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SNEA (P)
D.E.P. - D. EXPLOR.
LABORATOIRE DE GEOLOGIE DE PAU
-
GEO/LAB.PAU n°212/81 RP
/rj

BONAPARTE 2 (Australia)

1 - OPTICAL and GEOCHEMICAL STUDY OF THE ORGANIC MATTER (1500-6000')

2 - COMPARISON WITH LESUEUR 1, KEEP RIVER 1 and MINING EXPLORATION BOREHOLES

GEO/LAB.PAU n°212/81 RP

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Tech. Assistance : J.AUBERT

December 1981

PR 82/08

Work requested by R. LAWS (telex n°4878, January 22, 1981)

Work order n°460 315 101

Enclosures : 2 tables, 6 figures, 3 plates, 6 appendix

DISPATCHING LIST

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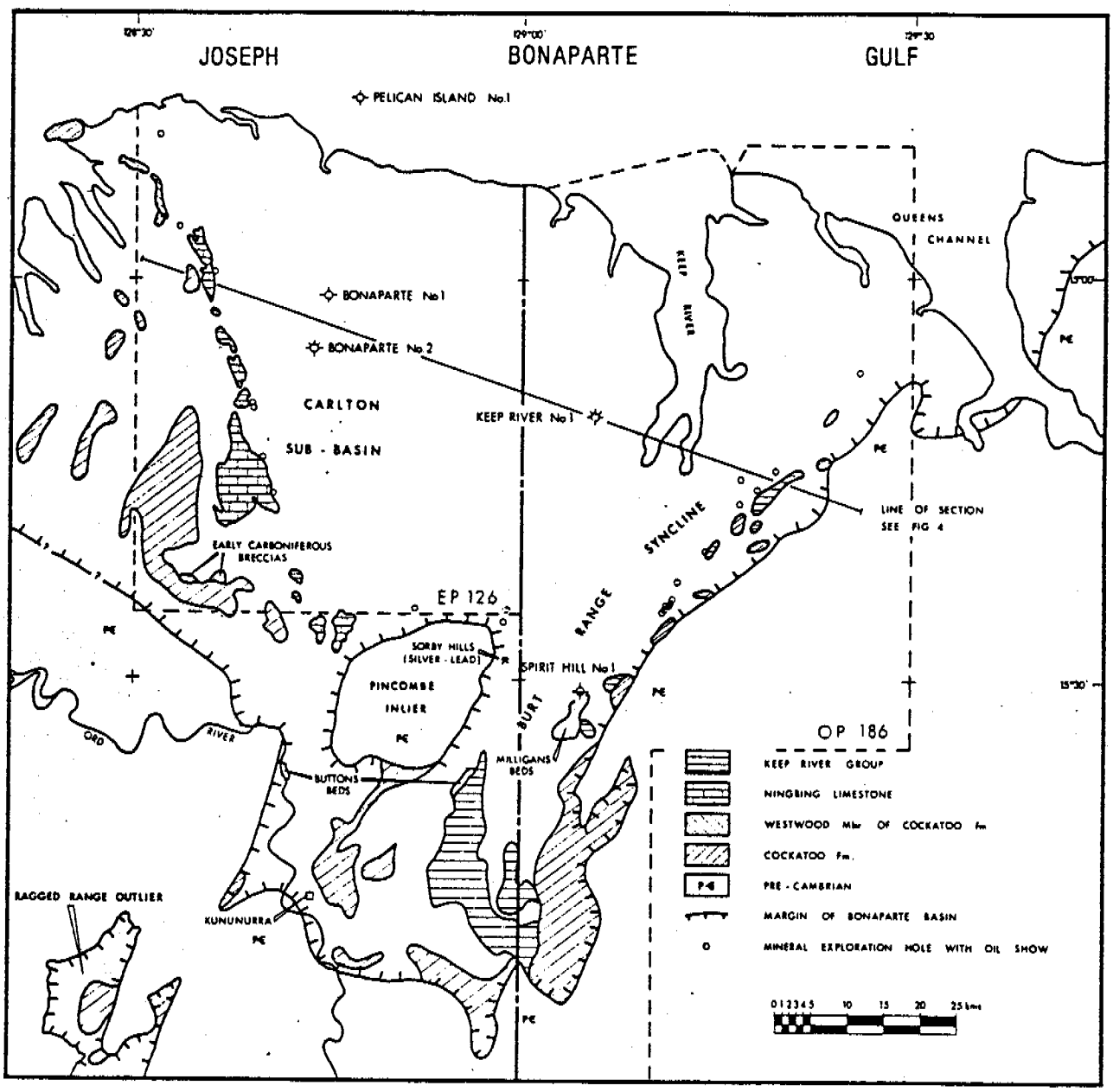


Australian Aquitaine Petroleum Pty. Ltd.

ONSHORE BONAPARTE BASIN

LATE DEVONIAN TO EARLY CARBONIFEROUS

SIMPLIFIED GEOLOGICAL MAP

Author : R LAWS.	Date : JANUARY 1981	Dwg No. : 18770
Drafted by J BEVERLEY.	Report No.:	Base Plan :

ABSTRACT

- PART I

The quantity of organic matter (1 %) and its quality (mostly ligneous) give to the whole studied interval (1500 - 6000') an average to fair gas potential in spite of a maturation stage corresponding to the oil diagenetic zone.

The occurrence of reworked material below 4700' and of bitumens in the same interval seems to authorize a distinction between two intervals in the Bonaparte Beds.

- PART II

The comparison between oil and mineral exploration wells shows a decrease of the quantity of organic matter but an improvement of its quality in direction of the southern margins.

If we consider the maturation level of the organic matter, it appears that the Milligans Beds are favourably located in the oil window in the area between the oil exploration wells and the mineral exploration holes.

8 pages
2 tables
6 figures
3 plates
6 appendixes

I - OPTICAL AND GEOCHEMICAL STUDY OF THE ORGANIC MATTER (1500-6000')

I.1 - ORGANIC MATTER QUANTITY

A large number of total organic carbon (TOC) analyses were available from a previous study (Appendix 1).

We have taken into account these values to select the second sampling. The TOC contents (table 1) are in good keeping with the previous results. From a statistical point of view (diagram TOC vs. insoluble residue, plate 1) the amounts of organic matter appear average to good.

The organic extracts are rather low (less than 350 ppm), except in the 4860-4900' sample (863 ppm). The extractable organic matter/TOC ratios are also low (less than 5 %), except for the 4860-4900' sample which seems to be either contaminated or stained.

I.2 - ORGANIC MATTER QUALITY

I.2.1 - ORGANIC GEOCHEMISTRY

The carbon ratio values, rather high, allow us to assume either a mostly land-derived organic matter with a moderate maturation level or a sapropelic type kerogen at a high degree of catagenesis.

However the very high saturate content of the 4860-4900' sample confirms the contamination or the oil staining of this sample. This particularity is also emphasized by the hydrocarbons content (ppm) vs. TOC content (%) (Pl.2) diagram. All the samples are located in the fair to bad source rock potential zone. The 4860-4900' sample is the only one to be very near the contamined or oil-stained zone.

The occurrence of small amounts of ethylen and propylen in sorbed gaseous hydrocarbons is consistent with a mostly land-derived origin of the organic matter.

The chromatography of the saturates reveals different types of fingerprints which raise several problems. The pattern of sample 4860-4900' suggests the occurrence of an impregnation which may be slightly altered either by leaching or by evaporation proces (this fact has to be correlated with the occurrence of oxydized bitumen under blue light irradiation). The organic matter which has produced this oil may be of land derived origin. The gas chromatograms of the three other samples are not representative of a type III kerogen i.e. a predominant land-derived organic matter. Pristane/phytane ratios, lower than 1, seem to indicate a reducing paleoenvironment. Are these chromatograms representative of a drilling-mud additive which could be a distilled fraction from a crude from a carbonate basin ?

I.2.2 - OPTICAL STUDY

In transmitted light, most of the studied samples in the 1500-6000' zone are ligneous (CMO index < 3) with high occurrence of MOX and MOB. However there are some levels with small quantity of a more petroligenous material (generaly MOV and sometimes MOS). These levels are intermediate but keep a mostly land-derived organic matter (index CMO from 3.1 to 4.3) ; they are : 1460-1500', 2260-2280', 2460-2900', 4060-4100', 4460-4900', 5960-6000'.

In reflected light some vitrinite was observed in the whole studied series. At the bottom (5960-6000') the vitrinite is associated with oxydized bitumen with strong reflectance ; the 5260-5300' sample shows undeterminate organic particles which may be bitumen or vitrinite.

Under blue light irradiation some orange fluorescent particles have been observed in the 5960-6000' sample.

I.3 - MATURATION OF THE ORGANIC MATTER

I.3.1 - ORGANIC GEOCHEMISTRY

The amounts and gross composition of the extractable organic matter do not reflect any vertical evolution. This may indicate that these extracts are not indigenous and by the way not representative of the in situ organic matter.

The amounts and composition (table 1, plate 3) of sorbed gaseous hydrocarbons seem to be more representative and display a vertical evolution which is consistent with a mostly land-derived organic matter in a moderate maturation stage (oil zone) or with a marine organic matter in a high maturation stage (gas diagenetic zone - Ro > 1 %).

I.3.2 - OPTICAL STUDY

I.3.2.1 - In transmitted light

The TAI displays a regular evolution from 2.75 to 3.25. These values correspond to the oil window.

The samples can be grouped in four zones :

- . 1460-2280' : TAI ≃ 2.75
- . 2310-3300' : TAI ≃ 3.00
- . 3460-4700' : TAI ≃ 3.00 - 3.25
- . 4100-6000' : TAI ≃ 3.25

In the last zone, one can see the occurrence of more mature materials (3.50 - 3.75, which are probably reworked debris).

I.3.2.2 - In reflected light

The vitrinite reflectance increases from 0.64 at 2310-2400' to 0.78 % at 5960-6000'. These values as well as the occurrence of fluorescent materials (at 5960-6000') indicate a maturation stage corresponding to the oil diagenetic zone.

The vitrinite reflectance of the locally oxidized bitumens at 5960-6000' is 1.3 %. The measures of the 5260-5600' sample shows a vitrinite reflectance of 1.3 %. This fact may indicate that bitumen only were observed in this sample.

I.4 - CONCLUSION

The extractable organic matter does not show any vertical evolution and the gas chromatograms of saturates are representative of a mostly marine organic matter. This is in discrepancy with the sorbed gaseous hydrocarbons and the optical study so we can assume that these extracts are not representative of the kerogene.

The carbon-ratio values and the sorbed gaseous hydrocarbons cross checked with the optical study indicate a mostly land-derived organic matter in a good maturation stage (oil zone in the whole studied series, 1500-6000').

So, in spite of the good TOC contents (1 %) these series have a poor to bad source rock potential for liquid hydrocarbons but we can expect an average to fair gas potential.

II - COMPARISON WITH LESUEUR 1, KEEP RIVER 1 and MINING EXPLORATION BOREHOLES

This chapter deals with an attempted synthesis of all data on TOC, quality and maturity of kerogene gathered on Lesueur 1, Keep River 1, Bonaparte 2 and some Mining Exploration Boreholes.

Comparison of the data is difficult because of the different sources of information, the large stratigraphic interval covered by the Milligan beds and their thickness.

- In Lesueur 1, the first 200 feet of the top of the Milligan beds are poor in total organic carbon (TOC $\prec$ 0.30 %) and the organic matter is of an intermediate type with dominant ligneous components. The maturity level corresponds to the oil zone (Rc $\simeq$ 0.8 %) (GEO/LAB.PAU n°30/81 RP).

- In Keep River 1 (GEO/LAB.PAU n°8/81 RP) the TOC contents are low in the members 1, 2 and 3 (TOC $\prec$ 0.60 %) and average to good in the member 4 (0.60 % $\prec$ TOC $\prec$ 1.60 %).

  The organic matter is rather ligneous in spite of a slight improvement in member 3. The maturation stays in the oil zone (Ro = 0.80 to 0.90 %).

- In Mineral Exploration Holes the TOC contents and the kerogen type are variable (Table II.1). One can notice that the TOC contents and the organic matter quality increase from the center to the margins of the basin.

All the samples are in a maturation stage corresponding to the beginning of the oil window.

From a sedimentological point of view Lesueur 1 is in an estuary environment i.e. an environment with a higher energy than those of Keep River 1 and Bonaparte 2.

The occurrence of Visean Breccia in the Waggon creek area (R.LAWS 1981 APEA conférence) allows to locate in the area a detritus source for land-derived organic matter.

On the margins of the basin the autochtonous organic matter (sapropelic) is lower in quantity but better in quality (fig.II.6).

EXPLORATION CONCLUSION

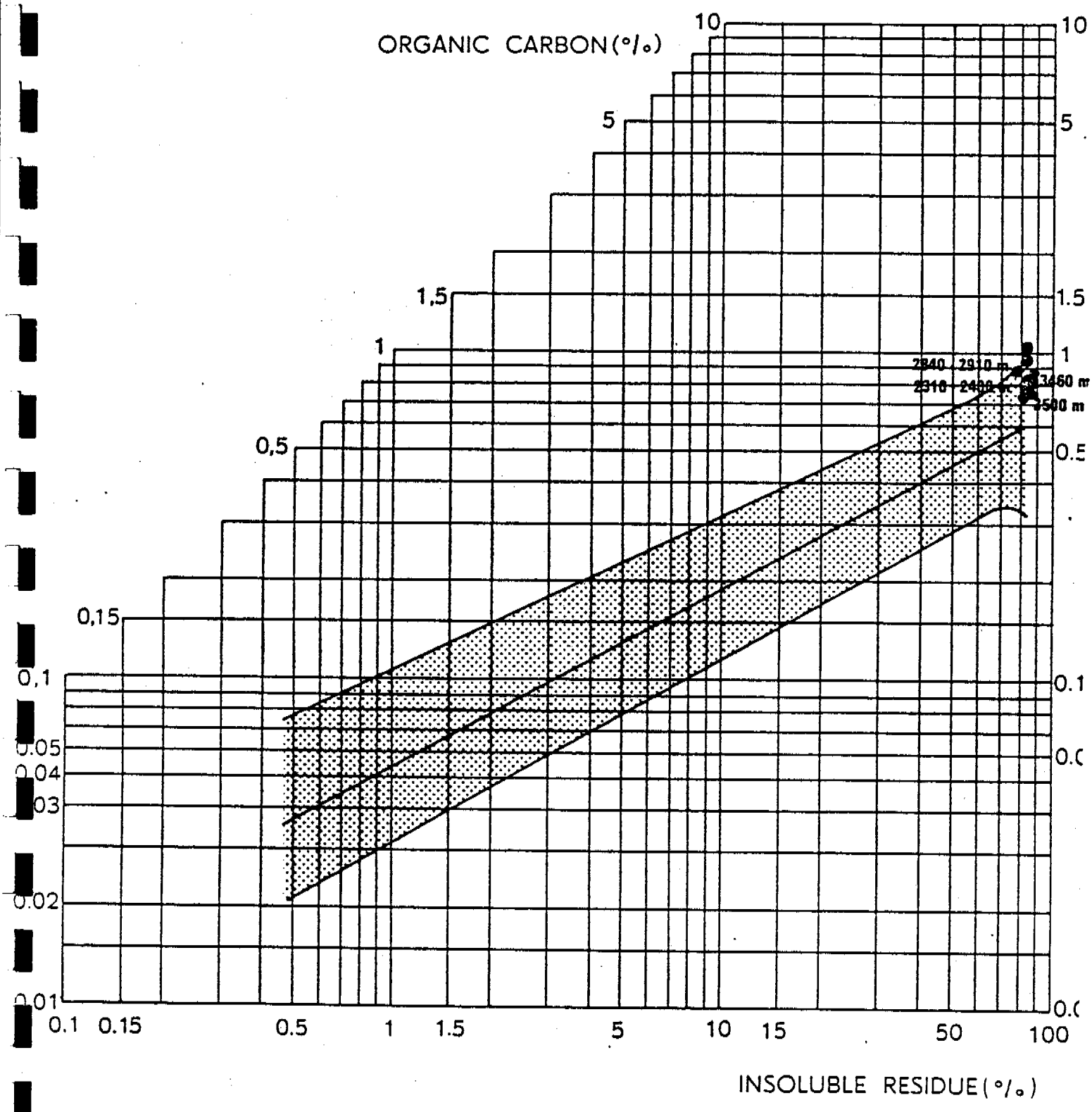
It seems that the margins of the basin are more favourable for oil than its center : the TOC contents are lower but the quality of the organic matter is better and the maturation stage stays in the beginning of the oil window.

Table 1

N° of sample	DEPTH	LITHOLOGY			ORGANIC CARBON			EXTRACTABLE ORGANIC MATTER									SORBED GASES						
		Calcite	Dolomite	Quartz	Insoluble Residu	T.O.C. (%)	Carbon Ratio	E.O.M. (ppm)	E.O.M./T.O.C. (%)	Saturates	Aromatics	Resins	Asphaltens	A/S (%	A + S (%)	A + S (ppm)	Σ HCG (µl/g)	$\frac{\Sigma HCG}{TOC}$ (µl/g)	C_1	C_2	R_2	R_7	R_6
863 398	2310-2400	0	0	18	79,76	0,88	0,80	198	2,2	22,4	9,5	46,6	21,4	0,42	31,9	63	0 32	0,36	79,5	10 2	0,128	0,118	1,095
399	2840-2930	0	0	16	84,34	0,92	0,84										0 50	0,54	83 9	11 1	0 132	0,057	2,679
400	3460-3500	0	0	21	84,30	0,81	0,84										0,11	0 13	87,4	9 5	0,109	0 035	2,180
401	4060 4120	0	0	24	83,89	0,73	0,90	342	4,6	22,0	13,1	38,5	26,3	0 60	35,2	120	0,51	0 69	86,5	9 3	0,108	0,048	5,272
402	4460-4500	0	0	33	82,74	0,75	0,90										1,23	1,69	84,6	10,2	0,121	0,057	1,430
403	4860-4900	0	0	25	81,40	0,76	0,85	863	11,3	53,0	6,6	23,5	16,9	0,12	59 6	514	3 25	4,27	89,0	7,8	0,088	0 033	1,143
404	5260-5300	0	0	16	81,74	0,82	0,86										7 13	8,69	91 6	5,9	0,065	0,024	1,014
405	5660-5700	0	0	17	82,82	1,00	0,88										3,52	3 52	92,8	5,1	0,055	0 020	1,331
406	5960-6000	0	0	27	81,29	0,80	0,87	221	2,8	21,9	14,8	40,7	22,5	0,68	36,8	81	3,09	3,86	92,6	5,3	0,058	0,019	2,314

bonaparte 2 - ORGANIC GEOCHEMISTRY DATA

PLATE 1



BONAPARTE 2

TOC VS INSOLUBLE RESIDUE

Plate 1B

TOC VS INSOLUBLE RESIDUE

BONAPARTE 2 PREVIONS RESULTS

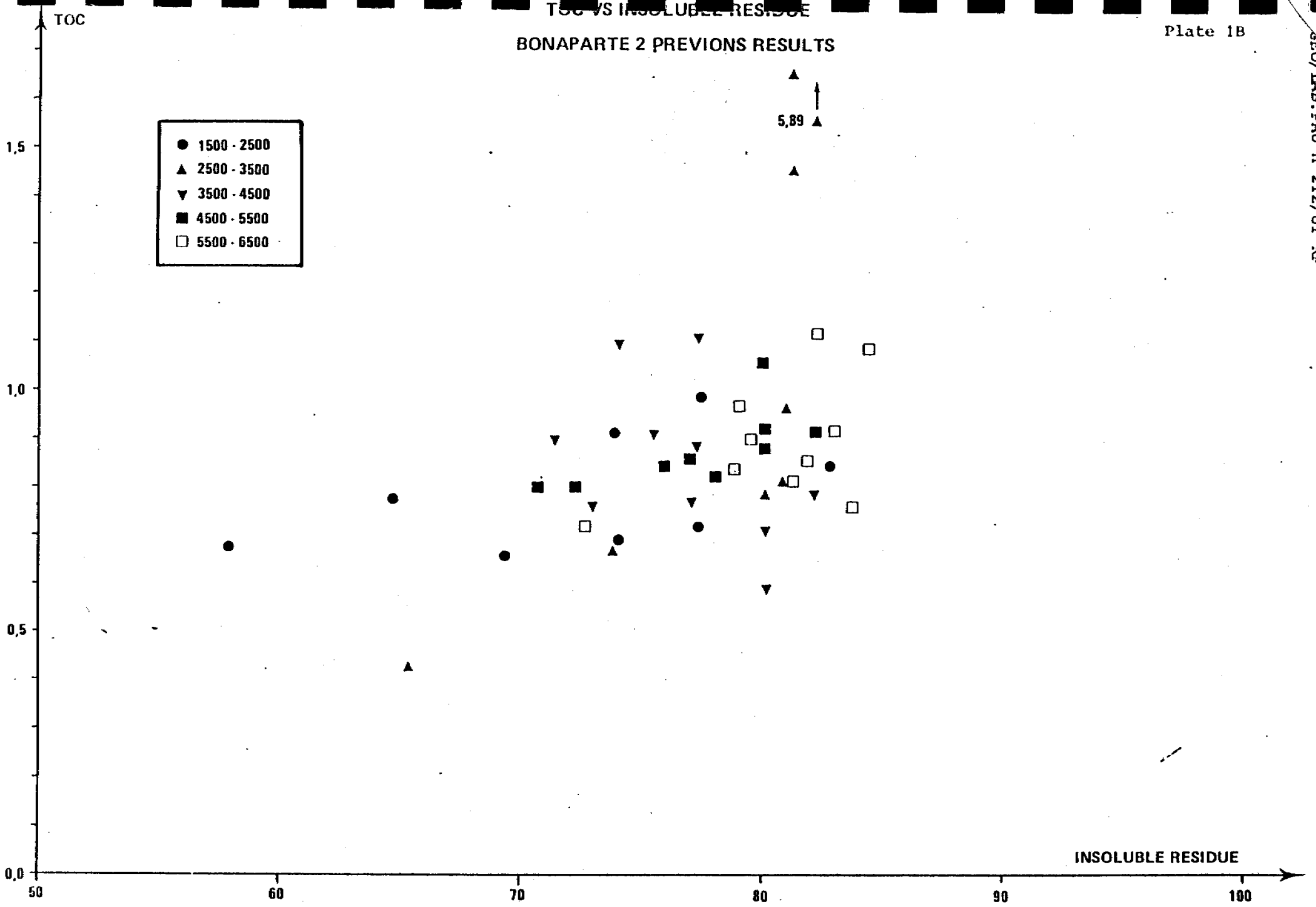
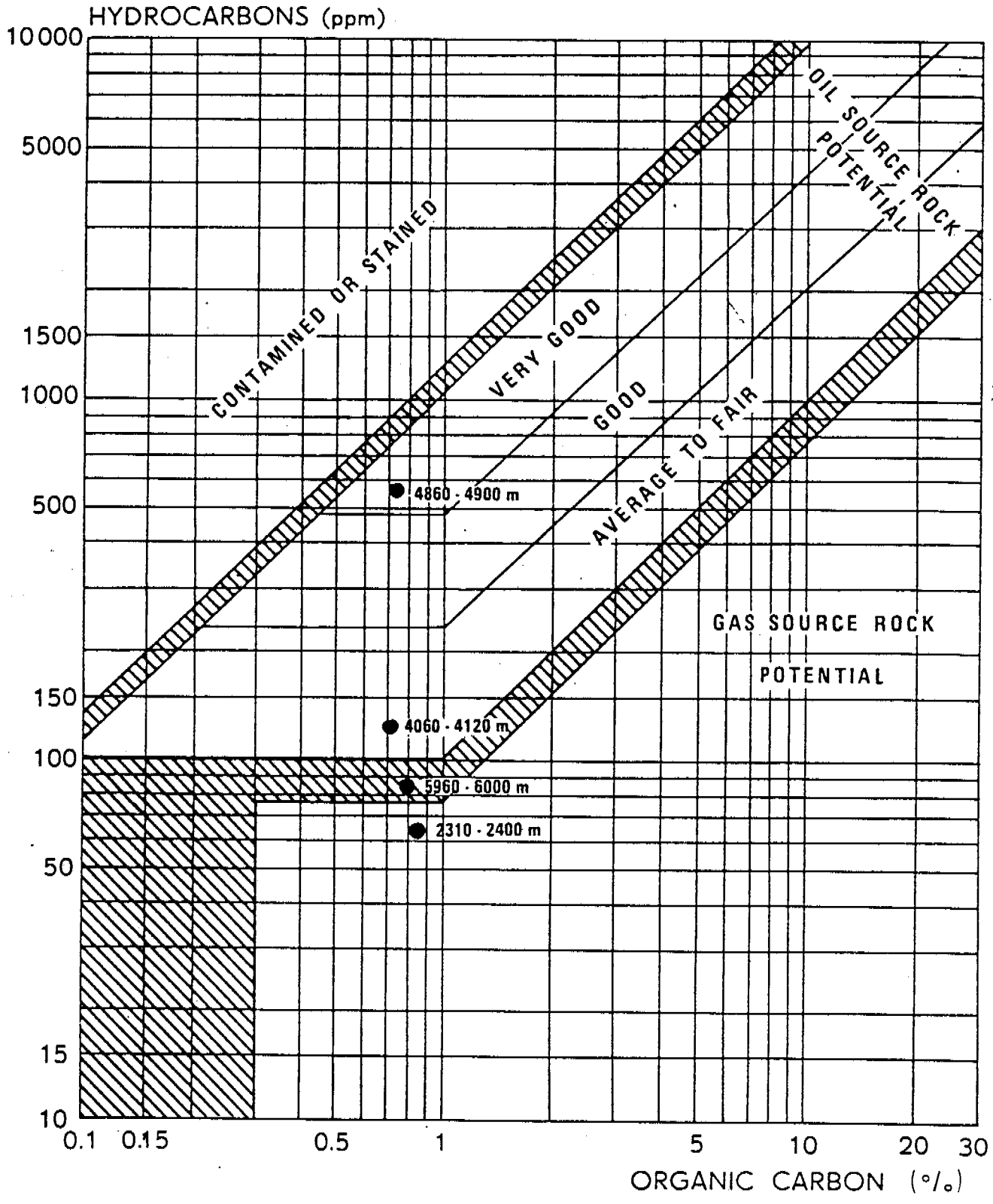


PLATE 2



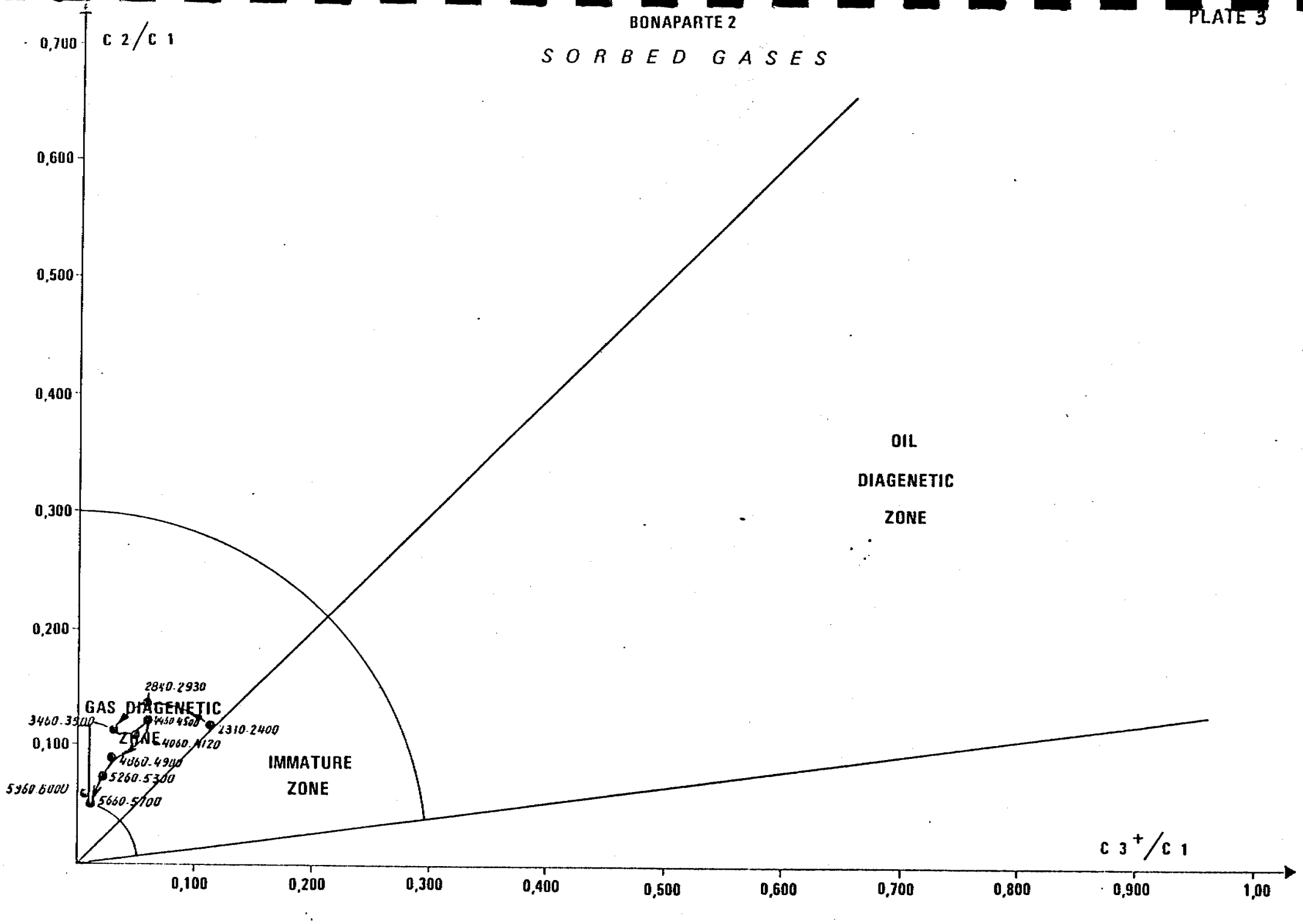
BONAPARTE 2

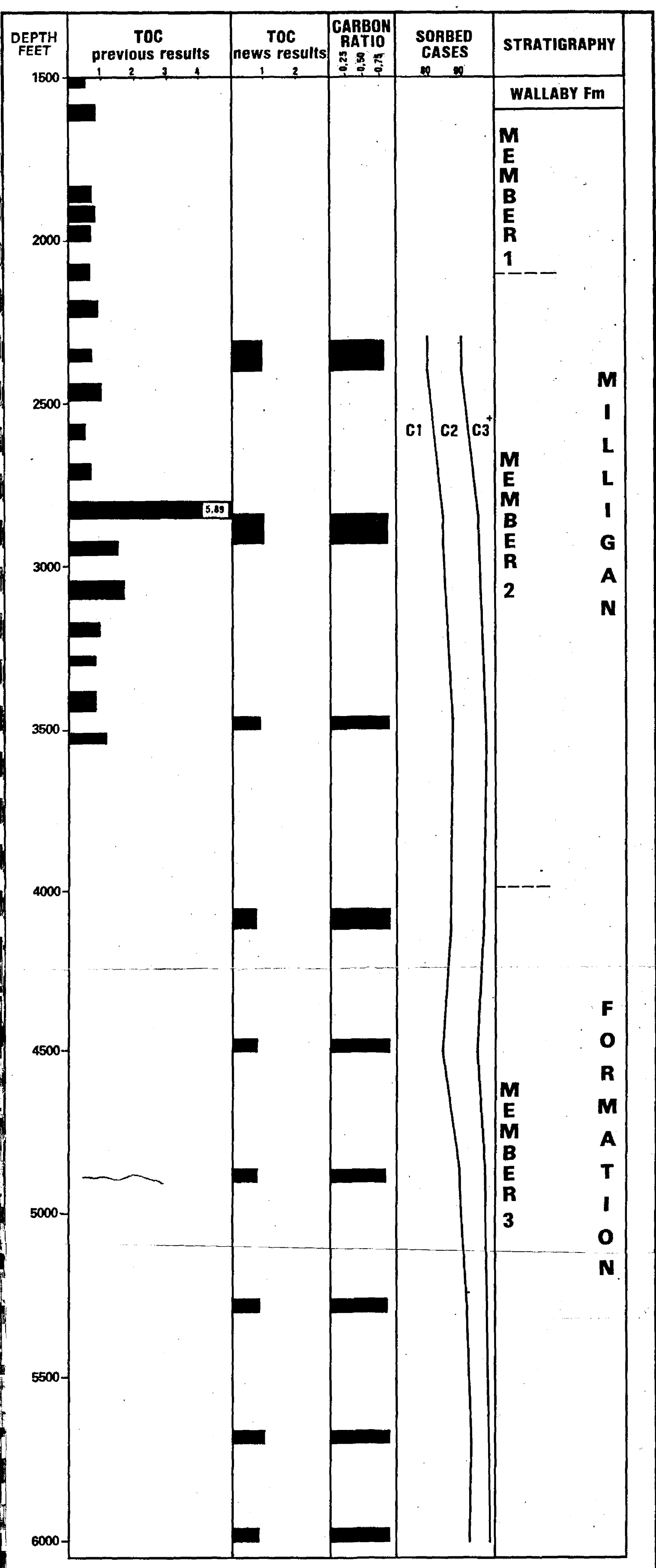
HYDROCARBONS VS TOC

BONAPARTE 2

PLATE 3

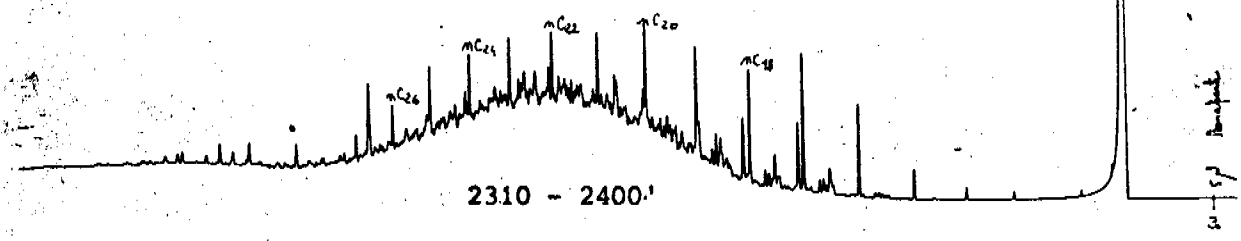
SORBED GASES

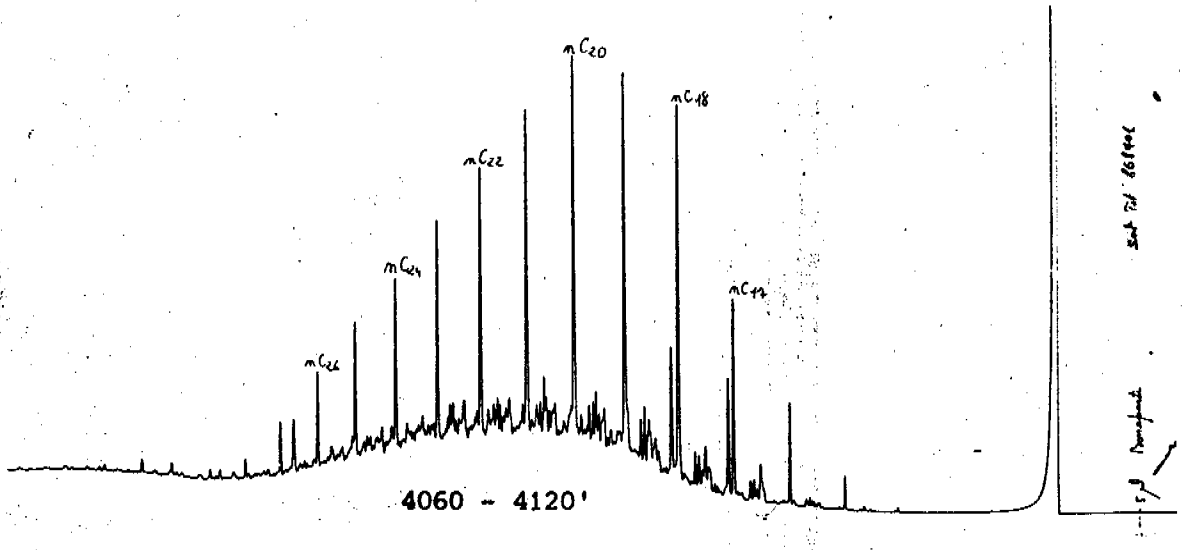


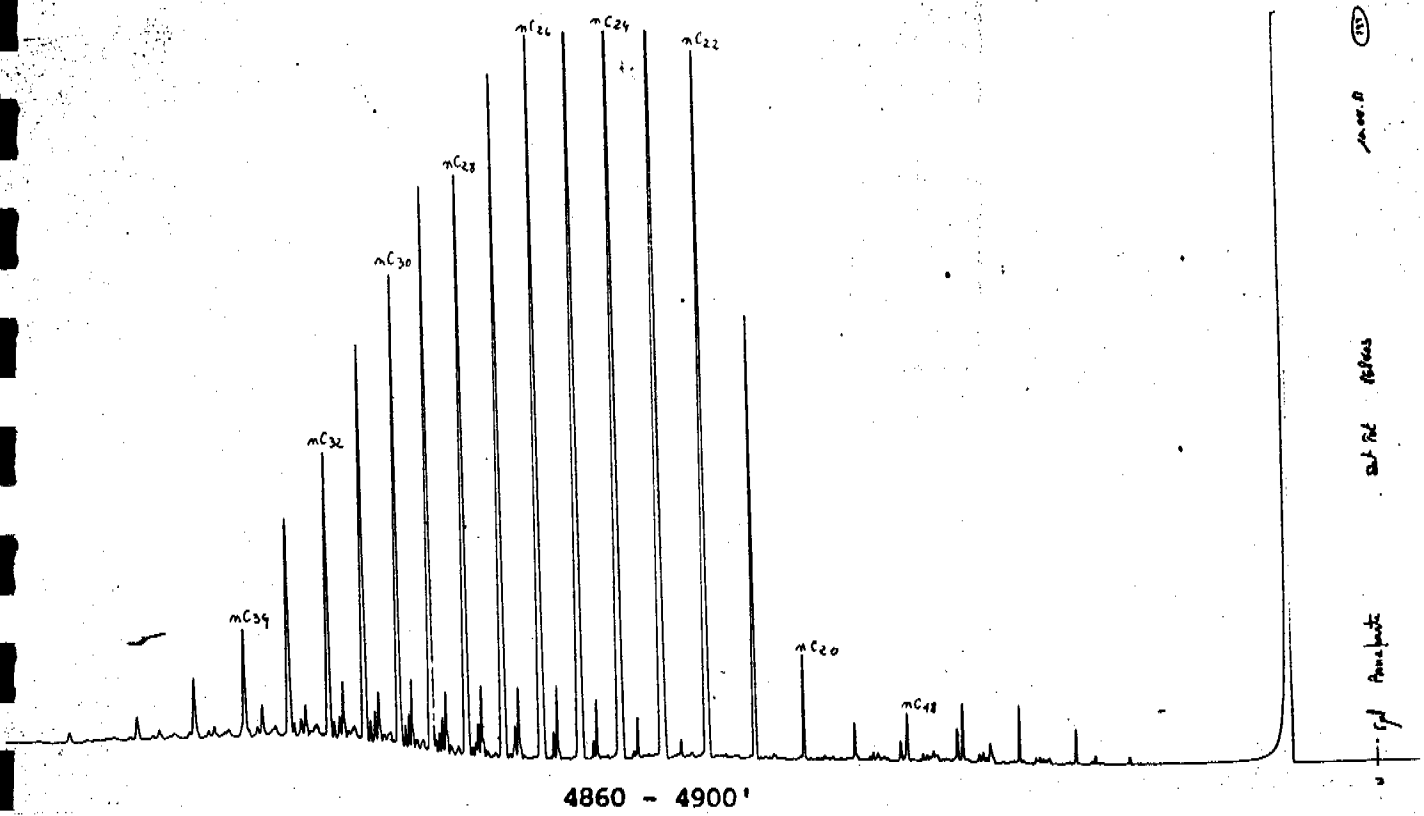


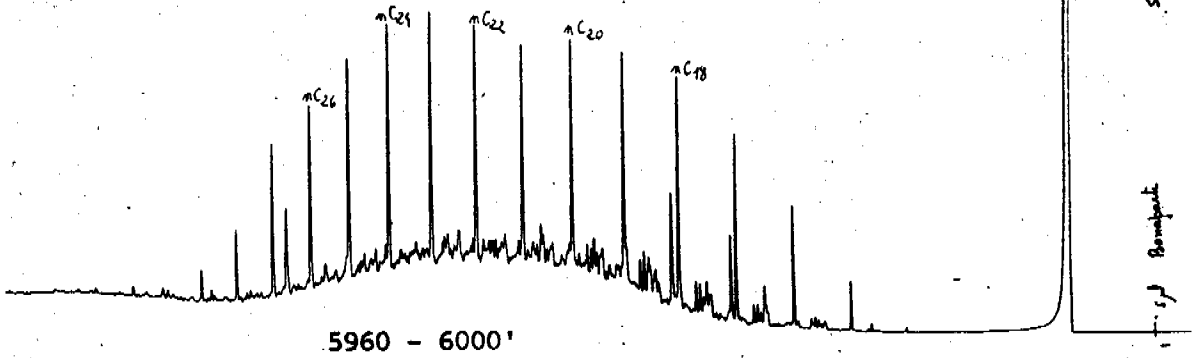
BONAPARTE 2

Appendix 1


nC26
nC24
nC22
nC20
nC18
2310 - 2400'


nC26
nC24
nC22
nC20
nC18
4060 - 4120'


nC34
nC32
nC30
nC28
nC26
nC24
nC22
nC20
nC18
4860 - 4900'


nC26
nC24
nC22
nC20
nC18
5960 - 6000'

COTES

FORMATIONS

REFLECTANCE

FLUORESCENCE

NATURE

0 1 2%

2400M

4120M

5300M

6000M

Vitrinite ou Bitume

Bitume

elf aquitaine

Appendix 3

Pays : AUTRALIE

Permis ou concession :

DIRECTION GENERALE DES PRODUCTIONS

DIRECTION EXPLORATION

Date : Avril 1984

Auteur : A.M. CASSOU

N° Class :

BONAPARTE.2

Bonaparte 2

Results on optical study of organic matter

STAGE	ANALYSED SAMPLES	Recovered organic matter %	TRANSMITTED LIGHT — Nature of organic matter											PR — Maturation of organic matter				
			MOS		MOV		MOX		MOB		MOF	Palyno. units UP-CH	MOS sapropelic / MOV vegetal cellular / MOX ligneous / MOB tracheids	T. A. I.				
				en %		en %		en %		en %			25 50 75					
M 2	3460-3500'		-		Q	11	A	24,5	A	44,5				3.00/3.25				
	3670-3700'		R	5	C	19	A	38	A	38				3.00/3.25				
	3860-3900'		R	5	C	19	A	38	A	38				3.00/3.25				
	4060-4100'		R	6	C-F	28	F	33	F	33				3.00/3.25				
	4270-4300'		R	5	C	21	A	42,5	F	31,5				3.25/3.00				
	4460-4500'		R	6	F	33	F	33	C-F	29				3.00/3.25				
M 3	4660-4700'		R	5	F	28,5	A	38	F	28,5				3,25/3.00				
	4700-4730'		Q	11	F	31,5	F	31,5	C-F	26	F			3.25	org. 3.50/3.75			
	4710-4720'		Q	8	A	34	A	34	F	24				3.25	org: 3.50/3.75			
	4860-4900'		R	4	A	35	A	35	F	26				3.25	org. 3.50/3.75			
	5060-5100'		-		Q	12,5	A	50	F	37,5			25 50 75	3.25	org. 3.50/3.75			

A : Abundant F : Fréquent C : Common S : Some R : Rare

Appendix 4

Bonaparte 2

Results on optical study of organic matter

STAGE	ANALYSED SAMPLES	Recovered organic matter %	TRANSMITTED LIGHT — Nature of organic matter												PR — Maturation of organic matter				
			MOS		MOV		MOX		MOB		MOF	Palyno. units UP-CH	MOS sapropelic MOV vegetal cellulo MOX ligneous MOB tracheids		T. A. I.				
				en %		en %		en %		en %			25 50 75						
	5260-5300'		-		Q	15	F	47	C-F	38					3.25	org. 3.50/3.75			
	5460-5500'		-		Q	12,5	A	50	F	37,5					3.25	org. 3.50/3.75			
	5660-5700'		Q	11	Q	11	A	45	F	33					3.25	org. 3.75/3.50			
	5860-5900'		-		Q	11	A	44,5	A	44,5					3.25	org. 3.75/3.50			
	868 406 5960-6000'	0.0	Q	13	Q-C	20	F	40	C	27	F				3.25/3.50	org. 3.75			
													25 50 75						

A : Abundant F : Fréquent C : Common S : Some R : Rare

Appendix 5

Bonaparte 2

Results on optical study of organic matter

STAGE	ANALYSED SAMPLES	Recovered organic matter %	TRANSMITTED LIGHT — Nature of organic matter												PR — Maturation of organic matter				
			MOS		MOV		MOX		MOB		MOF	Palyno. units UP-CH	MOS sapropelic MOV vegetal cellular MOX ligneous MOB tracheids	T. A. I.				
				en %		en %		en %		en %			25 50 75					
	1460-1500'		-		C	34	C	33	C	33				2.75				
M 1	1720-1760'		R	5	C	21	A	43	F	31				2.75/3.00				
	1860-1900'		R	6	C	24	F	35	F	35				2.75/3.00				
	2100'		R	6	C	25	F	37,5	C-F	31,5				3.00/2.75				
	2260-2280'		C	18	C	18	A	38	F	27				3.00/2.75				
	868 398 2310-2400	0.0	R	6	C	24	A	46	C	24				3.00				
M 2	2460-2500'		Q	7	A	31	A	31	A	31				2.75/3.00				
	2660-2700'		Q	17	Q	17	C	33	C	33				2.75/3.00				
	2860-2900'		C	15	F	23	A	31	A	31				3.00/2.75				
	3060-3100'		-		Q	12	A	47	F-A	41				3.00				
	3260-3300'		R	6	Q	12	A	47	F	35				3.00				

A : Abundant F : Fréquent C : Common S : Some R : Rare

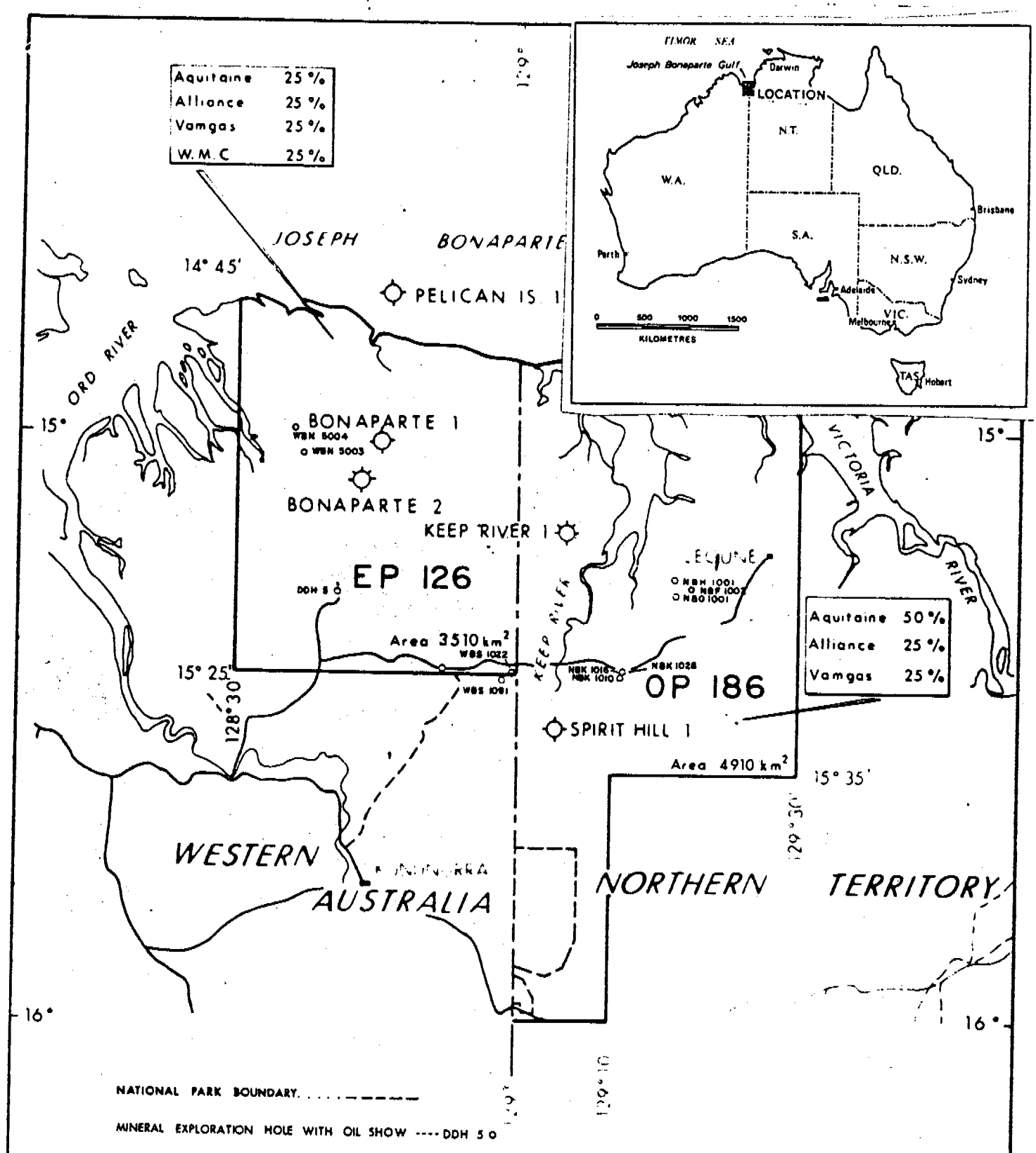
Appendix 6

Table II.1

MILLIGAN BEDS - MINERAL HOLES

WELL	DEPT (m)	TOC (%)	Ro (%)	TYPE
WBN.3	93.50	1	0.56	Humic
NBO.1001	115.90	0.41		
NBF.1002	147.00	3	0.45	Mixed
WBN.5004	46-48	1.52	0.45	Mixed
NBH.1001	143.90	0.46	0.44	
WBJ.1001	84.20	2.10	0.45	Mixed
DDH.2	76:00	0.49	0.48	
DDH.11	99.00	0.58	0.68	

Analyses from ROBERTSON and SNEA (P) (GEO.LAB.PAU n°52/80 RP)



Australian Aquitaine Petroleum Pty Ltd

SOURCE ROCK ANALYSIS DATA POINTS

SCALE 1 : 1 000 000

Author B. LAWS	Date MARCH 1981	Dwg.No. 18910	Fig.II.1
Drafting C. Griffin	Report No	Base Plan 16335	

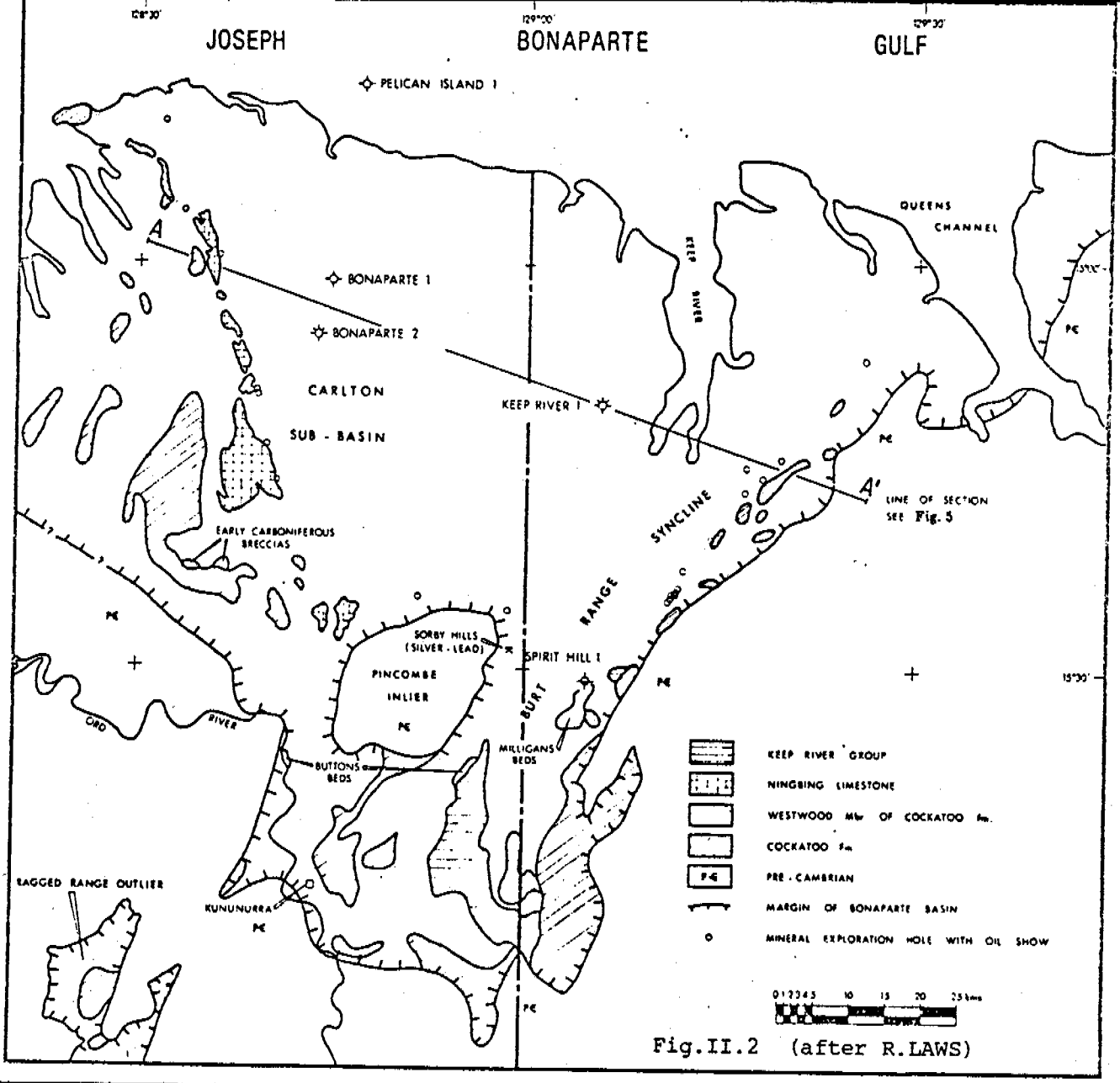


Fig.II.2 (after R.LAWS)

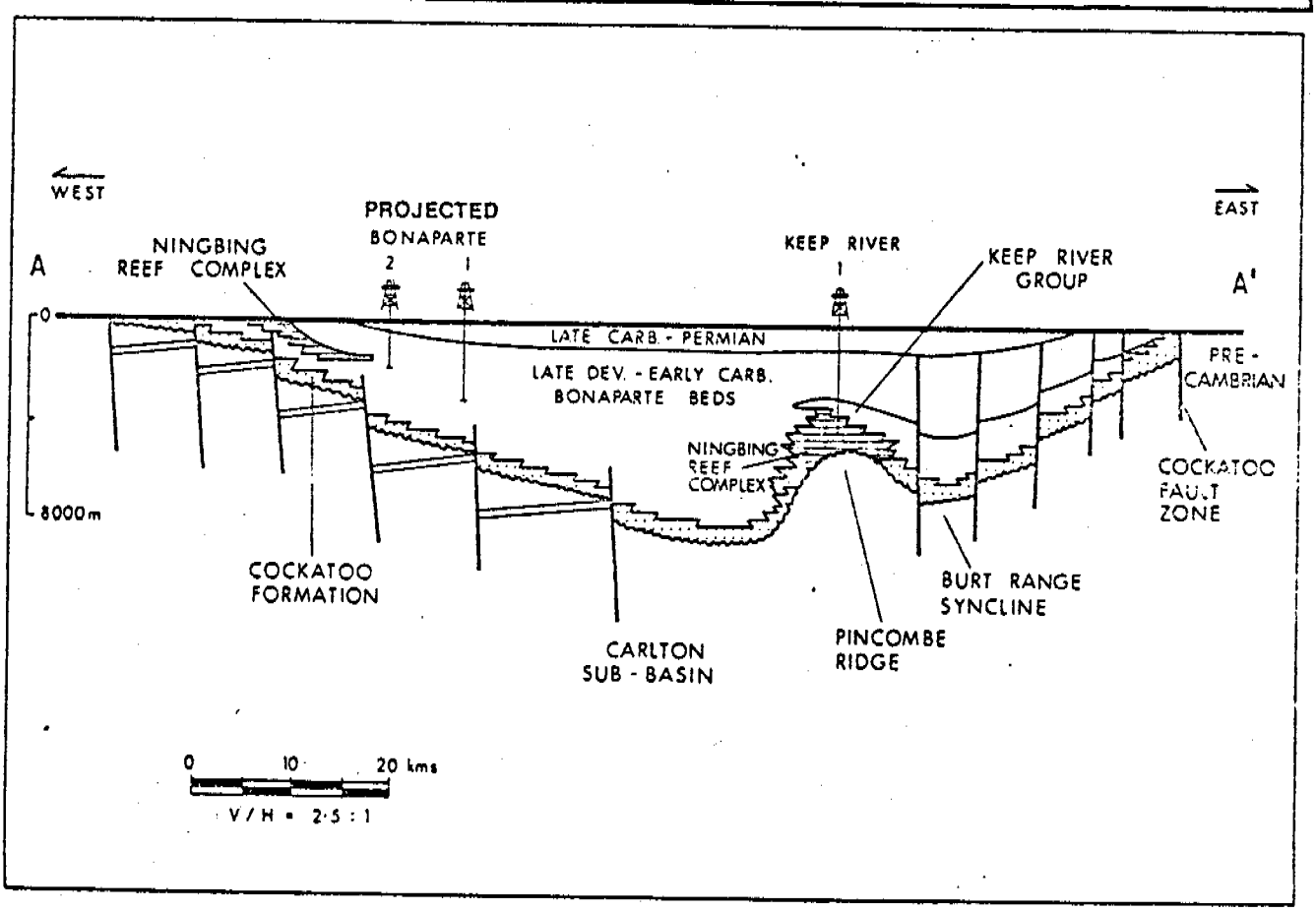


Fig.II.3 - Regional cross-section (see Fig.II.2 for line of section) (after R.LAWS)

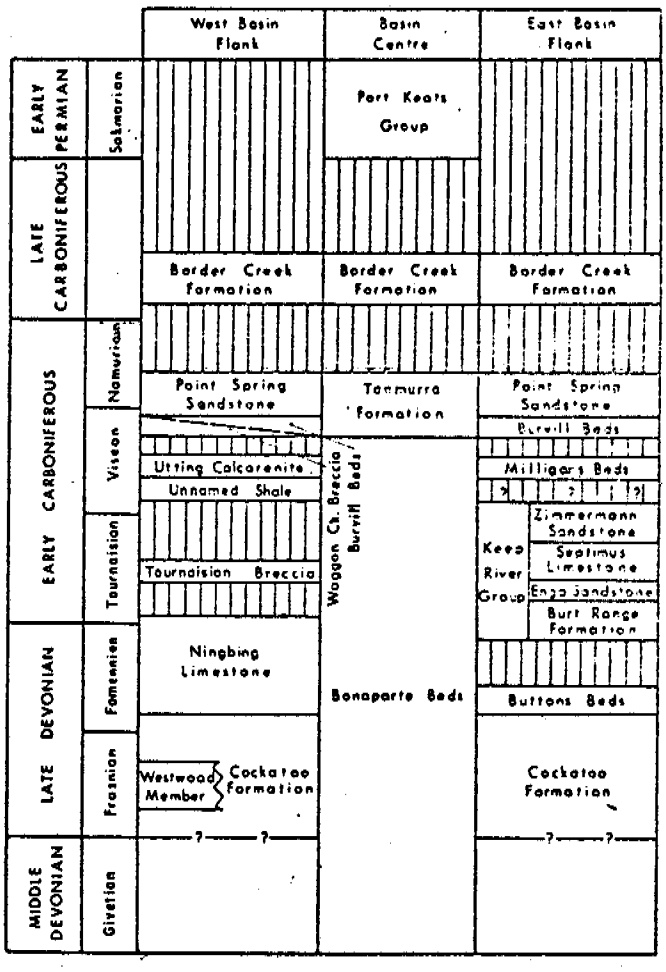


Fig.II.4 - Stratigraphic table of Late Devonian and Carboniferous (after R.LAWS)

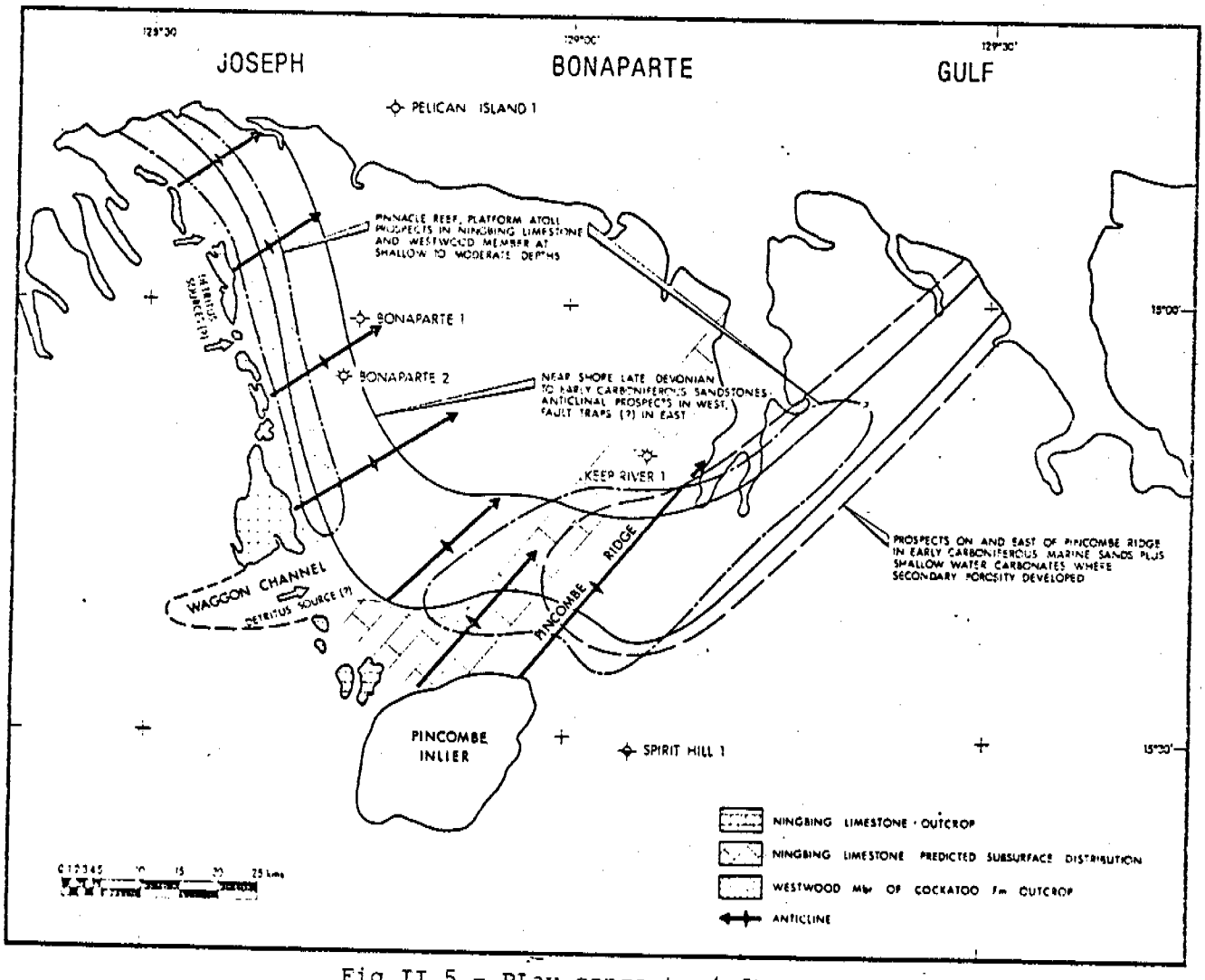
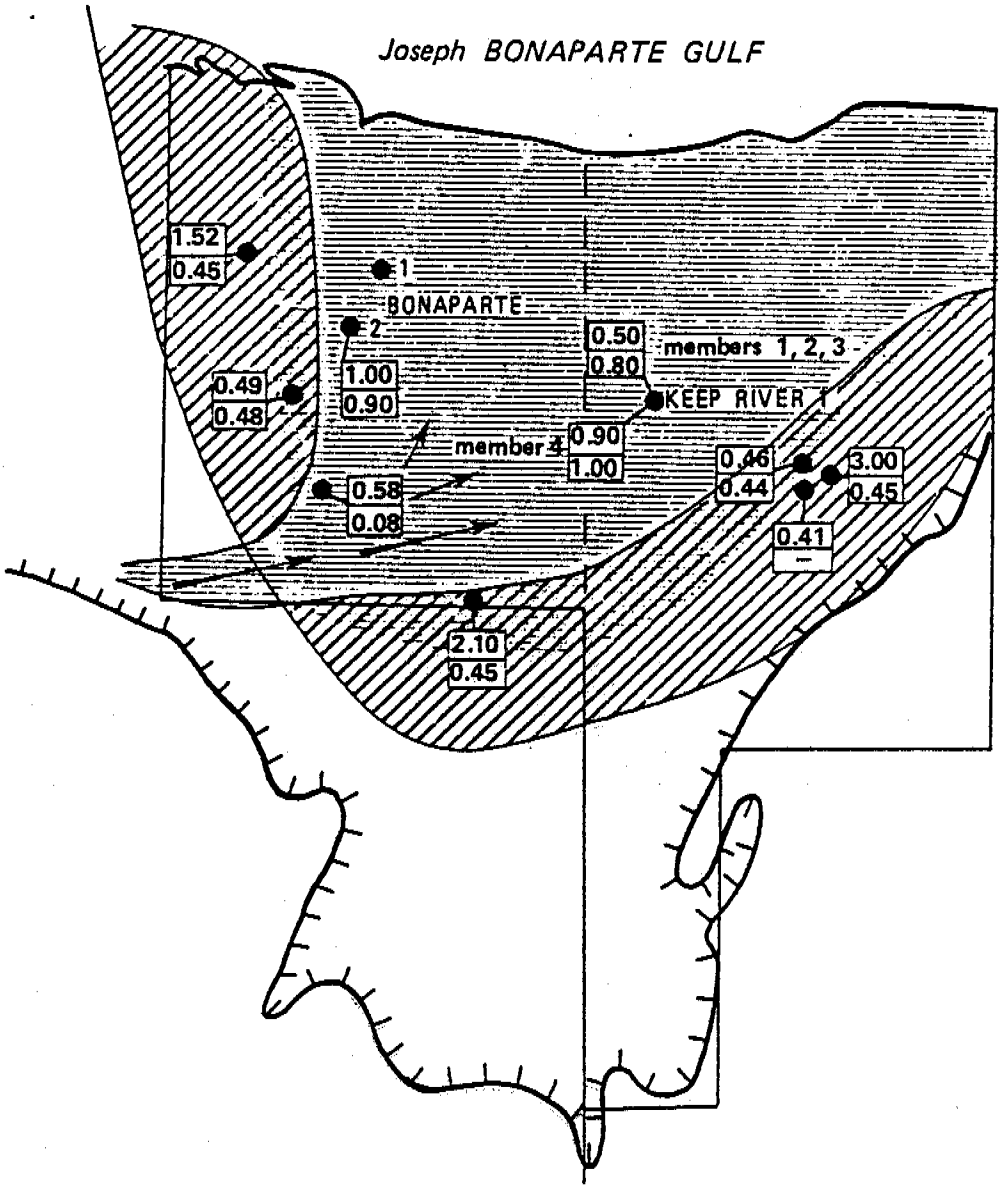


Fig.II.5 - PLay concepts (after R.LAWS)



NATURE and MATURATION OF THE ORGANIC MATTER

LIST OF TABLE, PLATES AND APPENDIXES

BONAPARTE 2 WELL

ORGANIC GEOCHEMISTRY SYNTHESIS