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**PEDIRKA AND EROMANGA BASINS THERMAL AND TECTONIC
HISTORY PROJECT**

REPORTS FOR THE PERIOD JANUARY 1995 TO DECEMBER 1996

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**SOURCE ROCK AND PETROLEUM GEOCHEMISTRY OF THE
ERINGA TROUGH, PEDIRKA BASIN**

Supplementary Report

Report for Department of Mines and Energy South Australia

by

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INTRODUCTION AND RATIONAL

This report is an adjunct to our earlier investigation (Staples *et al.*, 1995) concerning the petroleum potential of coals and carbonaceous sediments from the margins of the Eringa Trough, Pedirka Basin. Based on cuttings samples from Dalmatia-1 and Mt Hammersley-1 wells, Staples *et al.* (1995) indicated that the Crown Point Formation (1 sample; Early Permian) and an undifferentiated Permian unit (1 sample), are organically lean and have poor source potential (TOC = 0.35–0.41%; HI = 34–39). These units are immature for liquid hydrocarbon generation. The Purni Formation (11 samples; Early Permian) contains organic matter of considerably better source potential (TOC = 37.7–62.8%; HI = 113–359) which is similarly immature with respect to oil generation (R_o = 0.33–0.45%; T_{max} = 422–427° C).

Alexander *et al.* (1988) used aromatic hydrocarbons to establish oil-source rock correlations in the Cooper and Eromanga Basins. These correlations were established on the premise that Araucariaceae flora which evolved in the Early Jurassic and became prominent by the Middle Jurassic produced high concentrations of diterpenoid resins which gave rise to particular aromatic hydrocarbons, *viz* 1,2,5-trimethylnaphthalene, 1-methylphenanthrene, 1,7-dimethylnaphthalene and retene. Thus, source rocks of Jurassic age and younger commonly have high concentrations of these biomarkers. Conversely, Permian rocks from the Cooper Basin were found to contain low levels of these compounds.

Additional GC-MS analyses not detailed by Staples *et al.* (1995) but conveyed to Elinor Alexander (MESA) by Bernd Michaelsen showed that retene occurs in very high abundance relative to phenanthrene in many cuttings samples from the Purni Formation. The above finding was unexpected but potentially important for oil-source rock correlation strategies based on aromatic biomarkers. Therefore, this adjunct study of 3 *core* samples from the Purni and Crown Point Formations in the nearby Purni-1 and Witcherie-1 wells was initiated. The use of core samples eliminated potential down-hole contamination by cavings of younger sediments.

SAMPLE SELECTION AND EXPERIMENTAL METHODS

Sample details are provided in Table 1. The three core samples were analysed for total organic carbon (TOC) and by Rock-Eval pyrolysis. For each sample polished blocks were made and petrographically examined. The two most organic-rich samples (from Purni-1) were extracted using Soxhlet apparatus, and the resulting extract was fractionated using liquid chromatography. Saturated and aromatic hydrocarbon fractions were analysed by GC-MS. The experimental details were identical to those described in Staples *et al.* (1995).

RESULTS

Analytical data are summarised and presented herein as follows:

	<u>Table</u>	<u>Figure</u>
TOC and Rock-Eval pyrolysis	2	-
Petrographic descriptions and vitrinite reflectance data	3	-
Extract and biomarker data	4	1

DISCUSSION AND CONCLUSIONS

Total organic carbon, Rock-Eval pyrolysis, petrographic and vitrinite reflectance data are presented in Tables 2, 3, and 4. These data are included for addition to MESA's database (PEPS). The important findings of this study are based on the data in Table 4 and Figure 1 which may be summarised as follows:

- 1 Retene is essentially *absent* in both core samples from Purni-1. This may throw into question the integrity of previously reported data from Dalmatia-1 and Mt Hammersley-1 cuttings samples. We suggest that the high retene concentrations in Dalmatia-1 and Mt Hammersley-1 cuttings may be due to cavings from overlying Jurassic strata. Nevertheless, all Permian samples ($n = 8$) have lower $\frac{\text{retene}}{\text{phenanthrene}}$ ratios when compared to the Jurassic data ($n = 3$).
- 2 Concentrations of the demethylated hopane 28,30-bisnorhopane are consistently higher, relative to 17 α -hopane, in Permian rocks (Purni, Crown Point Formations) than in Jurassic Algebuckina Sandstone samples. High concentrations of 28,30-bisnorhopane are indicative of rocks deposited under suboxic and anoxic conditions (especially the latter: cf. Peters and Moldowan, 1993).

The second of these findings presents explorers of the Eringa Trough with a potentially useful parameter which is independent of aromatic hydrocarbon distribution.

Future oil discoveries with elevated $\frac{28,30\text{-bisnorhopane}}{17\alpha\text{-hopane}}$ ratios are likely to be sourced from the Permian, whereas those with low 28,30-bisnorhopane contents could be expulsion products of Jurassic source rocks. Caution should be exercised when applying this hypothesis, as the Eringa Trough geochemical database is presently derived from a very small sample set.

Finally, we recommend that, wherever possible, source rock studies should be based on core material.

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TABLE 1: Core sample details

Well/depth	Formation	Sample description
<i>Purni-1</i>		
4743'6"	Purni Formation	Laminated dark grey to green siltstone.
5814'	Crown Point Fm	Grey to green siltstone.
<i>Witcherie-1</i>		
1824'10"	Crown Point Fm	Grey to green siltstone.

TABLE 2: Rock-Eval pyrolysis data

Well / Depth	I.D.	T_{\max}	S1	S2	S3	S1+S2	S2/S3	PI	PC	TOC	HI	OI
<i>Purni-1</i>												
4743'6"		429	0.15	10.28	1.34	10.43	0.01	7.67	0.86	7.48	137	17
5814'0"		429	0.00	0.00	0.15	0.00	0.00	0.00	0.00	0.22	0	68
<i>Witcherie-1</i>												
1824'10"		420	0.05	3.06	1.42	3.11	0.02	2.15	0.25	3.38	90	42

T_{\max} = temperature of maximum generation of S2 hydrocarbons

S1 = mg hydrocarbons/g rock; S2 = mg hydrocarbons/g rock; S3 = mg CO₂/g rock

PI = S1/(S1+S2); PC = pyrolysable carbon; TOC = total organic carbon

HI = S2/g TOC; OI = S3/g TOC

TABLE 3: Petrographic descriptions and vitrinite reflectance data

Sample	Lithology	R _o (%)	Description
<i>Purni-1</i> 4743'6"	Siltstone	0.89	Inertinites and oxidised vitrinite dominant. Vitrinite comprises oxidised eu-ulminite, corpogelinite and densinites. Liptinites comprise sporinite and rare telalginite. R_o unreliable.
5814'	Siltstone	nd	Very sparse organics include liptodetrinite, sporinite, ?telalginite, inertodetrinite and densinite.
<i>Witcherie-1</i> 1824'24"	Siltstone	0.51	Oxidised vitrinite and inertinite abundant. Liptinite comprises liptodetrinite and sporinite. R_o possibly unreliable.

TABLE 4: Geochemical and biomarker data summary

Well	Depth	Sample		TOC (%)	EOM		Yield			EOM			Ret Phen	28,30-Bis Hop
		type	Formation		ppm	mg/g	TOC	Sat	Aro	Pol	(%)	(%)	(%)	
AFMECO Cur-3	251.6m	Core	Algebuckina	34.30	46519	432	20.6	4.7	74.7	5.95				0.0371
AFMECO Cur-3	251.9m	Core	Algebuckina	39.00	69412	178	4.3	3.8	91.9	26.5				
AFMECO Cur-3	259.5m	Core	Algebuckina	47.20	76429	162	4.8	3.0	92.2	25.9				0.0018
AFMECO Cur-5	209.2m	Core	Algebuckina	52.90										
AFMECO Cur-5	210.1m	Core	Algebuckina	50.50	71317	141	2.4	5.5	92.1	6.44				
AFMECO Cur-5	249.4m	Core	Algebuckina	58.70	80691	137	1.9	2.9	95.2	7.43				249.4 0.002
Dalmatia-1	1940-1990'	Cuttings	Purni	49.20	26427	54	6.3	7.0	86.7	0.233				0.340
Dalmatia-1	2010-2050'	Cuttings	Purni	44.30	21482	48	6.8	8.6	84.6	0.162				0.024
Dalmatia-1	2080-2120'	Cuttings	Purni	37.70										
Dalmatia-1	2340-2370'	Cuttings	Purni	38.50	30298	79	6.3	4.9	88.8					0.134
Dalmatia-1	2600-2660'	Cuttings	Purni	39.40										
Mt Hammersley-1	2020-2070'	Cuttings	Purni	63.10	18267	29	4.7	7.1	88.2	0.445				0.275
Mt Hammersley-1	2160-2210'	Cuttings	Purni	62.80	16985	27	5.5	8.5	86.0	0.780				
Mt Hammersley-1	2310-2360'	Cuttings	Purni	58.70	19704	34	4.7	9.0	86.3	0.303				0.965
Mt Hammersley-1	2500-2540'	Cuttings	Purni	59.10	31962	54	6.4	10.2	83.4	0.169				
Mt Hammersley-1	2750-2800'	Cuttings	Purni	55.80	31680	57	7.1	7.9	85.0	1.09				0.140
Mt Hammersley-1	2860-2910'	Cuttings	Purni	52.80	26155	50	11.2	8.3	80.5	0.717				
Mt Hammersley-1	4000-4060'	Cuttings	Undiff. Permian	0.41	367	89	25.8	6.6	67.6	0.232				0.066
Mt Hammersley-1	4620-4670'	Cuttings	Crown Point	0.35										
Purni-1	4743'6"	Core	Purni	7.48	3119	42	5.4	14.2	80.4	0.005				0.35
Purni-1	5814'0"	Core	Crown Point	0.22	116	52	4.7	2.3	93.0	0.003				?0
Witcherie-1	1824'10"	Core	Crown Point	3.38										

Pol = Resins + Asphaltenes

Ret = Retene

Phen = Phenanthrene

28,30-Bis = 17 α ,21 β - and 17 β ,21 α -28,30-bisnorhopaneHop = 17 α -hopane

Fig. 1

