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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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SEPARATELY HELD DATA (held in MESA Library)

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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August 1995

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 similarily 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:

	Table	Figure
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 17α-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 independant of aromatic hydrocarbon distribution.

Future oil discoveries with elevated $\frac{\text{28,30-bisnorhopane}}{\text{17}\alpha\text{-hopane}}$ 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.

REFERENCES

Alexander R., Larcher A. V., Kagi R. I. and Price P. L. (1988) The use of plant-derived biomarkers for correlation of oils with source rocks in the Cooper/Eromanga Basin system, Australia. *APEA J.* **28**(1), 310–324.

Staples C. J., Michaelsen B. H. and McKirdy D. M. (1995) Source rock and petroleum geochemistry of the Eringa Trough, Pedirka Basin. Unpublished report for Mines and Energy South Australia.

Peters K. E. and Moldowan J. M. (1993) *The Biomarker Guide: Interpreting Molecular Fossils in Petroleum and Ancient Sediments*. Prentice Hall, Englewood Cliffs.

TABLE 1: Core sample details

Well/depth	Formation	Sample description
Purni–1		
4743'6"	Purni Formation	Laminated dark grey to green siltstone.
5814'	Crown Point Fm	Grey to green siltstone.
Witcherie–1		
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
Purni-1												
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
Witcherie–1												
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 CO_2/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
Purni–1			
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.
Witcherie–1			
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 type	Formation	TOC (%)	EOM ppm	Yield mg/g TOC	EOM Sat (%)	EOM Aro (%)	EOM Pol (%)	Ret / Phen	28,30-Bis / Hop
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

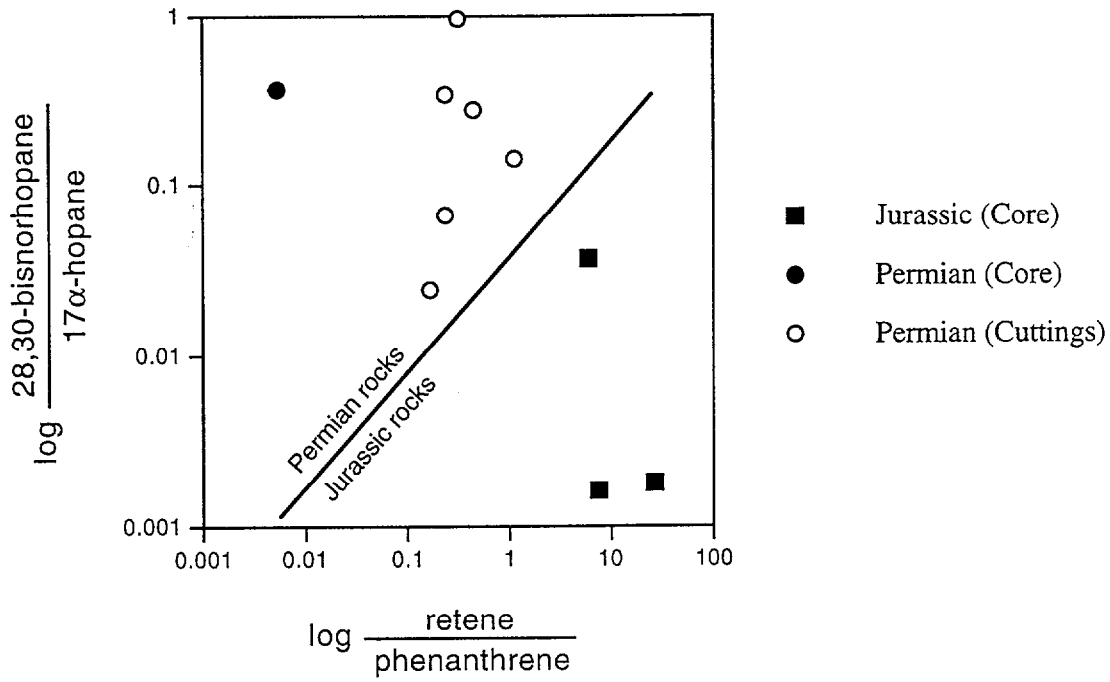
Ret = Retene

Phen = Phenanthrene

28,30-Bis = 17α,21β- and 17β,21α-28,30-bisnorhopane

Hop = 17α-hopane

Fig. 1


log 28,30-bisnorhopane / 17α-hopane
1
0.1
0.01
0.001
0.001
0.01
0.1
1
10
100
log retene / phenanthrene
Permian rocks
Jurassic rocks
Jurassic (Core)
Permian (Core)
Permian (Cuttings)