930	0.45	0.17	51	-	-
1225	0.50	0.17	63	30	42
1810	0.60#	0.17	87#	40	57
Lucindale No. 1					
600	0.40	0.23	43	-	-
810	0.45	0.23	45	-	-
740*	0.45*	0.62*	49*	-	-
800*	0.50*	-†	52*	30*	42*
Penola No. 1					
880	0.40	0.21	45	-	-
1250	0.50	0.33	62	33	46
1520	0.60	-	74	42	61
Kalangadoo No. 1					
1810	0.50	0.33	68	32	45
1930	0.55	0.48	70	45	65
2130	0.70	1.00	74	60	89
Banyula No. 1					
1630	0.50	0.19	51	32	45
1740*	0.50	0.24*	54*	-	-
2460	0.70	0.26	71	61	90
2340*	0.70*	0.37*	68*	60*	89*
2750*	0.90*	0.91*	78*	80*	121*
Breaksea Reef No. 1					
1970	0.50	0.12	59	43	62
3470	0.70	0.19	92	74	111
4300	0.90	0.31	111	88	133
Triton No. 1					
2070	0.50	0.20	77	40	57
2860	0.70	0.32	104	73	109
3345	0.90	0.57	123	88	133
Krambruk No. 13					
255	0.60	0.23	25	52	76
615	0.70	0.31	33	65	97
1110	0.90	0.48	47	80	120
1508	1.10	0.57	62	90	136

* alternative reflectance profile
† insufficient data
# extrapolated

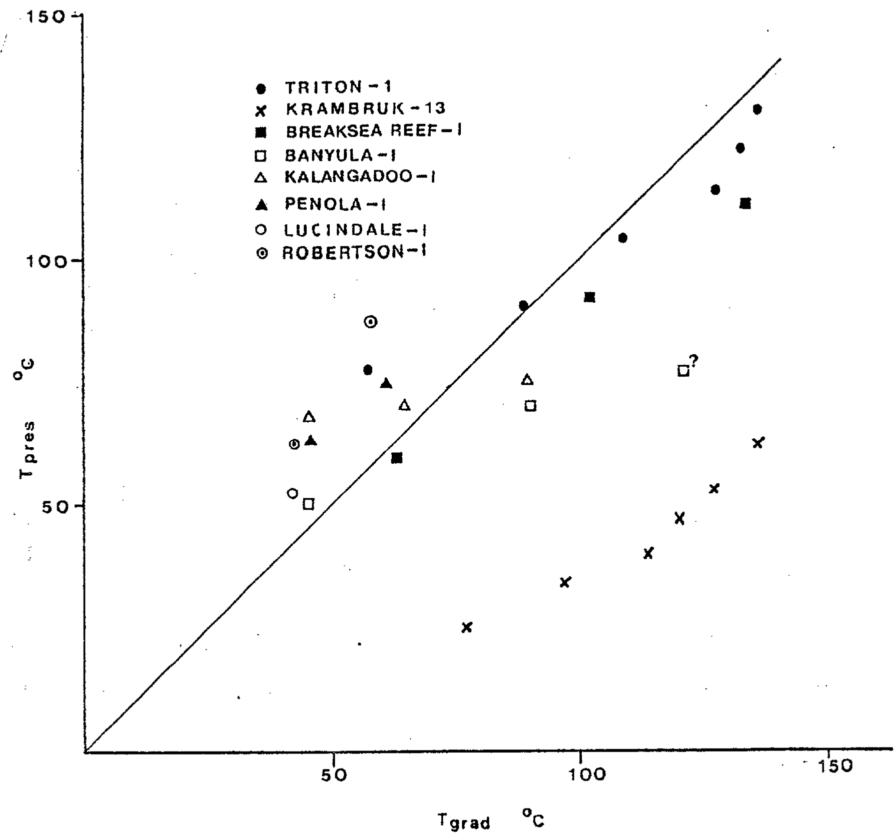

Figure 13: Present well temperatures plotted against gradthermal model temperatures.

Hydrocarbon Source Potential

The hydrocarbon source potential of the major stratigraphic units sampled at Robertson No. 1 is summarized in Table 4.

The sediments of the Tertiary sequence are thermally immature and contain very little organic matter, except for one sample containing abundant coal. Overall, the source potential is assessed as poor to fair.

The upper part of the Eumeralla Formation shows fair source potential in containing sparse liptinite and vitrinite rich dispersed organic matter. Coal and shaly coal are abundant in samples from the depth interval of 293m to 442m (960ft to 1450ft). If coal is considered to be a source for oil (Cook and Struckmeyer, 1986), the source potential of this interval can be assessed as good. But the sediments do not reach oil maturity and are likely to have generated mainly biogenic methane. Dom contents in the deeper part of the Eumeralla Formation range between 1 and 2% and coal/shaly coal is abundant to major in the deeper part of this section. Both dom and coal are rich in liptinite. The sediments reach marginal maturity at the base of the Eumeralla Formation and may have sourced considerable amounts of hydrocarbons from the early phase of generation. The predominance of detrovitrinite in association with suberinite and telovitrinite suggests an ability to generate liquid hydrocarbons at relatively low rank (Figure 14). The occurrence of oil droplets in coal and a bright yellow colouration of the embedding material in the vicinity of coal clasts supports this suggestion. Oil generation from other liptinite macerals, such as sporinite and cutinite, is unlikely to have occurred, as their main oil generation phase is thought to occur at higher reflectance levels (Figure 14).

The Pretty Hill Formation contains common dom overall, but coal and shaly coal are present in minor amounts only. Although dom is relatively rich in liptinite, inertinite is the dominant maceral in most samples. Overall, the source potential is assessed as fair to good. The sediments reach early maturity in the deeper part of the section and some hydrocarbons from the early phase of generation may have been sourced from this sequence.

Very good source rocks containing abundant alginite were found in the deeper sample from the ?pre-Cretaceous. Although the oil shale horizon is likely to be very thin, the amount of organic matter present indicates very good source potential. The sediments are mature, but do not reach the main zone of oil generation from alginite (0.70% to 0.90% $\bar{R}_v max$).

Conclusions

Thirty samples from Robertson No. 1 were examined for the assessment of the organic matter type and abundance and the maturation level. The content of organic matter in the Lower Cretaceous sequence is low to moderately high, comprising

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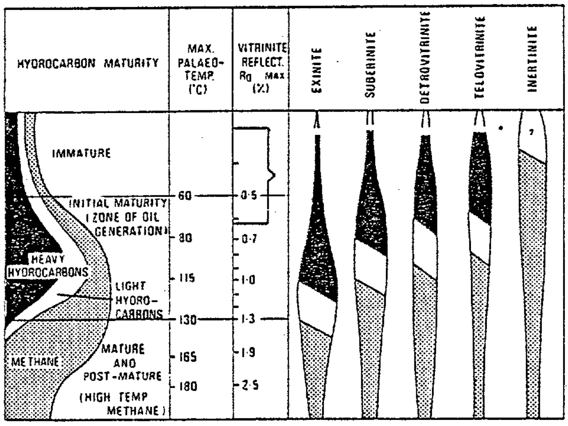

Figure 14: Maturation model for the main organic matter groups and subgroups. Maximum widths on generation envelopes are not to scale (from Smith & Cook, 1984). The bracket shows the reflectance range for Robertson No. 1.

Table 4: Hydrocarbon source potential of the major units at Robertson No. 1.

Formation/ Unit	Source Potential	Maturation Level	Probable resultant hydrocarbon generation/migration
Knight Group	poor to fair	immature	minor biogenic methane
Eumeralla Formation upper part	fair, coal abundant	immature	mainly biogenic methane
Eumeralla Formation deeper part	good, coal abundant	immature to marginally mature	biogenic methane and considerable hydrocarbons from the early phase of generation
Pretty Hill Formation	fair to good	immature to early mature	some hydrocarbons from the early phase of generation
?Pre-Cretaceous	good to locally very good	mature	possibly significant hydrocarbons

dispersed organic matter (dom), coal and shaly coal. Good source rocks containing considerable amounts of detrovitrinite and liptinite are present within the depth interval of 802m to 925m (2630-2970ft). Significant amounts of torbanitic lamosite were found in one sample from the ?pre-Cretaceous.

The maturation levels for the Lower Cretaceous range from immature to early mature for the generation of liquid hydrocarbons. The deepest part of the Eumeralla Formation is marginally mature, whereas the sediments of the Pretty Hill Formation reach early maturity. The dominance of detrovitrinite and its association with suberinite in the greater part of the Lower Cretaceous possibly results in systematically low reflectance values and suggests that maturation levels for this section may be up to 0.05% $\bar{R}_v$max higher than the data obtained indicate. The shape of the reflectance profile and, to a certain extent, the calculated model temperatures suggest that the Lower Cretaceous sequence underwent relatively slow burial, under a palaeothermal gradient possibly lower than the present geothermal gradient. Given reflectance levels, however, are reached at relatively shallow depths as compared with other wells from the Penola Trough area, indicating that some post-coalification cover loss may have occurred, and that heat flow from basement may have played a major role in the coalification history at Robertson No. 1.

Overall, the source potential of the Lower Cretaceous sequence at Robertson No. 1 is assessed as fair to good, but the deepest part of the Eumeralla Formation shows good source potential, if the abundant coal is included in the assessment. Although these sediments only reach marginal maturity, the maceral associations indicate that considerable hydrocarbons from the early phase of generation may have been generated. The presence of alginite rich oil shale in the ?pre-Cretaceous suggests that very good source rocks are present in sediments directly overlying basement. The oil shale horizon is probably relatively thin, and was either missed in sampling other wells reaching basement or is developed only locally. Correlation of this facies type with the deepest part of the Banyula No. 1 sequence is thought to be possible.

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APPENDICES

Appendix 1:	Sample descriptions - Robertson No. 1
Appendix 2:	Grain count estimate chart
Appendix 3:	KARWEIL diagram (after Bostick)
Appendix 4:	List of well reports to date

Legend: V - Vitrinite
I - Inertinite
L - Liptinite

ROBERTSON NO. 1

0592

Sample description

Sample-No.	Depth in ft (m)	
		Gambier Limestone Knight Group (345ft/105m)
21576	490-520 (149-158) Ctgs	$\bar{R}_v$max = 0.34% (20). Lithology: sandstone > sandy siltstone > carbonate. Dom sparse: V > L > I; all three maceral groups rare. Liptinite: rare liptodetrinite, yellow to yellow orange; rare sporinite, yellow to yellow orange; rare cutinite, yellow; rare resinite, yellow. Mud additives abundant. Iron oxides common. Carbonate abundant. Foraminifer tests present. Pyrite abundant, partly framboidal.
21577	850-900 (259-274) Ctgs	$\bar{R}_v$max = 0.32% (16). Lithology: sandstone >> carbonate > siltstone > coal. Coal abundant: V >> L; vitrite (ulminite, texto-ulminite, eu-ulminite). Dom very rare: L = I = V; trace of all three maceral groups. Liptinite: trace of liptodetrinite, yellow. Mud additives abundant. Carbonate abundant. Pyrite abundant, partly framboidal.
21578	900-930 (274-283) Ctgs	$\bar{R}_v$max = 0.33% (1). Lithology: sandstone >> siltstone. Dom rare: L > I > V; liptinite rare, trace of inertinite and vitrinite. Liptinite: rare liptodetrinite and cutinite, yellow to yellow orange; trace of sporinite, yellow. Carbonate sparse. Pyrite abundant, partly framboidal.
		Eumeralla Formation (925ft/282m)
21579	930-960 (283-293) Ctgs	$\bar{R}_v$max = 0.34% (2). Lithology: sandstone >> siltstone. Dom rare: L > V > I; liptinite rare, trace of vitrinite and inertinite. Liptinite: rare liptodetrinite, yellow to orange. Mud additives abundant. Carbonate sparse. Pyrite sparse, partly framboidal.

Sample-No.	Depth in ft (m)	
21580	960–990 (293–302) Ctgs	$\bar{R}_v$max = 0.35% (17). Lithology: sandstone >> carbonate > siltstone > coal. Coal abundant: V > I; vitrite > fusite. Dom rare: I > V > L; all three maceral groups rare. Liptinite: rare liptodetrinite, sporinite and cutinite, yellow to orange; rare suberinite, non-fluorescent. Carbonate common. Pyrite sparse, partly framboidal.
21581*	1330–1360 (405–414) Ctgs	$\bar{R}_v$max = 0.38% (25). Lithology: sandstone > siltstone > coal > shaly coal > carbonate. Coal major: V > I >> L; vitrite >> fusite. Shaly coal abundant to major: V > I > L; vitrite > durite = duroclarite = vitrinertite (v). Dom sparse to common: V > I > L; vitrinite sparse, inertinite and liptinite rare. Liptinite: rare liptodetrinite, yellow to orange; rare sporinite and cutinite, yellow to orange; rare resinite, yellow to dull yellow; rare suberinite, dull brown. About 20% of the sample consists of mud additives and metal flakes. Carbonate common. Pyrite common, partly framboidal.
21582*	1420–1450 (433–442) Ctgs	$\bar{R}_v$max= 0.37% (14). Lithology: sandstone = siltstone >> coal > claystone = carbonate > shaly coal. Coal abundant: V > I >> L; vitrite > clarite = inertite. Shaly coal common: V >> L; vitrite. Dom sparse: L > I > V; liptinite sparse, inertinite and vitrinite rare. Liptinite: sparse cutinite and liptodetrinite, yellow to dull orange; rare sporinite, yellow to orange; rare resinite, yellow to yellow orange. About 15% of the sample consists of mud additives and metal flakes. Carbonate common. Pyrite sparse.
21583	1630–1660 (497–506) Ctgs	$\bar{R}_v$max = 0.36% (9). Lithology: sandy siltstone > silty sandstone > carbonate. Dom sparse to common: L > I > V; all three maceral groups sparse. Liptinite: sparse liptodetrinite, yellow to orange; rare cutinite and sporinite, yellow to orange; rare phytoplankton (?acritarchs), greenish yellow; rare resinite, yellow. Diffuse organic matter present. Carbonate common. Siderite sparse. Pyrite rare.

Sample-No.	Depth in ft (m)	
21584*	1830-1860 (558-567) Ctgs	$\bar{R}_v$max = 0.38% (7). Lithology: sandstone >> siltstone > claystone > carbonate > coal = shaly col. Coal common: V > I = L; duroclarite. Shaly coal common: V > L > I; duroclarite. Dom sparse to common: L >> I > V; liptinite sparse to common, inertinite rare, trace of vitrinite. Liptinite: sparse sporinite, yellow to dull orange; sparse cutinite and liptodetrinite, yellow to dull orange; rare suberinite, dull brown; rare resinite, green to yellow orange. Carbonate abundant, Pyrite sparse.
21585*	2070-2100 (631-640) Ctgs	$\bar{R}_v$max = 0.40% (10). Lithology: sandy siltstone > sandstone > carbonate > claystone. Dom common: L > I > V; liptinite common, inertinite and vitrinite sparse. Liptinite: common sporinite and cutinite, yellow to orange; sparse liptodetrinite, yellow to dull orange; rare resinite, greenish yellow to yellow. Rare green oil droplets present in claystone. Organic rich siltstone and claystone lenses present in sandstone. Carbonate abundant. Siderite common. Pyrite common.
21586*	2300-2330 (701-710) Ctgs	$\bar{R}_v$max = 0.41% (10). Lithology: calcareous siltstone (partly sandy) > calcareous sandstone > carbonate > claystone > coal = shaly coal. Trace of coal: V >> L; vitrite. Trace of shaly coal: V >> L; vitrite. Dom common: L > I > V; liptinite and inertinite common, vitrinite sparse. Liptinite: sparse cutinite, yellow to dull orange; sparse sporinite, yellow to orange; sparse liptodetrinite, yellow to dull orange; sparse ?phytoplankton, greenish yellow; rare resinite, yellow. Carbonate abundant. Siderite common. Pyrite rare.
		Coaly Facies (2614ft/797m)
21587	2630-2660 (802-811) Ctgs	$\bar{R}_v$max = 0.42% (25). Lithology: calcareous siltstone > calcareous sandstone > coal > carbonate > claystone > shaly coal. Coal major: V > I > L; clarite > duroclarite > durite = clarodurite = vitrite.

Sample-No.	Depth in ft (m)	
		Shaly coal abundant: V > L >> I; clarite. Dom common: L > V > I; liptinite common, vitrinite and inertinite sparse. Liptinite: abundant sporinite, yellow to dull orange; common suberinite, brown; common cutinite and liptodetrinite, yellow to dull orange; sparse resinite, greenish yellow to dull yellow; sparse fluorinite, green; rare bitumen, greenish yellow. Sparse green oil droplets present in coal. Mud additive sparse. Carbonate abundant. Siderite sparse. Pyrite sparse, partly framboidal.
21588	2850-2890 (869-881) Ctgs	$\bar{R}_v max = 0.45\%$ (25). Lithology: calcareous siltstone > calcareous sandstone > coal = claystone > carbonate. Coal abundant to major: V > I > L; duroclarite > clarite = vitrite = vitrinertite (v) > fusite. Dom common: L > I > V; liptinite common, inertinite and vitrinite sparse. Liptinite: common sporinite, yellow to dull orange; common liptodetrinite, yellow to dull orange; sparse suberinite, brown; sparse cutinite, yellow to dull orange; sparse resinite, green to yellow. Rare green oil droplets present in coal. Detrovitrinite shows weak brown fluorescence. Carbonate major. Siderite common. Pyrite rare.
21589	2930-2970 (893-905) Ctgs	$\bar{R}_v max = 0.45\%$ (25). Lithology: calcareous sandstone > calcareous siltstone > carbonate > calcareous claystone = coal > shaly coal. Coal abundant to major: V > I > L; clarite > duroclarite > durite = vitrite. Shaly coal abundant: V > L >> I; clarite. Dom abundant: L > I > V; liptinite common, inertinite and vitrinite sparse. Liptinite: common to abundant sporinite, yellow to dull orange; common liptodetrinite and cutinite, yellow to dull orange; sparse suberinite, brown; sparse resinite, greenish yellow to dull yellow; rare fluorinite, green; rare bitumen, greenish yellow; rare ?telalginite, yellow. Rare green oil droplets present in coal. Detrovitrinite shows brown fluorescence. Embedding material (polyester resin) shows bright greenish yellow fluorescence in vicinity of coal clasts. Carbonate major. Siderite common. Pyrite rare.

Sample-No.	Depth in ft (m)	
		Pretty Hill Formation (2975ft/907m)
21606	3258 (993.0) Core	$\bar{R}_v max$ = 0.41% (25). Lithology: siltstone >> sandstone > coal > shaly coal. Coal abundant: V >> L; vitrite > clarite. Shaly coal abundant: V >> L; clarite. Dom abundant: V > L >> I; vitrinite and liptinite abundant, inertinite rare. Liptinite: abundant cutinite, bright yellow to dull orange; common sporinite, yellow to dull orange; common resinite, greenish yellow to dull yellow; sparse liptodetrinite, yellow to dull orange. Vitrinite occurs as long stringers and layers and is texturally immature (texto-ulminite, eu-ulminite). It is associated with cutinite and resinite and is mostly leaf-tissue. Siderite sparse. Carbonate common. Pyrite rare.
21607	3259.5 (993.5) Core	$\bar{R}_v max$ = -. Lithology: calcareous siltstone (partly sandy) >> sandstone. Dom common: I > L; inertinite common, liptinite sparse, vitrinite absent. Liptinite: sparse sporinite and liptodetrinite, yellow to dull orange; sparse cutinite, yellow to orange; rare resinite, yellow. Siderite common. Carbonate abundant. Pyrite rare.
21590	3380-3410 (1030-1039) Ctgs	$\bar{R}_v max$ = 0.44% (5). Lithology: sandstone > carbonate > siltstone > claystone > coal. Coal rare: V >>L > I; duroclarite. Dom common: L > I > V; liptinite and inertinite sparse, vitrinite rare. Liptinite: sparse liptodetrinite, yellow to dull orange; sparse sporinite, yellow to orange; rare cutinite, yellow. Carbonate abundant. Pyrite rare.
21591	3640-3670 (1109-1118) Ctgs	$\bar{R}_v max$ = 0.47% (15). Lithology: calcareous siltstone (partly sandy) > sandstone > carbonate. Dom common: V > L > I; vitrinite common, liptinite and inertinite sparse. Liptinite: sparse liptodetrinite, yellow to dull orange; rare cutinite and sporinite, yellow to dull orange; rare resinite, greenish yellow to yellow. Part of the vitrinite population appears to be reworked. Rounded siltstone grains present in sandstone. Carbonate abundant. Siderite sparse. Pyrite rare.

Sample-No.	Depth in ft (m)	
21592	3800–3840 (1158–1170) Ctgs	$\bar{R}_v$max = 0.49% (5). Lithology: calcareous siltstone (partly sandy) > calcareous sandstone > carbonate > claystone. Dom common: L > I > V; liptinite and inertinite sparse, vitrinite rare. Liptinite: sparse liptodetrinite, yellow to orange; rare sporinite, yellow to orange; rare cutinite, yellow; rare suberinite, brown. Carbonate abundant. Siderite common. Pyrite rare.
21593*	4100–4130 (1250–1259) Ctgs	$\bar{R}_v$max = 0.51% (12). Lithology: calcareous siltstone (partly sandy) > sandstone > carbonate > claystone. Dom common: I > L > V; inertinite and liptinite sparse, vitrinite rare. Liptinite: sparse liptodetrinite and sporinite, yellow to dull orange; rare cutinite, yellow to dull orange. Carbonate abundant. Siderite common. Pyrite rare.
21594	4400–4440 (1341–1353) Ctgs	$\bar{R}_v$max = 0.48% (6). Lithology: calcareous siltstone > siltstone > carbonate > sandstone > claystone > shaly coal. Shaly coal rare: I > L; durite. Dom common: I > L > V; inertinite and liptinite sparse, vitrinite rare. Liptinite: sparse liptodetrinite, yellow to dull orange; rare sporinite and cutinite, yellow to orange; rare suberinite, brown. Shaly coal may be cavings. Carbonate abundant. Siderite sparse. Pyrite sparse.
21595	4620–4650 (1408–1417) Ctgs	$\bar{R}_v$max = 0.52% (13). Lithology: siltstone > calcareous siltstone > calcareous sandstone > carbonate > claystone > coal. Trace of coal: I only; fusite. Dom common: I > L > V; inertinite common, liptinite sparse, vitrinite rare. Liptinite: sparse liptodetrinite and cutinite, yellow to dull orange; rare to sparse sporinite, yellow to dull orange. Coal may be cavings. Carbonate abundant. Siderite sparse. Pyrite rare.

Sample-No.	Depth in ft (m)	
21596	4720-4785 (1439-1469) Ctgs	$\bar{R}_v max$ = 0.51% (20). Lithology: calcareous siltstone (partly sandy) > calcareous sandstone > carbonate > claystone > coal. Trace of coal: V >>L; vitrite. Dom common: I > V > L; inertinite common, vitrinite and liptinite sparse. Liptinite: sparse cutinite, sporinite and liptodetrinite, yellow to dull orange; rare resinite, greenish yellow to yellow; rare suberinite, brown. Siderite sparse. Carbonate abundant. Pyrite rare.
21598*	4795-4820 (1461-1469) Ctgs	$\bar{R}_v max$ = 0.54% (20). Lithology: calcareous sandstone = calcareous siltstone (partly sandy) > carbonate > claystone. Dom common: I > L > V; inertinite sparse to common, liptinite and vitrinite sparse. Litpinite: sparse liptodetrinite, yellow to dull orange; rare sporinite and cutinite, yellow orange to dull orange; rare resinite, yellow. Siderite common. Carbonate abundant. Pyrite rare.
21599	4820-4860 (1469-1481) Ctgs	$\bar{R}_v max$ = 0.54% (25). Lithology: calcareous siltstone (partly sandy) > sandstone > carbonate > coal. Coal common: V only; vitrite (eu-ulminite). Dom common: I > V > L; all three maceral groups sparse. Liptinite: sparse cutinite and sporinite, dull yellow to brown; rare liptodetrinite, yellow to brown; rare resinite, dull yellow. Siderite and carbonate abundant. Pyrite rare.
21600	5300-5330 (1615-1624) Ctgs	$\bar{R}_v max$ = 0.54% (8). Lithology: calcareous siltstone (partly sandy) > calcareous sandstone > carbonate > claystone > coal. Coal rare: I > V >>L; vitrite = fusite. Dom common: L > I > V; all three maceral groups sparse. Liptinite: sparse cutinite, yellow orange to brown; sparse liptodetrinite, yellow to brown; sparse sporinite, orange to brown; rare resinite, yellow; rare bitumen, yellow. Siderite and carbonate abundant. Pyrite rare.
21601	5510-5570 (1679-1698) Ctgs	$\bar{R}_v max$ = 0.58% (8). Lithology: claystone > calcareous siltstone > sandstone > carbonate. Dom common: I > L > V; inertinite common, liptinite sparse, vitrinite rare.

Sample-No.	Depth in ft (m)	
		Liptinite: sparse liptodetrinite, yellow to dull orange; rare sporinite and cutinite, yellow to dull orange. Siderite common. Carbonate abundant. Pyrite rare.
		?Pre-Cretaceous (5570ft/1698m)
21603	5570-5610 (1698-1710) Ctgs	$\bar{R}_{v}max$ = 0.57% (8). Lithology: claystone > siltstone > sandstone > carbonate. Dom common: I > L > V; inertinite common, liptinite sparse, vitrinite rare. Liptinite: rare liptodetrinite, yellow to dull orange; rare sporinite and cutinite, yellow orange to dull orange. Siderite sparse. Carbonate common. Pyrite rare.
21604	5740-5780 (1749-1762) Ctgs	$\bar{R}_{v}max$ = 0.59% (10). Lithology: siltstone (partly calcareous) >> oil shale > sandstone > claystone = carbonate. Dom abundant: L > I > V; liptinite abundant, inertinite common, vitrinite sparse. Liptinite: common telalginite (Botryococcus-related), bright greenish yellow; common lamalginite, bright yellow to yellow;common liptodetrinite, bright yellow to dull orange; sparse sporinite, yellow to dull orange; rare cutinite, yellow orange to dull orange. About 14% of the sample consists of oil shale (torbanitic lamosite; Dom: L>>V>>I). Alginite occurs in association with low reflecting vitrinite (0.35% $\bar{R}_{v}max$). Sporinite, liptodetrinite and cutinite occur in siltstone, but some lamalginite is also present in siltstone. Siderite abundant in siltstone. Framboidal pyrite common in oil shale.
		Basement (5791ft/1765m)
21605	5860-5900 (1786-1798) Ctgs	$\bar{R}_{v}max$ = 0.62% (6). Lithology: siltstone > sandstone >> claystone > carbonate. Dom sparse: I > L > V; inertinite sparse, liptinite and vitrinite rare. Liptinite: rare liptodetrinite, greenish yellow to dull orange; rare sporinite, yellow to dull orange; rare cutinite, orange; rare lamalginite, greenish yellow. Iron oxides common. Siderite and carbonate common. Pyrite rare.

Appendix 2

Sample - No.	Project	Formation	Depth	Type	Date

	$\bar{R}_v$ max	Range	No.
RI			

COAL			DOM			Inertinite / Exinite		

LIPTINITE	COLOUR G Y O DO B	ABUNDANCE
Cutinite		
Sporinite		
Resinite		
Fluorinite		
Liptodetrinite		
Dinofl. / Acrit.		
Suberinite		
Telalginite		
Bituminite		
Exsudatinite		
OIL CUTS		
OIL DROPS		

Remarks

Coal	Dom	
1 Telovitrinite	3 Assoc. / Inertinite	5 no identific.
2 Detrovitrinite	4 Assoc. / Liptinite	6 leaf tissue

DOM	% V		% I		% E		% DOM	
MAJOR								
ABUNDANT								
COMMON								
SPARSE								
RARE								
DOM > >	Total ___		Total ___		Total ___		Total ___	

	COAL	SHALY COAL
V	%	%
I	%	%
E	%	%
MICRO-LITHOTYPES		
% TOTAL	______	______

Vitrinite	No	%
1		
2		
3		
4		
5		
6		
		100

Remarks ____

____

____

____

	Sandstone				Siltstone				Claystone				Limestone/ Carbonate				Others				COAL			SHALY COAL		
	V	I	E	D	V	I	E	D	V	I	E	D	V	I	E	D	V	I	E	D	V	I	E	V	I	E
5																										
10																										
15																										
20																										
25																										
30																										
	___ %				___ %				___ %				___ %				___ %				___ %			___ %		

		%
+	MAJOR	> 10
X	ABUNDANT	2 - 10
|	COMMON	0.5 - 2
=	SPARSE	0.1 - 0.5
-	RARE	< 0.1
0	ABSENT	0

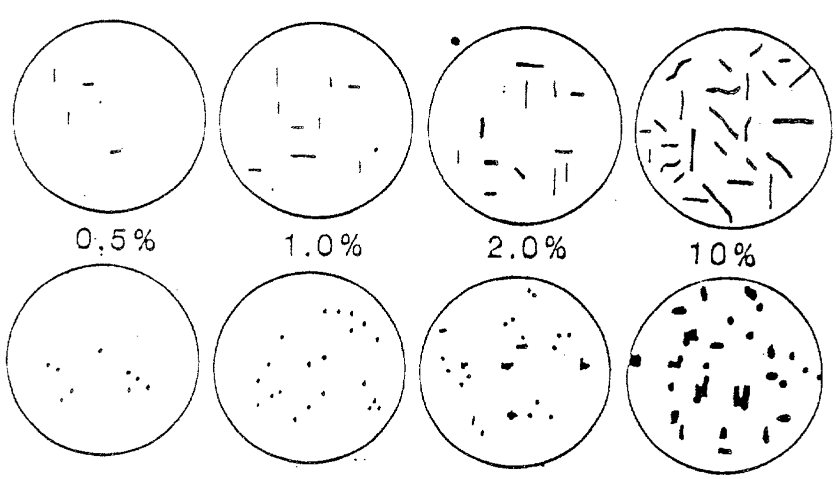
DOMINANT > 50%

SHALY COAL > 40 - < 70%

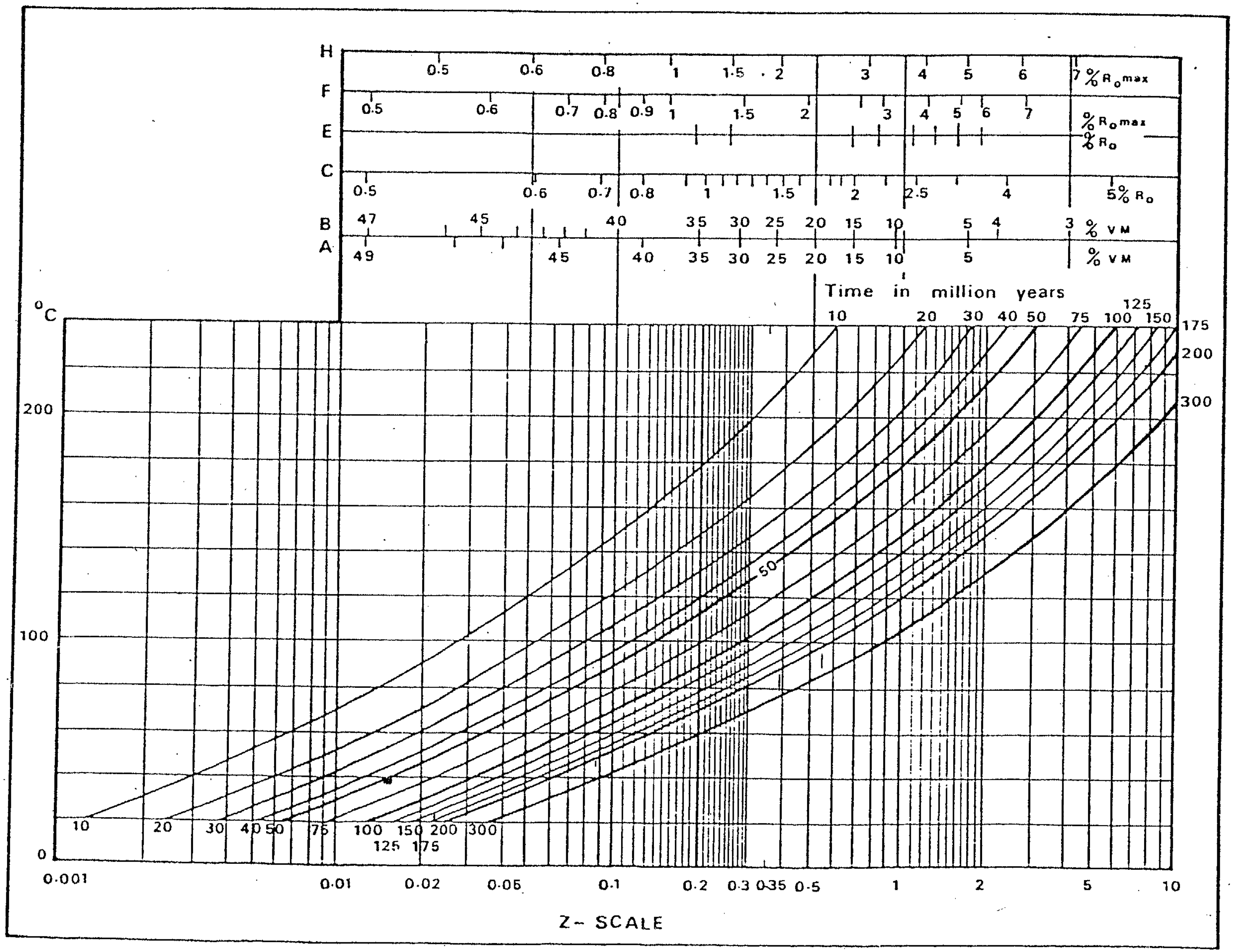
COAL > 70%

PYRITE	MUD ADDITIVES
FORAMS	SHELL FRAGMENTS

Remarks ______________________



KARWEIL DIAGRAM (AFTER BOSTICK)



Appendix 3

List of Well Reports to Date

Well Report	Well Name	Date
No. 1	Krambruk No. 13 Whooreel No. 7	November 1984
No. 1a	Whooreel No. 7 (revised)	February 1985
No. 2	Triton No. 1	January 1985
No. 3	Irrewillipe No. 16 Moorbanool Nos. 18/19 Yaugher No. 36 2 outcrops	March 1985
No. 4	Cobboboonee No. 2 Gorae No. 4	June 1985
No. 5	Breaksea Reef No. 1	September 1985
No. 6	Banyula No. 1	November 1985
No. 7	Kalangadoo No. 1	March 1986
No. 8	Penola No. 1	June 1986
No. 9	Lucindale No. 1	August 1986
No. 10	Robertson No. 1	October 1986