APPENDIX. II.

GEOCHEMICAL. ANALYSIS.

PINE LODGE - 1

W1034

p 547

AMDEL
CORE
SERVICES

25th January 1991

Gas and Fuel Exploration NL
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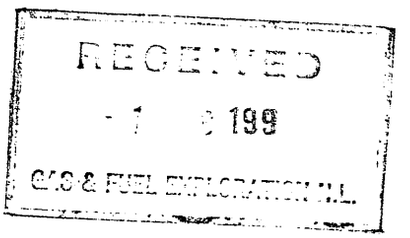

Attention: Val Akbari

REPORT: 009/545

CLIENT REFERENCE:	O/N 406
MATERIAL:	Sidewall Cores
LOCALITY:	Pine Lodge - 1
WORK REQUIRED:	Geochemical Analyses

Please direct technical enquiries regarding this work to the signatory below under whose supervision the work was carried out.

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Laboratory Supervisor
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Amdel Core Services Pty Limited
(Incorporated in South Australia)

1. INTRODUCTION

Total organic carbon (TOC) and Rock-Eval analyses were carried out on 12 sidewall core samples from Pine Lodge - 1. This report contains the results of these analyses along with brief details of the analytical procedures used, graphical displays of the data and interpretative comments.

2. ANALYTICAL PROCEDURE

2.1 Sample Preparation

Cuttings samples (as received) were ground in a Siebtechnik mill for 20-30 seconds.

2.2 Total Organic Carbon (TOC)

Total organic carbon was determined by digestion of a known weight (approximately 0.2g) of powdered rock in 50% HCI to remove carbonates, followed by combustion in oxygen and measurement of the resultant CO_2 by infra-red detection.

2.3 Rock-Eval Analyses

A 100 mg portion of powdered rock was analysed by the Rock-Eval pyrolysis technique (Girdel IFP-Fina Mark 2 instrument; operating mode, Cycle 1).

2.4 Organic Petrology

Representative portions of each sample (crushed to -14+35 BSS mesh) were obtained with a sample splitter and then mounted in cold setting Glasscraft resin using a 2.5 cm diameter mould. Each block was ground flat using diamond impregnated laps and carborundum paper. The surface was then polished with aluminium oxide and finally magnesium oxide.

Reflectance measurements were made with a Leitz MPV1.1 microphotometer fitted to a Leitz Ortholux microscope and calibrated against synthetic standards. All measurements were taken using oil immersion (n = 1.518) and incident monochromatic light (wavelength 546 nm) at a temperature of 23±1°C. Fluorescence observations were made on the same microscope utilising a 3 mm BG3 excitation filter, a TK400 dichroic mirror and a K510 suppression filter.

3. RESULTS

TOC and Rock-Eval data are presented in Table 1. Figure 1 is a plot of Hydrogen Index versus Tmax illustrating kerogen Type and maturity. Vitrinite Reflectance data is summarised in Table 2. A histogram plot of individual measurements is included as Figure 2. Photographs illustrating key aspects of the organic petrology are included in Appendix 1.

Table 3 includes alkane ratios, bulk composition and extract yield data for the sidewall core sample from 2121 metres depth. A gas chromatogram of the saturated hydrocarbons isolated from this extract is presented as Figure 3.

4. INTERPRETATION

4.1 Maturity

The Vitrinite Reflectance, determination on the sidewall core sample from 2121 metres depth (0.48%) is consistent with the range of maturities indicated by the Rock-Eval Tmax and Hydrogen Index values (Table 1). These maturity measurements indicate that the sediments intersected in the Pine Lodge - 1 location are sufficiently mature for the generation of:

- light oil and condensate from the thermally labile exinites (resinite and bituminite) below approximately 2000 metres depth (VR threshold = 0.45%).

- Significant gas generation from woody - herbaceous kerogen (vitrinite and to a lesser extent inertinite) commences at a maturity corresponding to a Vitrinite reflectance of 0.6%. Extrapolation of maturity from Rock-Eval data is rather imprecise but suggests that sediments intersected in this location may be sufficiently mature for significant gas generation below approximately 3000 metres depth.

- Oil from exinites other than resinite and bituminite commences at maturities corresponding Vitrinite Reflectance values in excess of 0.7%.

Rock-Eval production indices are uniformly low indicating that these sediments do not contain migrated hydrocarbons.

4.2 Source Richness

Total organic carbon values (Table 1) lie within the range 1.10 - 46.0%, although these values typically lie within the range 1.10 - 2.98%. These TOC values indicate fair organic richness for the most part and excellent organic richness in the sidewall core from 2121 metres depth.

Source richness for the generation of hydrocarbons is however, uniformly poor, ($S_1 + S_2$ <2 Kg of hydrocarbons / tonne - Table 1) in all samples except the coal from 2121 metres depth which has excellent source richness ($S_1 + S_2$ = 228.25 kg of hydrocarbons / tonne).

4.3 Organic Matter Type and Source Quality

Rock-Eval Hydrogen index and Tmax values indicate that the majority of the samples analysed from Pine Lodge - 1 contain organic matter with the bulk composition of Type III to Type IV kerogen.

Organic matter in the coal from 2121 metres depth has the bulk composition of Type II kerogen. Organic petrology shows that this organic matter consists largely of inertinite (50%) and exinite (35%) with only minor quantities of vitrinite (15%). The major exinite macerals present are sporinite, cutinite, lamalginite and resinite with minor quantities of liptodetrinte, telalginite,

suberinite and bituminite. Fluorescence colours are generally moderate orange and are significantly depressed compared to that normally expected at this maturity (Appendix 1). This is consistent with an oxic environment of deposition, as is the high ratio of inertinite to vitrinite. Telalginite is Botryoccocus-related (Appendix 1).

4.4 Extraction of Organic Matter

Pristane/n-heptadecane and phytane/n-octadecane ratios (Table 3, Figures 3 - 4) are consistent with the relatively low maturity of this sidewall core (VR = 0.48%) as is the pronounce odd over even-carbon-number preference of the C_{23} - C_{33} alkanes.

The high pristane/phytane ratio (5.1) and alkane distribution are consistent with this extract originating from predominantly higher plant organic mater which was deposited in highly oxic conditions. Such conditions typically occur in terrestrial peat swamps. The bi-modal nature of the alkane distribution is consistent with the algal and higher plant organic matter contents of this coal.

5. CONCLUSIONS

The sidewall core sample from 2121 metres depth consists of a coal with both excellent source richness ($S_1 + S_2$ = 228.25 kg of hydrocarbons/tonne), and organic richness (TOC = 46.00%). Organic petrology of this sample shows that it consists largely of inertinite (50%) and exinite (35%) with only minor quantities of vitrinite (15%) (Appendix 1).

Telalginite in this coal is significant in that it is Botryoccocus-related and is one of the very few occurences of this algae in the Otway Basin. The importance of this algae as an oil source in this basin has been well documented as the biomarker Botryoccocane is commonly found in oil seeps and strandings on beaches in South Eastern South Australia and Western Victoria. Therefore, the presence of this algae in a rich oil prone source rock such as this coal, is indeed significant. This unit may be an important source unit in parts of the basin where it reaches higher maturities (VR = 0.7 - 1.1%) which is the main generation range for the major exinite macerals present in this coal (VR measured = 0.48%).

Extract data from this coal (2121 metres depth) concurs with the organic petrology in illustrating the low maturity and highly oxic environment of deposition of this unit. The degree of oxicity as indicated by the pristane/phytane ratio may well show some variation within this unit, both vertically and laterally. The bi-modal alkane distribution of this extract (C_{11} - C_{36}) is also similar to those of the oil strandings mentioned above with a distinct algal component (C_{11} - C_{17}) combined with a waxy higher-plant component (C_{18} - C_{36}).

TABLE 1

AMDEL CORE SERVICES

Rock-Eval Pyrolysis

25/10/90

Client: GAS AND FUEL CORP.

Well: PINELODGE-1

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
1787	415	0.07	0.68	0.77	0.75	0.09	0.88	0.06	2.98	22	25
1815	350	0.11	0.57	0.72	0.68	0.16	0.79	0.05	1.38	41	52
1898	388	0.11	0.89	1.50	1.00	0.11	0.59	0.08	1.70	52	88
1931	369	0.10	0.77	0.66	0.87	0.12	1.16	0.07	1.56	49	42
2007	228	0.12	0.82	0.78	0.94	0.13	1.05	0.08	1.58	52	49
2030	435	0.12	1.85	0.80	1.97	0.06	2.31	0.16	2.17	85	36
2052	418	0.17	0.75	0.89	0.92	0.18	0.84	0.07	1.21	61	73
2076	434	0.13	1.28	0.52	1.41	0.09	2.46	0.11	1.80	71	28
2091	433	0.15	1.02	0.40	1.17	0.13	2.55	0.09	1.10	92	36
2121	434	8.59	219.66	1.65	228.25	0.04	133.12	19.02	46.00	477	3
2135	439	0.11	1.05	0.30	1.16	0.09	3.50	0.09	2.18	48	13

TABLE 2

SUMMARY OF VITRINITE REFLECTANCE MESUREMENTS, PINE LODGE-1

Depth (m)	Mean Maximum Reflectance	Standard Deviation	Range	Number of Determinations
2121	0.48	0.04	0.42-0.55	22

TABLE 3

C_{12+} BULK COMPOSITION AND ALKANE RATIOS OF EXTRACTED ORGANIC MATTER, PINE LODGE - 1

Depth (m)	Extract Yield		C_{12+} Composition			Alkane Ratios			
	ppm	mg/g TOC	Sats	Arom	Res+Asph	Np/Pr	Pr/Ph	Pr/n-C_{17}	Ph/n-C_{18}
2121	3,900	8.49	52.4	30.9	16.7	0.25	5.1	2.53	0.39

Arom	=	aromatic hydrocarbons	Np	=	norpristane
Res	=	resins + polar compounds	Pr	=	pristane
Asph	=	asphaltenes	Ph	=	phytane
Sats	=	saturated hydrocarbons	n-C_{17}	=	n-heptadecane
			n-C_{18}	=	n-octadecane

FIGURE 1

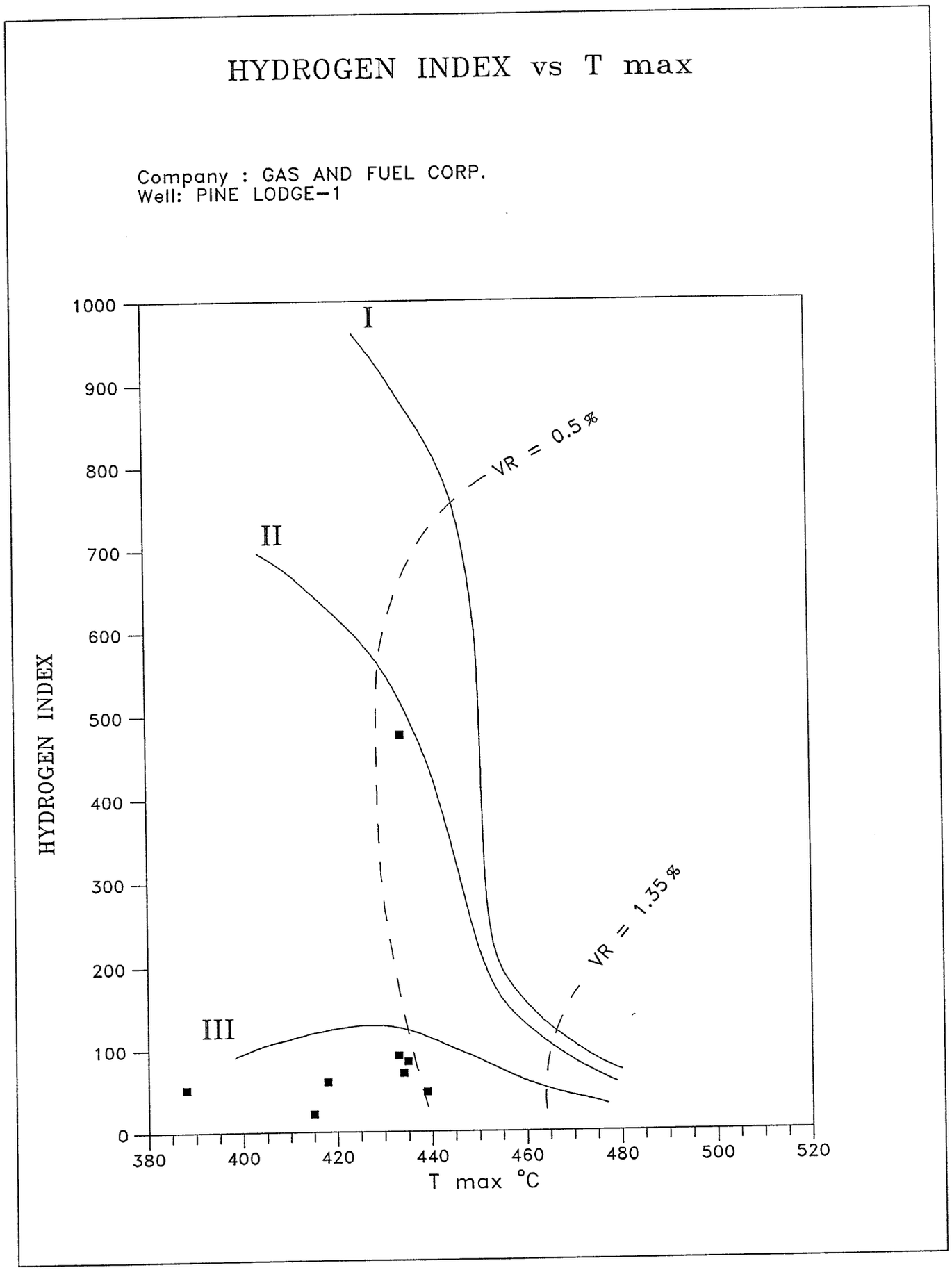

HYDROGEN INDEX vs T max
Company : GAS AND FUEL CORP.
Well: PINE LODGE-1
HYDROGEN INDEX
1000
900
800
700
600
500
400
300
200
100
0
I
II
III
VR = 0.5%
VR = 1.35%
380
400
420
440
460
480
500
520
T max °C

FIGURE 2

VITRINITE REFLECTANCE VALUES

Well Name: PINE LODGE-1
Depth: 2121 m

Sorted List

0.42	0.48	0.55
0.42	0.48	0.55
0.43	0.49	
0.43	0.50	
0.45	0.50	
0.46	0.50	
0.47	0.51	
0.47	0.51	
0.47	0.52	
0.48	0.53	

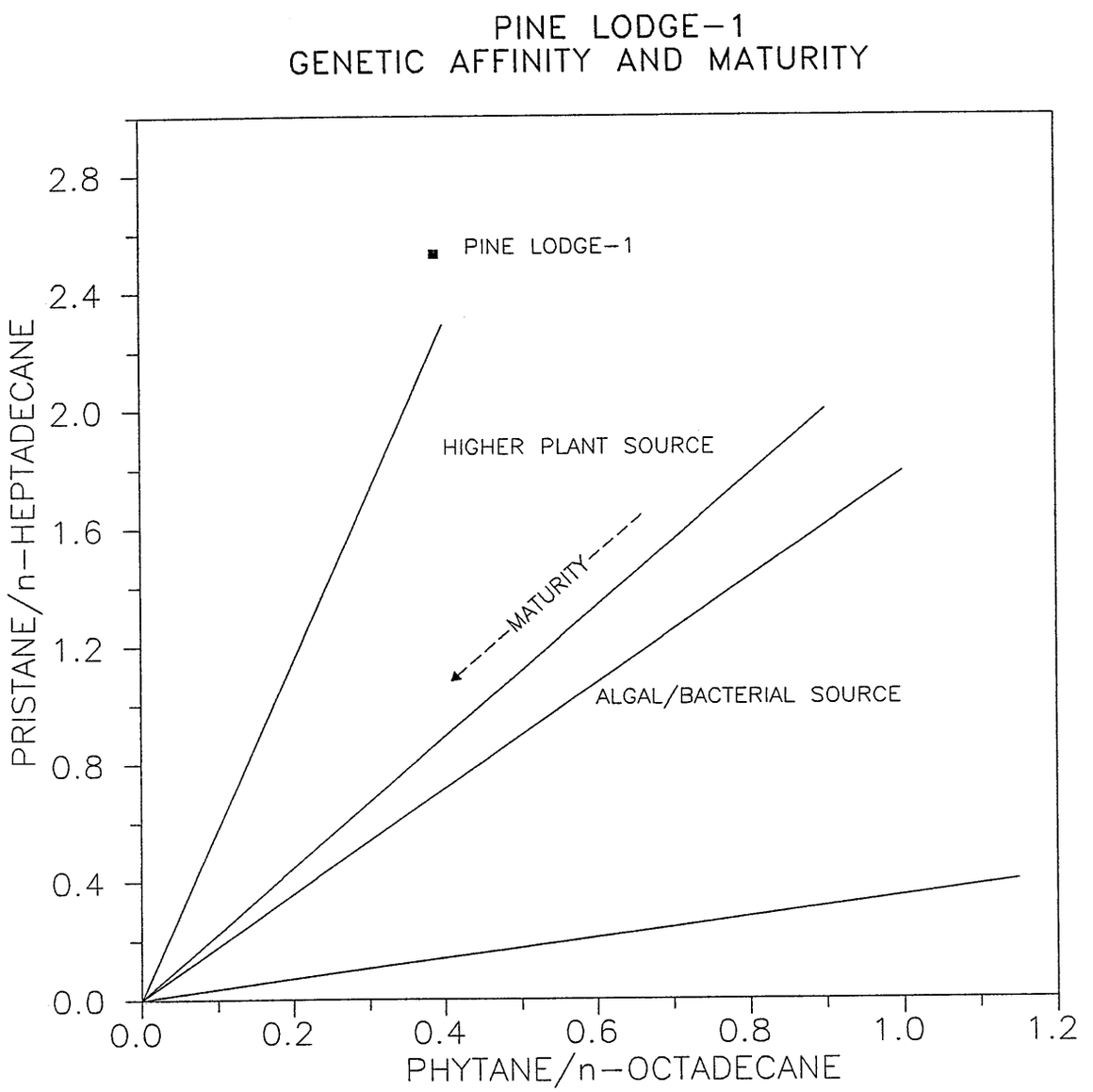
Number of values= 22

Mean of values 0.48
Standard Deviation 0.04

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

42-44	****
45-47	*****
48-50	*******
51-53	****
54-56	**

FIGURE 3


PINE LODGE-1
GENETIC AFFINITY AND MATURITY
PINE LODGE-1
HIGHER PLANT SOURCE
MATURITY
ALGAL/BACTERIAL SOURCE
PRISTANE/n-HEPTADECANE
PHYTANE/n-OCTADECANE
0.0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
0.0
0.2
0.4
0.6
0.8
1.0
1.2

APPENDIX 1

PHOTOGRAPHS OF DISPERSED ORGANIC MATTER

PINE LODGE -1

PE906569

This is an enclosure indicator page.
The enclosure PE906569 is enclosed within the container PE903706 at this location in this document.

The enclosure PE906569 has the following characteristics:

ITEM_BARCODE	= PE906569
CONTAINER_BARCODE	= PE903706
NAME	= Photomicrographs - Organic Matter, 1 of 3
BASIN	= OTWAY
PERMIT	= PEP105
TYPE	= WELL
SUBTYPE	= PHOTOMICROGRAPH
DESCRIPTION	= Photomicrographs - Organic Matter, 1 of 3, Appenix 11, Pine Lodge-1
REMARKS	=
DATE_CREATED	= 25/01/1991
DATE_RECEIVED	=
W_NO	= W1034
WELL_NAME	= PINE LODGE-1
CONTRACTOR	= AMDEL
CLIENT_OP_CO	= GAS AND FUEL EXPLORATION NL

(Inserted by DNRE - Vic Govt Mines Dept)

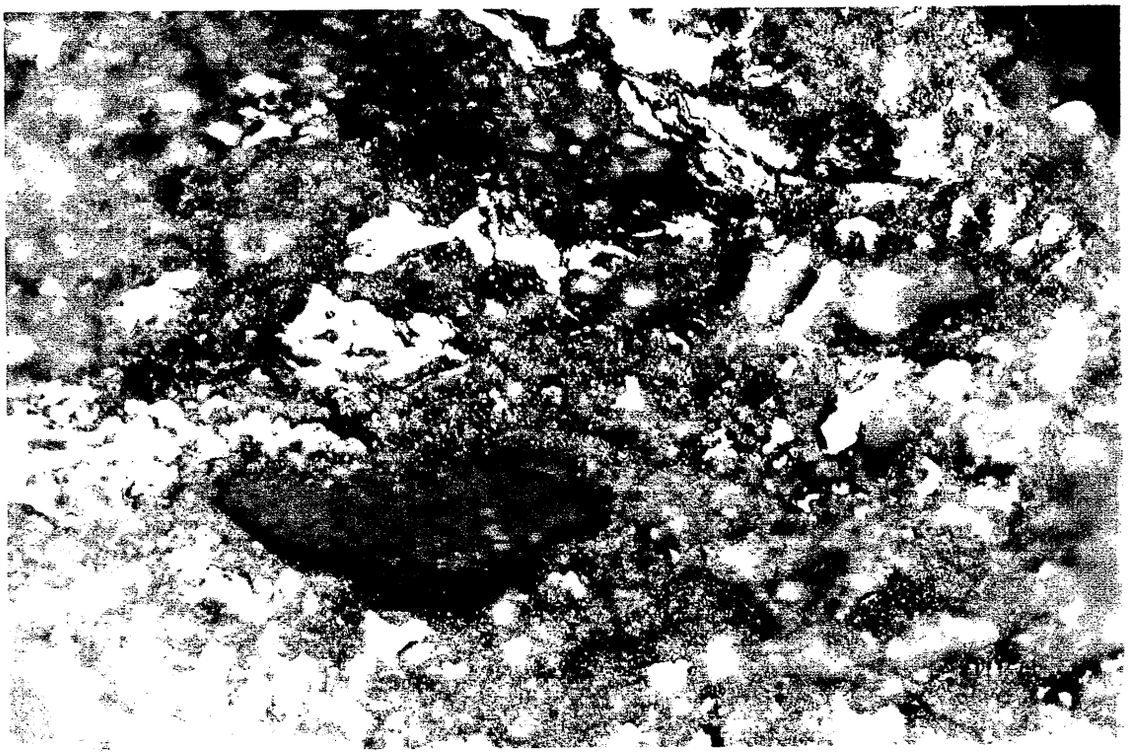


Plate 1: 2121 metres depth **Reflected Light**
Inertinite (white; semifusinite, macrinite and inertodetrinite) occur in this coal fragment with exinite (brown).
Field Dimensions: 0.26 x 0.18 mm

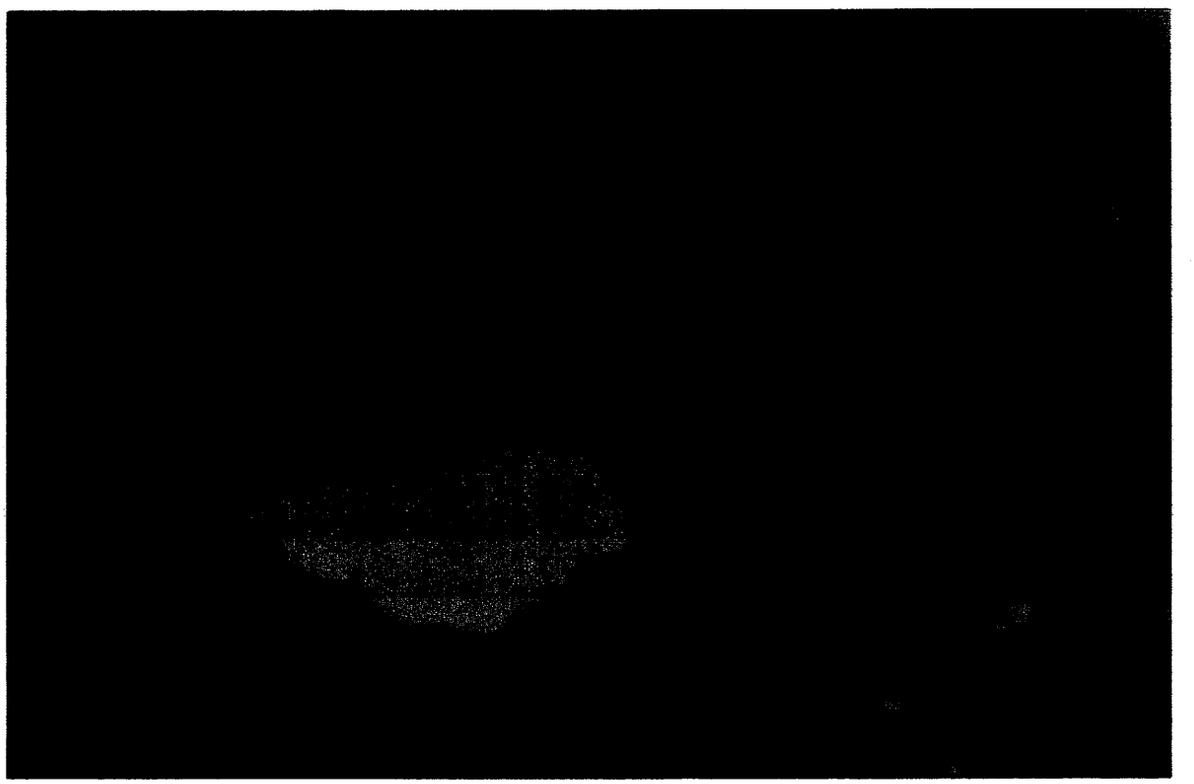


Plate 2: Same Field as above. **Fluorescence Mode**
Exinite macerals present are telaginite (T; Botryoccocus-related), lamalginite, sporinite and liptodetrinite.

PE906570

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The enclosure PE906570 has the following characteristics:

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BASIN	= OTWAY
PERMIT	= PEP105
TYPE	= WELL
SUBTYPE	= PHOTOMICROGRAPH
DESCRIPTION	= Photomicrographs - Organic Matter, 2 of 3, Appenix 11, Pine Lodge-1
REMARKS	=
DATE_CREATED	= 25/01/1991
DATE_RECEIVED	=
W_NO	= W1034
WELL_NAME	= PINE LODGE-1
CONTRACTOR	= AMDEL
CLIENT_OP_CO	= GAS AND FUEL EXPLORATION NL

(Inserted by DNRE - Vic Govt Mines Dept)

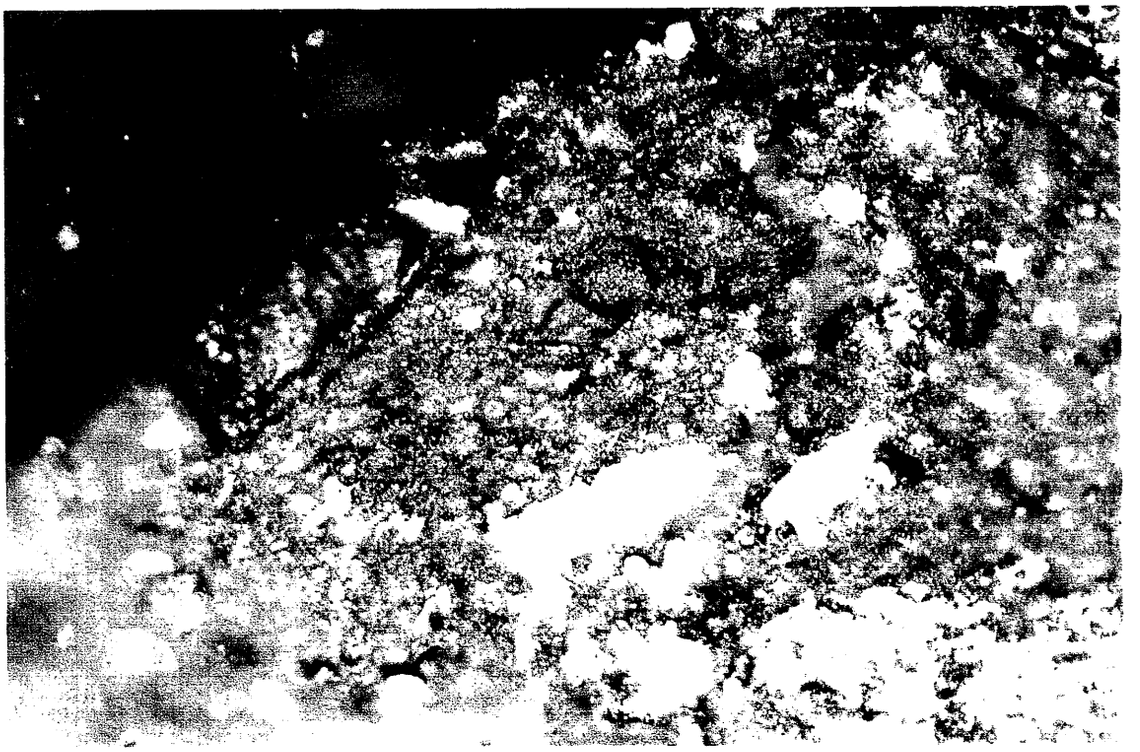

Plate 3: 2121 metres depth. **Reflected Light**
This field is similar to that of the previous plates (1 & 2) containing largely inertinite (white) and exinite (brown).
Field Dimensions: 0.26 x 0.18 mm.

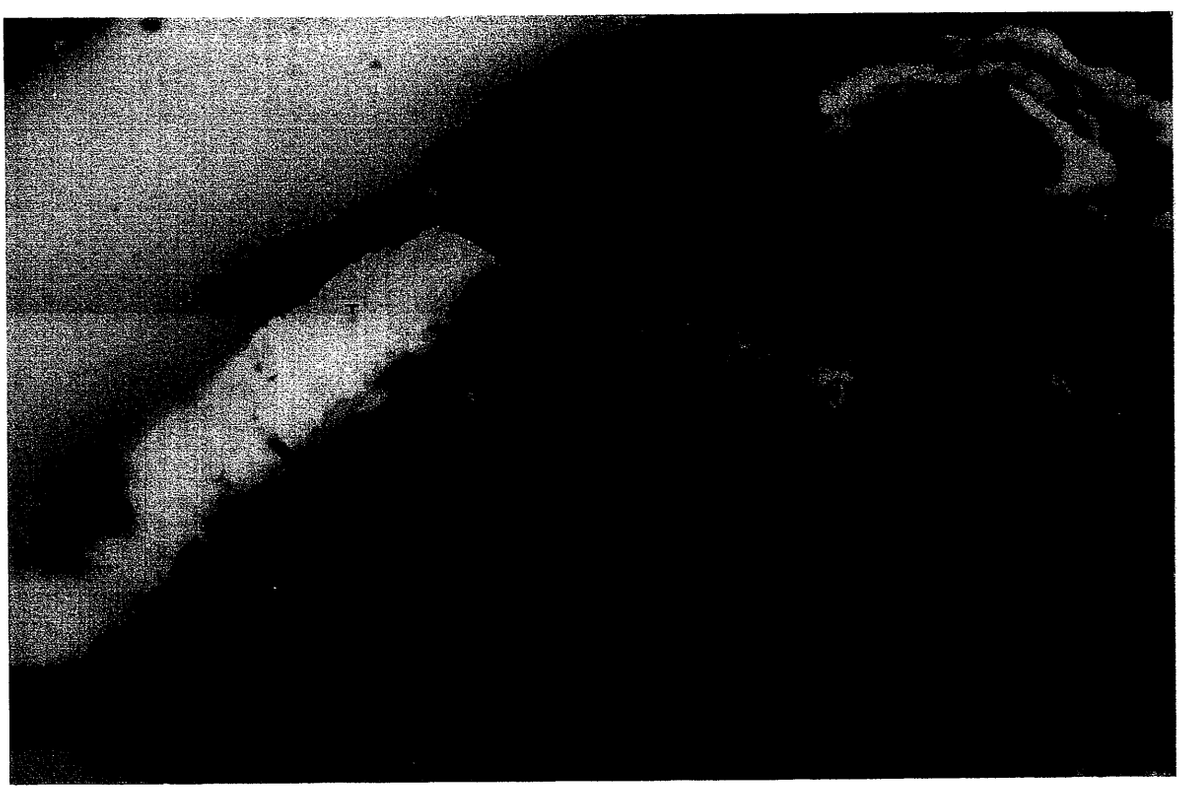

Plate 4: Same Field as above. **Fluorescence Mode**
Exinite macerals include telalginite (T), sporinite (centre), lamalginite and liptodetrinite.

PE906571

This is an enclosure indicator page.
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The enclosure PE906571 has the following characteristics:

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CONTAINER_BARCODE	= PE903706
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BASIN	= OTWAY
PERMIT	= PEP105
TYPE	= WELL
SUBTYPE	= PHOTOMICROGRAPH
DESCRIPTION	= Photomicrographs - Organic Matter, 3 of 3, Appenix 11, Pine Lodge-1
REMARKS	=
DATE_CREATED	= 25/01/1991
DATE_RECEIVED	=
W_NO	= W1034
WELL_NAME	= PINE LODGE-1
CONTRACTOR	= AMDEL
CLIENT_OP_CO	= GAS AND FUEL EXPLORATION NL

(Inserted by DNRE - Vic Govt Mines Dept)

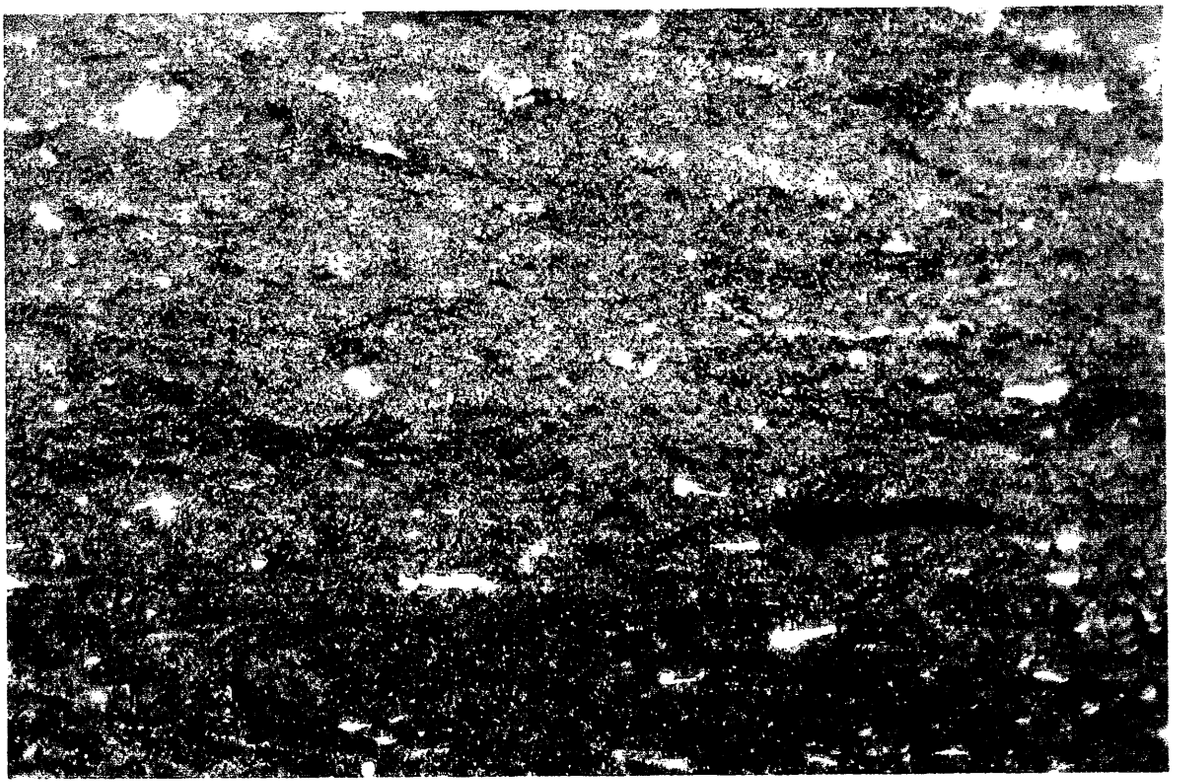

Plate 5: 2121 metres depth. **Reflected Light**
Exinite (brown) is the dominant type of organic matter present in this field.
Inertinite (white) is rare to sparse.
Field Dimensions: 0.26 x 0.18 mm.

Plate 6: Same Field as above. **Fluorescence Mode**
Exinite macerals present in this field include cutinite, resinite, sporinite, lamalginite and ?telalginite.