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OCTOBER 1986

GEOCHEMISTRY BRANCH

A GEOCHEMICAL STUDY OF THE WELL NORMANBY-1, OTWAY BASIN,
OFFSHORE SOUTHERN AUSTRALIAN MARGIN

by

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Subject

A GEOCHEMICAL STUDY OF THE WELL NORMANBY-1, OTWAY BASIN,
OFFSHORE SOUTHERN AUSTRALIAN MARGIN

Prior to uplift the conventional OGT lay in sediments now at ca 2600m. Sediments at TD were moderately mature (R_o 0.6-0.7%; $\pm 130^\circ\text{C}$). The Paaratte and Waarre Coals have excellent potentials/residual potentials to source gas and gas/condensate respectively. The associated mudstones/siltstones show only poor/moderate gas potential. The coals do not appear to be volumetrically significant.

None of the sediments we extracted shows any genetic relationship with the weathered oil seeps stranded along the southern Australian coast.

M.J. Gibbons
3249

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I N D E X S H E E T

Report Number (internal only): GCB/226/86

Title: A GEOCHEMICAL STUDY OF THE WELL NORMANBY-1. OTWAY BASIN,
OFFSHORE SOUTHERN AUSTRALIAN MARGIN

Author(s): M.E. Dunn

Company: BP

Date of Report: October, 1986

Keywords: Geochemistry, Sediment, Source Rock

Country or Area (if applicable): Otway Basin, Australia

Well Names (if applicable): Normanby-1

Oil/Gas Field Names (if applicable):

PLEASE COMPLETE IF REPORT REFERS TO GEOGRAPHICAL/GEOLOGICAL AREA

Area Covered:	Northernmost Latitude	d	m	S
	Westernmost Longitude	d	m	S
	Southernmost Latitude	d	m	S
	Easternmost Longitude	d	m	S

Sedimentary Basin: Otway

Stratigraphy: Tertiary (Youngest Age)

Cretaceous (Oldest Age)

Indexer: M.E. Dunn Date: 15.10.86

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OTWAY BASIN OFFSHORE VICTORIA NORMANBY-1 LOCATION MAP

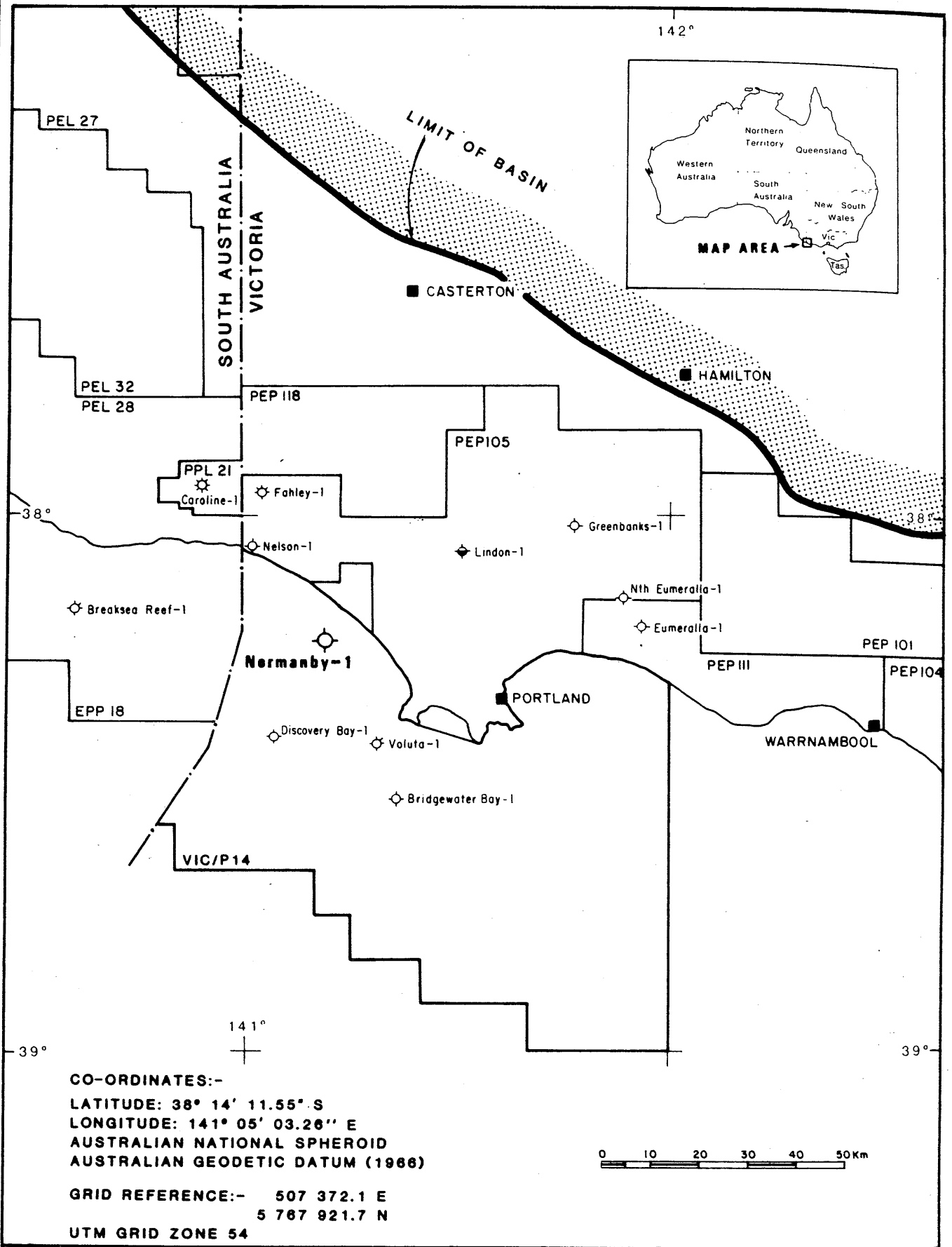


Figure 1

Taken from BP Pet. Dev. Australia, Ref. W28 Drg. TS 3818

RCS.6513

1. INTRODUCTION

The well Normanby-1, located in the licence area Vic/P14 in the Otway Basin, Offshore Victoria (Figure 1) reached T.D. at 3306m in sediments of Cretaceous age without encountering significant hydrocarbons.

The aims of the study are to establish maturity and source potential and to identify a source for the non-marine crudes stranded along the South Australian margin.

2. RESULTS AND DISCUSSION

2.1 Maturity

Vitrinite reflectance generally increases from 0.4% R_o at 740m to 0.73% R_o at 3300m (Figure 2). A least squares fit to these data suggests that, prior to uplift, the conventional OGT (0.55% R_o) lay in sediments now at ca. 2600m. The reflectance data are supported by the molecular maturity parameter data, which suggest that sediments at 1715m are immature and that sediments at 3225m are moderately mature (equivalent R_o 0.6%). In contrast, spore colours suggest that sediments are no more than marginally mature even at T.D. In this instance the reflectance and molecular maturity data are considered to be more reliable.

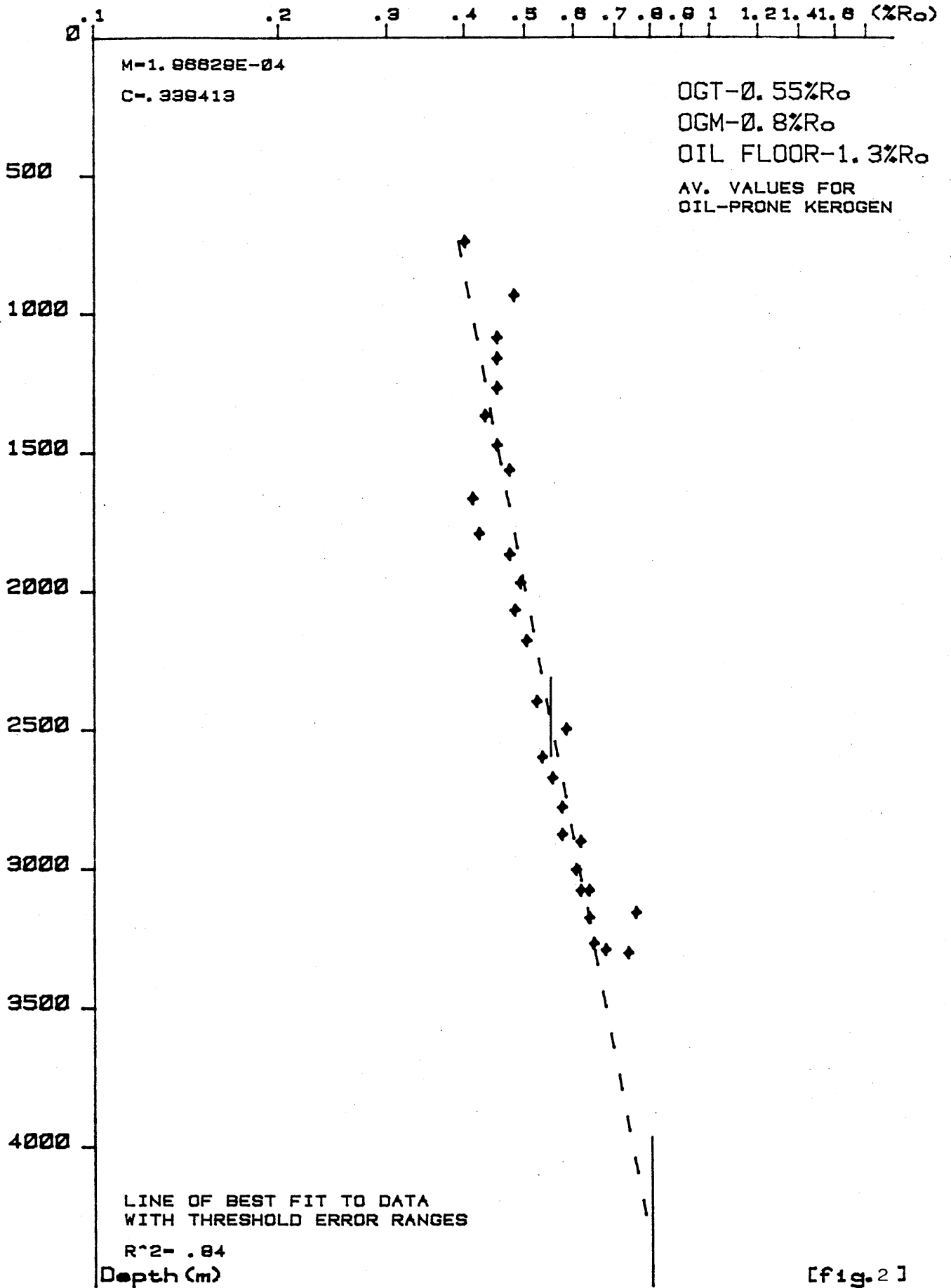
The molecular maturity parameter data for the sediment extract from 1160m are discounted as they indicate mixing of immature and early mature assemblages (the latter probably due to contamination). The possibility of contamination is supported by the P_1 distribution.

2.2 Source Potential and Type

i) Tertiary

The analysed siltstones and mudstones from the Dilwyn and Pember Mudstone Formations generally show moderate to good source potential for the expulsion of gas with some condensate at temperatures $> 150^{\circ}\text{C}$ (P_2 0.8 - 11.4 kg/tonne; GOGI 0.38 - 0.50). Additionally a thin coal interval within the Dilwyn Formation at $\sim 1210\text{m}$ shows very good source potential and will also expel gas-condensate at $> 150^{\circ}\text{C}$ (P_2 32.4 kg/tonne; GOGI 0.45).

Vitrinite Reflectance Analysis
for well: NORMANBY-1



[fig. 2]

ii) Cretaceous

The analysed mudstones and siltstones generally show poor to moderate source potential. Due to their lean nature they will expel only gas with minor condensate at temperatures greater than 150°C. The coals within the Paaratte Formation between 1635 and 1840m generally show excellent source potential for gas (P₂ 35.9 - 63.0 kg/tonne; GOGI 0.51 - 0.89) whereas the coals within the Waare Formation between 3200 and 3300m show excellent residual potentials (P₂ 38.8 - 132.7 kg/tonne; GOGI 0.42 - 0.47) for gas-condensate. The Waare coals will have been richer and possibly more oil prone in the past. These pyrolysis data are supported by the available visual kerogen descriptions.

2.3 Soluble Extract Studies

One siltstone from 1160m and two coal samples from 1715 and 3225m were characterised by GC, GC-MS and carbon isotopes. These extracts are compared with bitumens (weathered oil seeps) stranded along the southern margin coast (data in McKirdy 1984 and summarised by Gibbons and Fry, 1986) which are with one exception (sample 48, of apparently higher plant origin) of algal origin.

The siltstone extract from 1160m is probably contaminated (see Section 2.1).

The SAC chromatogram for the coal extract from 1715m within the Paaratte Formation is characterised by low concentrations of n-alkanes (due to immaturity) and the presence of diterpanes (derived from conifer resins) and triterpenoids. The sterane and triterpane GC-MS traces are dominated by diterpanes and C₂₉ steranes (S3; 9:18:73). The kerogen has a stable carbon isotope ratio of $\delta^{13}\text{C}$ -23.8‰.

The SAC chromatogram for the coal extract from 3225m, within the Waare Formation, is characterised by a back-end biased n-alkane distri-

bution, indicative of higher-land-plant waxes, and a high pristane/phytane ratio (9.3). The sterane and triterpane distributions are characterised by high C₂₉ sterane contents (S₃ 18:21:61) and a high hopane/hopane + sterane ratio (M₄ 83.6). The kerogen has a stable carbon isotope ratio of $\delta^{13}\text{C}$ -25.4‰.

These coals, as with the coals in Duntroon-1 (Gibbons and Fry, 1986), did not source the weathered oil seeps of algal origin stranded along the Southern Australian Margin.

3. CONCLUSIONS

- 1) The maturity data suggest that, prior to uplift, the conventional OGT lay in sediments now at ca. 2600m.
- 2) Coals within the Paaratte Formation show excellent source potential for gas which will be expelled at temperatures > 150°C. Coals within the Waare Formation show excellent residual potentials (they may have been richer and more oil prone in the past) for the expulsion of gas and condensate, also at temperatures > 150°C.
- 3) These coals, as with the coals in Duntroon-1, did not source the weathered oil seeps of algal origin stranded along the Southern Australian margin.

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Report F5769/84 (Part 8 -
final). AMDEL.

TABLE 1a

L I T H O L O G Y A N D S T R A T I G R A P H Y

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE	FORMATION	AGE	LITHOLOGY
710.00	680-710	NIRRANDA GROUP	TERTIARY	SANDSTONE-100%
740.00	710-740	NIRR.-DILWYN	TERTIARY	SANDSTONE-100% :SILTSTONE-GY BRN TR
820.00	740-820	DILWYN	TERTIARY	SANDSTONE-100%
845.00	820-845	DILWYN	TERTIARY	SANDSTONE-TR WALNUT SHELLS/WOOD 100%
875.00	845-875	DILWYN	TERTIARY	SANDSTONE-TR WALNUT SHELLS/WOOD 100%
915.00	875-915	DILWYN	TERTIARY	SANDSTONE-100%
935.00	915-935	DILWYN	TERTIARY	SILTSTONE-DK GY 10% :SANDSTONE-90%
985.00	935-985	DILWYN	TERTIARY	SANDSTONE-100%
1010.00	985-1010	DILWYN	TERTIARY	SANDSTONE-100%
1035.00	1010-1035	DILWYN	TERTIARY	MUDSTONE-GY BRN SILTY 5% :SANDSTONE-95%
1060.00	1035-1060	DILWYN	TERTIARY	MUDSTONE-GY BRN SILTY 40% :SANDSTONE-60%
1085.00	1060-1085	DILWYN	TERTIARY	SILTSTONE-GY 40% :SANDSTONE-60%
1110.00	1085-1110	DILWYN	TERTIARY	SILTSTONE-GY 50% :SANDSTONE-50%
1135.00	1110-1135	DILWYN	TERTIARY	SILTSTONE-DK GY 50% :SANDSTONE-50%
1160.00	1135-1160	DILWYN	TERTIARY	SILTSTONE-GY BRN 65% :SANDSTONE-35%
1185.00	1160-1185	DILWYN	TERTIARY	SILTSTONE-GY BRN 65% :SANDSTONE-35%
1210.00	1185-1210	DILWYN	TERTIARY	SILTSTONE-GY BRN 70% :SANDSTONE-30%
1210.10		DILWYN	TERTIARY	:COAL-BLK TR
1210.20		DILWYN	TERTIARY	
1240.00	1210-1240	DILWYN-PEMBER	TERTIARY	SILTSTONE-DK GY MUDDY 40% :SANDSTONE-60%
1265.00	1240-1265	PEMBER MDST	TERTIARY	MUDSTONE-DK GY OCC SILTY 90% :SANDSTONE-10%
1290.00	1265-1290	PEMBER-CURDIES	TERTIARY -CRETACEOUS	SILTSTONE-DK GY MUDDY 30% :SANDSTONE-70%
1315.00	1290-1315	CURDIES	CRETACEOUS	SILTSTONE-DK GY MUDDY 10% :SANDSTONE-90%
1340.00	1315-1340	CURDIES	CRETACEOUS	MUDSTONE-GY BRN OCC SILTY 10%
1365.00	1340-1365	CURDIES	CRETACEOUS	:SANDSTONE-90%
1390.00	1365-1390	CURDIES	CRETACEOUS	MUDSTONE-GY BRN OCC SILTY 20%
1415.00	1390-1415	CURDIES	CRETACEOUS	:SANDSTONE-80%
1445.00	1415-1445	CURDIES	CRETACEOUS	MUDSTONE-GY BRN OCC SILTY 10%
1470.00	1445-1470	CURDIES	CRETACEOUS	:SANDSTONE-90%
1490.00	1470-1490	CURDIES-PAARAT.	CRETACEOUS	SILTSTONE-DK GY MUDDY 60% :SANDSTONE-40%
1515.00	1490-1515	PAARATTE	CRETACEOUS	SILTSTONE-GY BRN 50% :SANDSTONE-50%
1535.00	1515-1535	PAARATTE	CRETACEOUS	SILTSTONE-GY DK GY 50% :SANDSTONE-50%
1560.00	1535-1560	PAARATTE	CRETACEOUS	SILTSTONE-GY BRN MUDDY 30% :SANDSTONE-70%
				MUDSTONE-GY OCC SILTY 35% :SANDSTONE-65%

TABLE 1b

L I T H O L O G Y A N D S T R A T I G R A P H Y

WELL : NORMANBY-1

LOCATION : AUSTRALIA

DEPTH (m)	DEPTH RANGE	FORMATION	AGE	LITHOLOGY
1590.00	1560-1590	PAARATTE	CRETACEOUS	MUDSTONE-GY OCC SILTY 10% :SANDSTONE-90%
1615.00	1590-1615	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 10% :SANDSTONE-90%
1635.00	1615-1635	PAARATTE	CRETACEOUS	MUDSTONE-GY OCC SILTY 100%
1665.00	1635-1665	PAARATTE	CRETACEOUS	SANDSTONE-50% :MUDSTONE-GY 40% :COAL-BLK 10%
1665.10		PAARATTE	CRETACEOUS	
1665.20		PAARATTE	CRETACEOUS	
1690.00	1665-1690	PAARATTE	CRETACEOUS	MUDSTONE-GY SILTY 40% :SANDSTONE-60%
1715.00	1690-1715	PAARATTE	CRETACEOUS	SANDSTONE-80% :MUDSTONE-GY SILTY 15% :COAL-BLK 5%
1715.10		PAARATTE	CRETACEOUS	
1715.20		PAARATTE	CRETACEOUS	
1740.00	1715-1740	PAARATTE	CRETACEOUS	SILTSTONE-GY 50% :SANDSTONE-45% :COAL-BLK 5%
1740.10		PAARATTE	CRETACEOUS	
1740.20		PAARATTE	CRETACEOUS	
1765.00	1740-1765	PAARATTE	CRETACEOUS	SILTSTONE-GY 50% :SANDSTONE-45% :COAL-BLK 5%
1765.10		PAARATTE	CRETACEOUS	
1765.20		PAARATTE	CRETACEOUS	
1790.00	1765-1790	PAARATTE	CRETACEOUS	SILTSTONE-GY 20% :SANDSTONE-80% :COAL-BLK TR
1790.10		PAARATTE	CRETACEOUS	
1790.20		PAARATTE	CRETACEOUS	
1815.00	1790-1815	PAARATTE	CRETACEOUS	SILTSTONE-GY 25% :SANDSTONE-75% :COAL-BLK TR
1815.10		PAARATTE	CRETACEOUS	
1815.20		PAARATTE	CRETACEOUS	
1840.00	1815-1840	PAARATTE	CRETACEOUS	SILTSTONE-GY 5% :SANDSTONE-95% :COAL-BLK TR
1840.10		PAARATTE	CRETACEOUS	
1840.20		PAARATTE	CRETACEOUS	
1865.00	1840-1865	PAARATTE	CRETACEOUS	SILTSTONE-GY 20% :SANDSTONE-80%
1890.00	1865-1890	PAARATTE	CRETACEOUS	SILTSTONE-GY 60% :SANDSTONE-40%
1915.00	1890-1915	PAARATTE	CRETACEOUS	SILTSTONE-GY 50% :SANDSTONE-50%
1940.00	1915-1940	PAARATTE	CRETACEOUS	SILTSTONE-GY 30% :SANDSTONE-70%
1965.00	1940-1965	PAARATTE	CRETACEOUS	SILTSTONE-GY 40% :SANDSTONE-60%
1990.00	1965-1990	PAARATTE	CRETACEOUS	SILTSTONE-GY 40% :SANDSTONE-60%

TABLE 1c

L I T H O L O G Y A N D S T R A T I G R A P H Y

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE	FORMATION	AGE	LITHOLOGY
2015.00	1990-2015	PAARATTE	CRETACEOUS	SILTSTONE-GY 30% : SANDSTONE-70%
2040.00	2015-2040	PAARATTE	CRETACEOUS	SILTSTONE-GY 40% : SANDSTONE-60%
2065.00	2040-2065	PAARATTE	CRETACEOUS	SILTSTONE-GY 70% : SANDSTONE-30%
2100.00	2065-2100	PAARATTE	CRETACEOUS	SILTSTONE-GY 55% : SANDSTONE-45%
2125.00	2100-2125	PAARATTE	CRETACEOUS	SANDSTONE-70% : SILTSTONE-GY 30%
2150.00	2125-2150	PAARATTE	CRETACEOUS	SILTSTONE-GY 55% : SANDSTONE-45%
2175.00	2150-2175	PAARATTE	CRETACEOUS	SILTSTONE-GY 50% : SANDSTONE-50%
2200.00	2175-2200	PAARATTE	CRETACEOUS	SILTSTONE-GY 65% : SANDSTONE-35%
2245.00	2220-2245	PAARATTE	CRETACEOUS	SILTSTONE-GY 30% : SANDSTONE-70%
2270.00	2245-2270	PAARATTE	CRETACEOUS	SILTSTONE-GY 70% : SANDSTONE-30%
2295.00	2270-2295	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 30% : SANDSTONE-70%
2320.00	2295-2320	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 50% : SANDSTONE-50%
2345.00	2320-2345	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 70% : SANDSTONE-30%
2370.00	2345-2370	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 20% : SANDSTONE-80%
2395.00	2370-2395	PAARATTE	CRETACEOUS	SILTSTONE-GY MUDDY 80% : SANDSTONE-20%
2420.00	2395-2420	PAARAT. -BELFAST	CRETACEOUS	SILTSTONE-GY 90% : SANDSTONE-10%
2445.00	2420-2445	BELFAST	CRETACEOUS	SILTSTONE-GY 100%
2470.00	2445-2470	BELFAST	CRETACEOUS	SILTSTONE-GY 100%
2495.00	2470-2495	BELFAST	CRETACEOUS	SILTSTONE-GY 100%
2520.00	2495-2520	BELFAST	CRETACEOUS	SILTSTONE-GY 100%
2545.00	2520-2545	BELFAST	CRETACEOUS	SILTSTONE-GY 100%
2570.00	2545-2570	BELFAST	CRETACEOUS	SILTSTONE-DK GY MUDDY 100%
2595.00	2570-2595	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2620.00	2595-2620	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2645.00	2620-2645	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2670.00	2645-2670	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2695.00	2670-2695	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2725.00	2695-2725	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2750.00	2725-2750	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2775.00	2750-2775	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2800.00	2775-2800	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2825.00	2800-2825	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2850.00	2825-2850	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2874.00		BELFAST	CRETACEOUS	MUDSTONE-DK GY 100%
2875.00	2850-2875	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2900.00	2875-2900	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2925.00	2900-2925	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%

TABLE 1d

L I T H O L O G Y A N D S T R A T I G R A P H Y

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE	FORMATION	AGE	LITHOLOGY
2950.00	2925-2950	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
2975.00	2950-2975	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 95% :LIMESTONE-WH 5%
3000.00	2975-3000	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
3025.00	3000-3025	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
3050.00	3025-3050	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
3075.00	3050-3075	BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
3075.50		BELFAST	CRETACEOUS	SILTSTONE-GY MUDDY 100%
3100.00	3075-3100	BELFAST-WAARRE	CRETACEOUS	MUDSTONE-DK GY 100%
3125.00	3100-3125	WAARRE	CRETACEOUS	SILTSTONE-GY MUDDY 95% :SANDSTONE-5%
3150.00	3125-3150	WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 60% :SANDSTONE-40%
3157.00		WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 60% :SANDSTONE-40%
3175.00	3150-3175	WAARRE	CRETACEOUS	SILTSTONE-DK GY 100%
3200.00	3175-3200	WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 40% :SANDSTONE-60%
3225.00	3200-3225	WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 65% :SANDSTONE-35%
3225.10		WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 85% :SANDSTONE-10%
3225.20		WAARRE	CRETACEOUS	:COAL-BLK 5%
3250.00	3225-3250	WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 80% :SANDSTONE-20%
3250.10		WAARRE	CRETACEOUS	:COAL-BLK TR
3250.20		WAARRE	CRETACEOUS	
3266.00		WAARRE	CRETACEOUS	
3275.00	3250-3275	WAARRE	CRETACEOUS	MUDSTONE-GY 100%
3275.10		WAARRE	CRETACEOUS	SILTSTONE-GY MUDDY 80% :SANDSTONE-20%
3275.20		WAARRE	CRETACEOUS	:COAL-BLK TR
3288.00		WAARRE	CRETACEOUS	
3300.00	3275-3300	WAARRE	CRETACEOUS	SILTSTONE-DK GY 100%
3300.10		WAARRE	CRETACEOUS	MUDSTONE-GY SILTY 85% :SANDSTONE-10%
3300.20		WAARRE	CRETACEOUS	:COAL-BLK 5%

TABLE 2

OPTICAL SOURCE ROCK MATURITY INDICATORS

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	FORMATION/AGE	SPORE COLOUR	VITRINITE REFLECTANCE (%Ro)		COMMENTS
740.00	NIRR.-DILWYN		0.40(21)		ST BS,MOD PHY,V 70% + I 30% PAR- Y+Y/O FL
935.00	DILWYN		0.48(20)		ST BS,LOW-MOD PHY,I 30% +V 70% PAR- Y/O FL
1085.00	DILWYN	2/3	0.45(21)		ST BS,LOW PHY,V 100% +TR I PAR- Y/O FL
1160.00	DILWYN		0.45(22)		ST BS,LOW PHY,V 100% +TR I PAR- Y-LO FL
1265.00	PEMBER MDST		0.45(21)		ST BS,LOW PHY,V 100% +TR I PAR- Y/O FL
1340.00	CURDIES	2/3			
1365.00	CURDIES		0.43(20)		ST BS,LOW PHY,V 70% +I 30% PAR- Y/O FL
1470.00	CURDIES		0.45(22)		ST BS,V 60% +I 40% PAR- Y/O FL
1560.00	PAARATTE		0.47(22)		ST BS,LOW PHY,V 70% +I 30% PAR- LO FL
1665.00	PAARATTE		0.41(22)		ST BS,ABUND PHY,V 50% +I 50% PAR- Y+Y/O FL
1665.10	PAARATTE	2/3			
1790.00	PAARATTE		0.42(22)		ST BS,ABUND PHY,I 50% +V 50% PAR-Y/O FL
1865.00	PAARATTE		0.47(23)		MOD BS,MOD PHY,I 80% +V 20% PAR- Y/O FL
1965.00	PAARATTE		0.49(23)		MOD BS,MOD PHY,I 100%+ TR V PAR- Y-LO FL
2065.00	PAARATTE	3	0.48(24)		MOD BS,MOD PHY,I 100% +TR V PAR- Y/O+LO FL
2175.00	PAARATTE		0.50(23)		MOD BS,MOD PHY,I 100% +TR V PAR- Y-LO FL
2270.00	PAARATTE	3			
2295.00	PAARATTE		0.50(21)		MOD BS,MOD PHY,I 100% +TR V PAR- Y/O FL
2395.00	PAARATTE		0.52(20)		MOD BS,MOD PHY,I 100% PAR+TR V PAR- Y/O FL
2495.00	BELFAST		0.58(20)		LT BS,MOD PHY,I 100% +TR V PAR- Y FL
2595.00	BELFAST	3	0.53(20)		LT BS,MOD PHY,I 100% +TR V PAR- Y FL
2670.00	BELFAST		0.55(20)		LT BS,MOD PHY,I 100% +TR V PAR- LO FL
2775.00	BELFAST		0.57(22)		LT BS,MOD PHY,I 100% +TR V PAR- LO FL
2874.00	BELFAST		0.57(21)		MOD BS,RICH PHY,I 100% +TR V PAR- LO FL
2900.00	BELFAST	3	0.61(20)		MOD BS,MOD PHY,I 100%+ TR V PAR- Y/O+LO FL
3000.00	BELFAST		0.60(20)		LT BS,MOD PHY,I 100% +TR V PAR- Y/O+LO FL
3075.00	BELFAST		0.61(24)		LT BS,MOD PHY,100% I +TR V PAR- LO FL
3075.50	BELFAST		0.63(8)		MOD BS,RICH PHY,I 100% +TR V PAR- LO FL
3157.00	WAARRE		0.75(18)	0.40(2)	MOD BS,MOD PHY,I 100% +TR V PAR- L-MO FL
3175.00	WAARRE	3-3/4	0.63(21)		LT BS,MOD PHY,I 100% +TR V PAR- L-MO FL
3266.00	WAARRE		0.64(18)		MOD BS,LOW PHY,I 100% +TR V PAR- MO FL
3288.00	WAARRE		0.67(20)		MOD BS,LOW PHY,I 100% +TR V PAR- MO FL
3300.00	WAARRE		0.73(23)		ST BS,ABUND PHY,V 90% +I 10% PAR- MO FL
3300.10	WAARRE	3			

TABLE 4b

SOURCE ROCK QUALITY INDICATORS

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE (m)	FORMATION/AGE	PICKED LITHOLOGY	P1 (kg/t)	P1 (mg/gC)	P2 (kg/t)	GOGI	HI	TOC (%)	CARB (%)
1665.10		PAARATTE	COAL	0.9	1.9	63.0	0.54	132	47.8	0.0
1665.20		PAARATTE	MUDSTONE	0.0	0.0	3.2		91	3.5	5.2
1690.00	1665-1690	PAARATTE	MUDSTONE	0.2		2.9				
1715.00	1690-1715	PAARATTE								
1715.10		PAARATTE	COAL	1.5	2.3	49.8	0.89	77	64.6	0.0
1715.20		PAARATTE	MUDSTONE	0.0	0.0	2.9		100	2.9	7.8
1740.00	1715-1740	PAARATTE								
1740.10		PAARATTE	COAL	0.2		35.9				
1740.20		PAARATTE	SILTSTONE	0.0		3.0				
1765.00	1740-1765	PAARATTE								
1765.10		PAARATTE	COAL	1.1	2.1	53.4	0.51	103	51.8	0.0
1765.20		PAARATTE	SILTSTONE	0.1	2.5	3.7		93	4.0	7.8
1790.00	1765-1790	PAARATTE								
1790.10		PAARATTE	COAL	0.2		61.4				
1790.20		PAARATTE	SILTSTONE	0.1		4.4				
1815.00	1790-1815	PAARATTE								
1815.10		PAARATTE	COAL	1.5	3.0	59.8		119	50.4	0.0
1815.20		PAARATTE	SILTSTONE	0.1	3.6	3.4		121	2.8	8.8
1840.00	1815-1840	PAARATTE								
1840.10		PAARATTE	COAL	1.0		54.6				
1840.20		PAARATTE	SILTSTONE	0.2		3.7				
1865.00	1840-1865	PAARATTE								
1890.00	1865-1890	PAARATTE	SILTSTONE	0.1	3.8	2.2		85	2.6	5.4
1915.00	1890-1915	PAARATTE	SILTSTONE	0.1		2.0				
1940.00	1890-1915	PAARATTE	SILTSTONE	0.1	4.0	1.8		72	2.5	7.4
1940.00	1915-1940	PAARATTE	SILTSTONE	0.0		2.1				
1965.00	1940-1965	PAARATTE	SILTSTONE	0.2		2.7		90	3.0	6.0
1990.00	1965-1990	PAARATTE	SILTSTONE	0.1	6.7	2.1				
2015.00	1990-2015	PAARATTE	SILTSTONE	0.1		2.3		82	2.8	9.8
2040.00	2015-2040	PAARATTE	SILTSTONE	0.1	3.6	2.3				
2065.00	2040-2065	PAARATTE	SILTSTONE	0.1		3.0		97	3.1	7.2
2100.00	2065-2100	PAARATTE	SILTSTONE	0.2	6.5	2.9		97	3.0	8.5
2125.00	2100-2125	PAARATTE	SILTSTONE	0.2	6.7	2.1				
2150.00	2125-2150	PAARATTE	SILTSTONE	0.0	0.0	2.1		68	3.1	3.2
2175.00	2150-2175	PAARATTE	SILTSTONE	0.1		2.5				
2200.00	2175-2200	PAARATTE	SILTSTONE	0.1	3.6	2.4		86	2.8	8.7
2245.00	2220-2245	PAARATTE	SILTSTONE	0.1	5.6	1.7		94	1.8	9.9
2270.00	2245-2270	PAARATTE	SILTSTONE	0.2		1.8				
2295.00	2270-2295	PAARATTE	SILTSTONE	0.2	7.7	2.4		92	2.6	7.0

TABLE 4c

SOURCE ROCK QUALITY INDICATORS

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE (m)	FORMATION/AGE	PICKED LITHOLOGY	P1 (kg/t)	P1 (mg/gC)	P2 (kg/t)	GOGI	HI	TOC (%)	CARB (%)
2320.00	2295-2320	PAARATTE	SILTSTONE	0.2		3.2				
2345.00	2320-2345	PAARATTE	SILTSTONE	0.1	9.1	1.0		91	1.1	28.8
2370.00	2345-2370	PAARATTE	SILTSTONE	0.3		3.6				
2395.00	2370-2395	PAARATTE	SILTSTONE	0.1	5.0	1.6		80	2.0	5.6
2420.00	2395-2420	PAARAT - BELFAST	SILTSTONE	0.1	6.3	1.4		88	1.6	8.5
2445.00	2420-2445	BELFAST	BULKED	0.2		1.1				
2470.00	2445-2470	BELFAST	BULKED	0.2	20.0	0.9		90	1.0	11.9
2495.00	2470-2495	BELFAST	BULKED	0.3		0.9				
2520.00	2495-2520	BELFAST	BULKED	0.1	9.1	0.7		64	1.1	13.4
2545.00	2520-2545	BELFAST	BULKED	0.3		0.7				
2570.00	2545-2570	BELFAST	BULKED	0.1	11.1	0.7		78	0.90	16.7
2595.00	2570-2595	BELFAST	BULKED	0.2		0.9				
2620.00	2595-2620	BELFAST	BULKED	0.2	20.0	1.0		100	1.0	13.0
2645.00	2620-2645	BELFAST	BULKED	0.2		1.0				
2670.00	2645-2670	BELFAST	BULKED	0.2	20.0	1.2		120	1.0	10.0
2695.00	2670-2695	BELFAST	BULKED	0.1		1.0				
2725.00	2695-2725	BELFAST	BULKED	0.1	11.1	0.9		100	0.90	12.6
2750.00	2725-2750	BELFAST	BULKED	0.2		1.1				
2775.00	2750-2775	BELFAST	BULKED	0.2	22.2	1.2		133	0.90	15.2
2800.00	2775-2800	BELFAST	BULKED	0.2		1.4				
2825.00	2800-2825	BELFAST	BULKED	3.0	156.0	8.9	0.28	356	2.5	25.9
2850.00	2825-2850	BELFAST	BULKED	0.5		2.3				
2874.00		BELFAST	BULKED							
2875.00	2850-2875	BELFAST	BULKED	0.6	26.1	2.7		117	2.3	18.3
2900.00	2875-2900	BELFAST	BULKED	0.4		2.6				
2925.00	2900-2925	BELFAST	BULKED	0.2	9.1	1.9		86	2.2	12.1
2950.00	2925-2950	BELFAST	BULKED	0.3		2.1				
2975.00	2950-2975	BELFAST	SILTSTONE	0.3	15.0	1.9		95	2.0	9.2
3000.00	2975-3000	BELFAST	BULKED	0.4		2.1				
3025.00	3000-3025	BELFAST	BULKED	0.3	17.6	1.6		94	1.7	13.8
3050.00	3025-3050	BELFAST	BULKED	0.2		1.6				
3075.00	3050-3075	BELFAST	BULKED	0.3	20.0	1.3		87	1.5	11.1
3075.50		BELFAST	BULKED							
3100.00	3075-3100	BELFAST - WAARRE	SILTSTONE	0.3		1.5				
3125.00	3100-3125	WAARRE	MUDSTONE	0.4	30.8	2.0		154	1.3	12.8
3150.00	3125-3150	WAARRE	MUDSTONE	0.3		1.5				
3157.00		WAARRE	BULKED							
3175.00	3150-3175	WAARRE	MUDSTONE	0.5	35.7	1.7		121	1.4	13.2

TABLE 4d

SOURCE ROCK QUALITY INDICATORS

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	DEPTH RANGE (m)	FORMATION/AGE	PICKED LITHOLOGY	P1 (kg/t)	P1 (mg/gC)	P2 (kg/t)	GOGI	HI	TOC (%)	CARB (%)
3200.00	3175-3200	WAARRE	MUDSTONE	0.3		1.5				
3225.00	3200-3225	WAARRE								
3225.10		WAARRE	COAL	13.2	21.5	132.7	0.47	216	61.4	0.0
3225.20		WAARRE	MUDSTONE	0.5	17.2	3.5	0.43	121	2.9	7.7
3250.00	3225-3250	WAARRE								
3250.10		WAARRE	COAL	6.8	23.5	38.8		134	28.9	0.0
3250.20		WAARRE	MUDSTONE	0.4	20.0	2.0		100	2.0	11.2
3266.00		WAARRE	BULKED							
3275.00	3250-3275	WAARRE								
3275.10		WAARRE	COAL	1.0		10.7				
3275.20		WAARRE	SILTSTONE	0.1		1.3				
3288.00		WAARRE	BULKED							
3300.00	3275-3300	WAARRE								
3300.10		WAARRE	COAL	12.3	25.4	119.8	0.42	247	48.5	0.0
3300.20		WAARRE	MUDSTONE	0.2	15.4	1.2		92	1.3	10.0

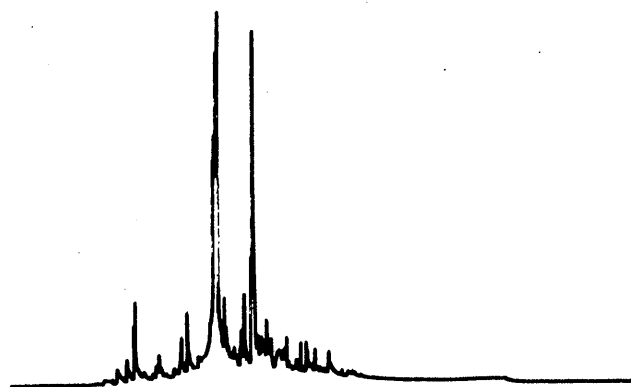
TABLE 5

PYROLYSIS - PGC DATA

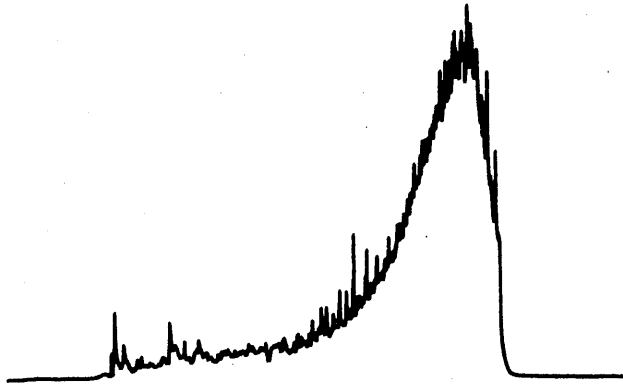
WELL: NORMANBY-1

LOCATION: AUSTRALIA

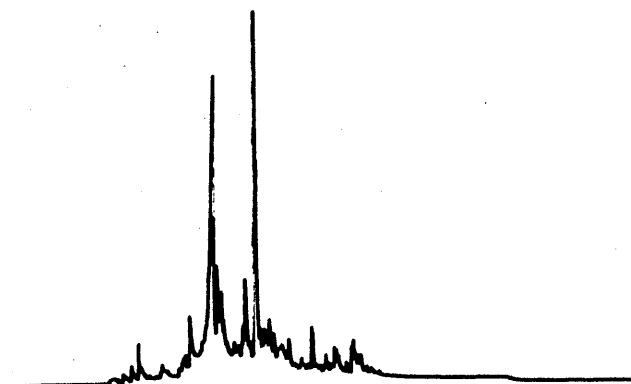
DEPTH (m)	FORMATION/AGE	C1-C5 (%)	C6-C9 (%)	C10-C13 (%)	C14-C22 (%)	C23-C36 (%)	GOGI	HI	TOC (%)
1060.00	DILWYN	32	22	28	15	3	0.48	224	4.2
1160.00	DILWYN	30	21	27	18	4	0.43	237	4.8
1210.10	DILWYN	31	16	21	23	9	0.45	69	46.8
1240.00	DILWYN-PEMBER	33	25	19	20	3	0.50		
1415.00	CURDIES	28	22	22	23	5	0.38	124	3.7
1665.10	PAARATTE	35	12	18	24	12	0.54	132	47.8
1715.10	PAARATTE	47	11	21	16	5	0.89	77	64.6
1765.10	PAARATTE	34	11	17	25	13	0.51	103	51.8
2825.00	BELFAST	22	23	16	25	14	0.28	356	2.5
3225.10	WAARRE	32	12	11	23	23	0.47	216	61.4
3225.20	WAARRE	30	19	15	24	13	0.43	121	2.9
3300.10	WAARRE	30	10	10	23	27	0.42	247	48.5



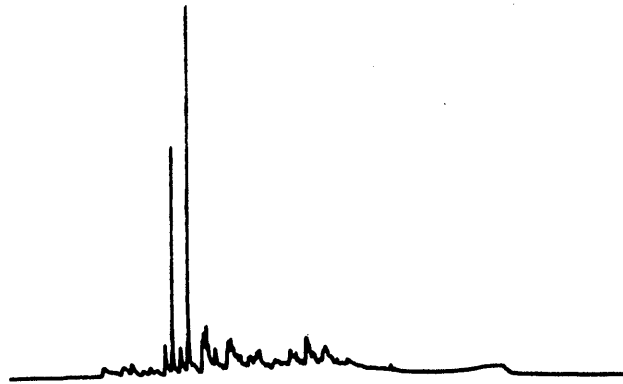
SAMPLE . 1080



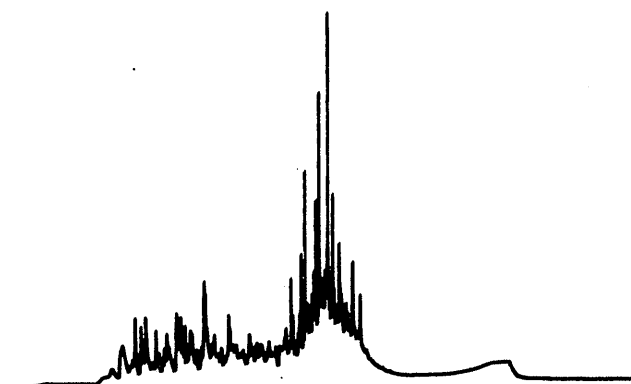
SAMPLE . 2825



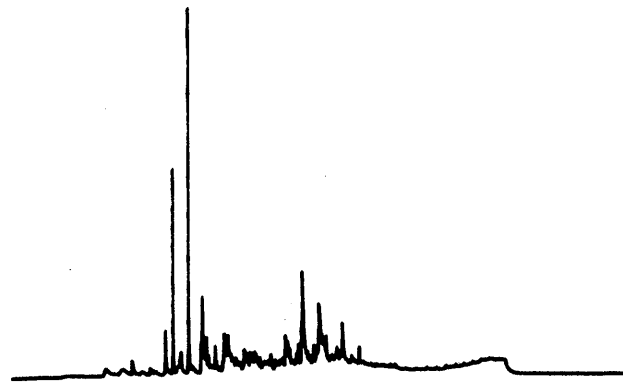
SAMPLE . 1180



SAMPLE . 3225.1



SAMPLE . 1240

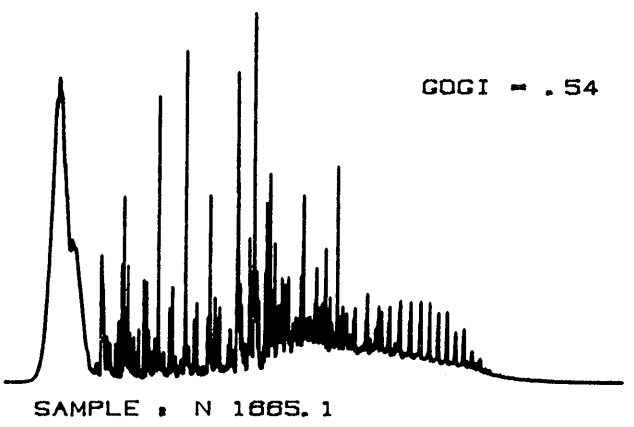
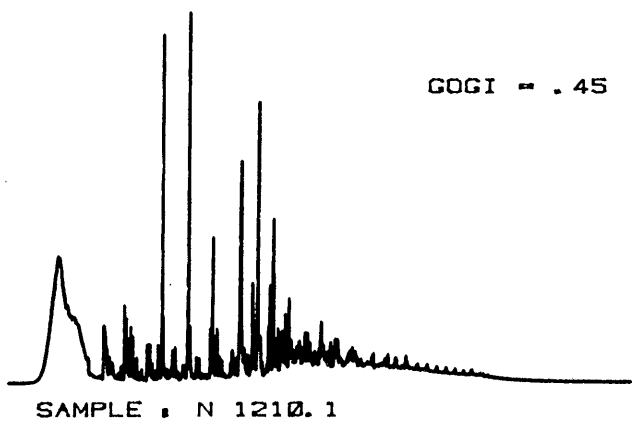
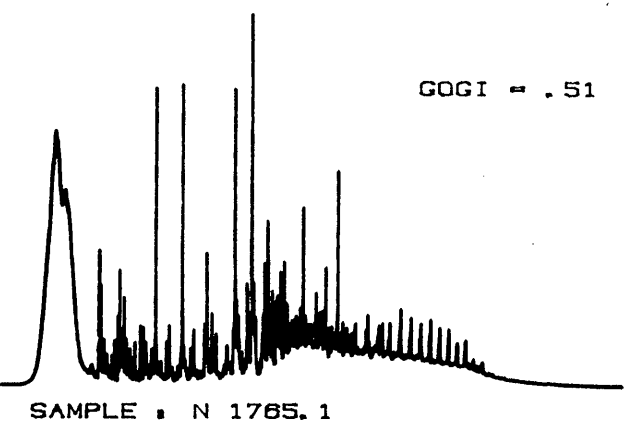
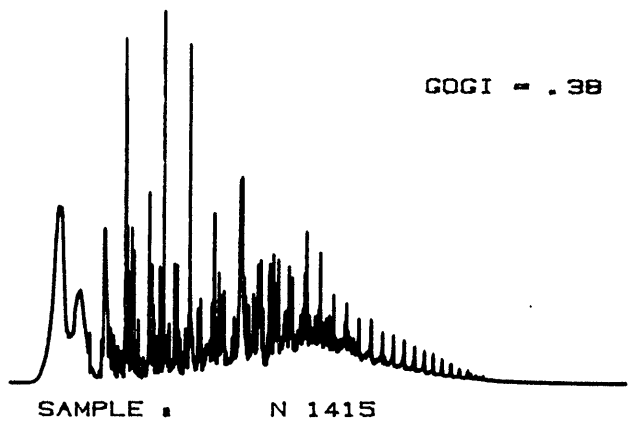
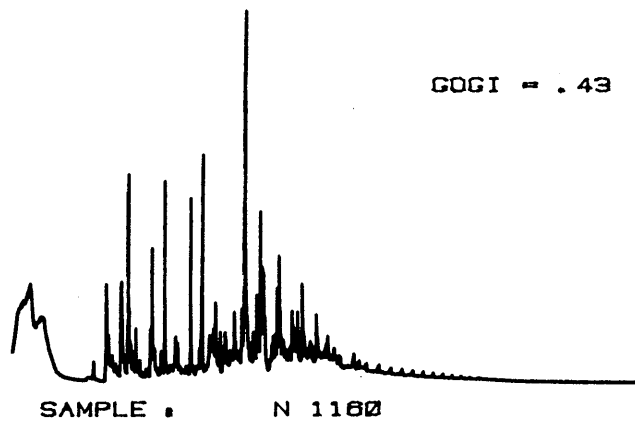
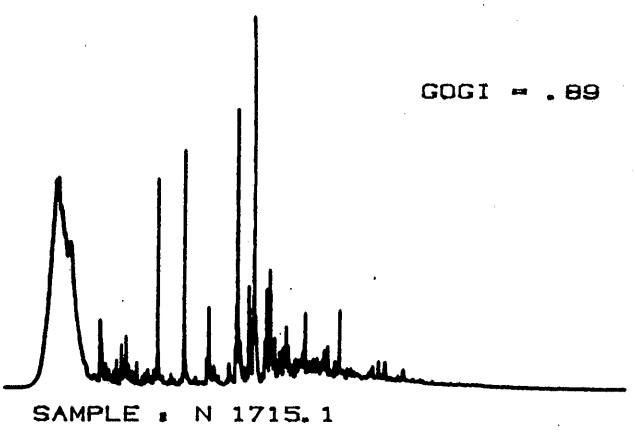
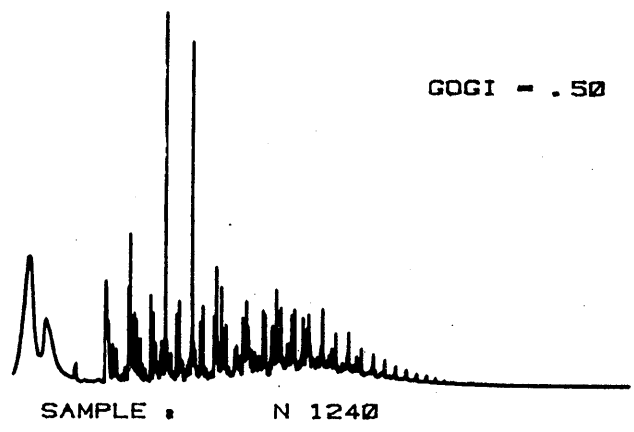
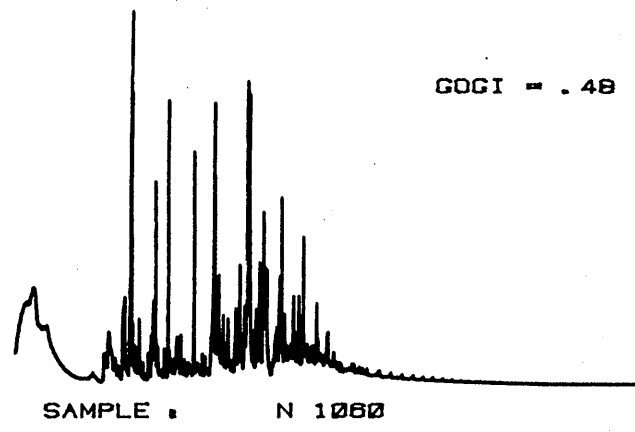


SAMPLE . 3300.1

GEOCHEMISTRY BRANCH, BP SUNBURY

THERMAL VOLATILATES (P1)

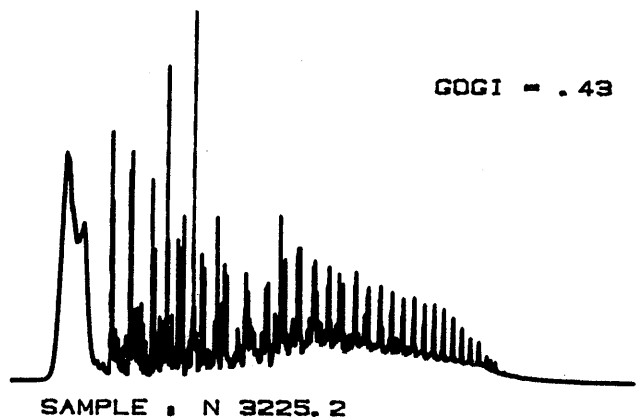
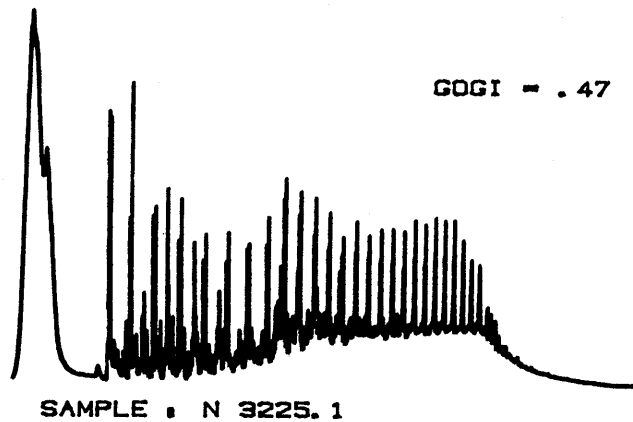
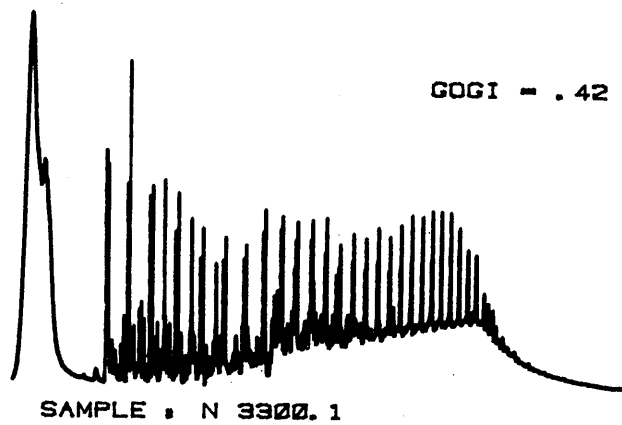
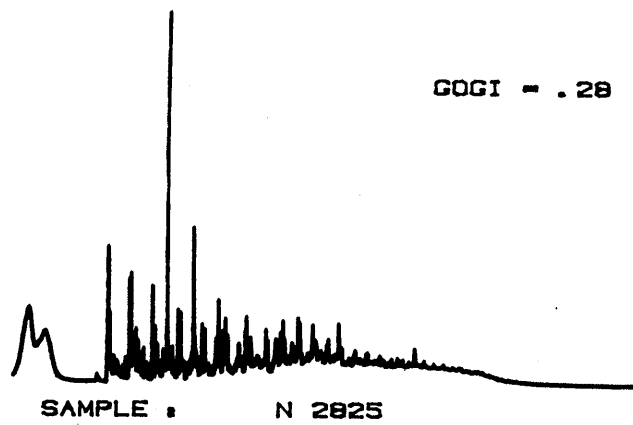
Fig. 3



GEOCHEMISTRY BRANCH, BP SUNBURY

KEROGEN PYROLYSATES (P2)

Fig. 4a



GEOCHEMISTRY BRANCH, BP SUNBURY

KEROGEN PYROLYSATES (P2)

Fig. 4b

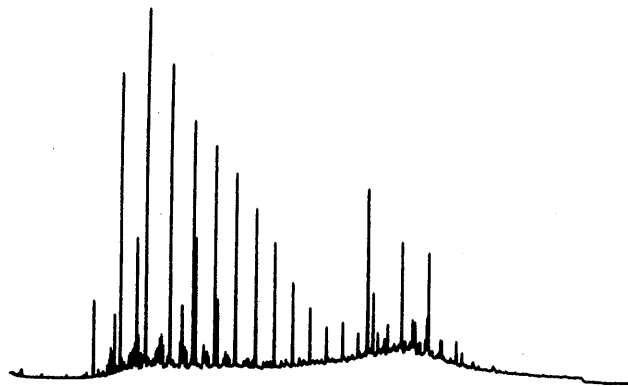
TABLE 6

S O L U B L E E X T R A C T D A T A

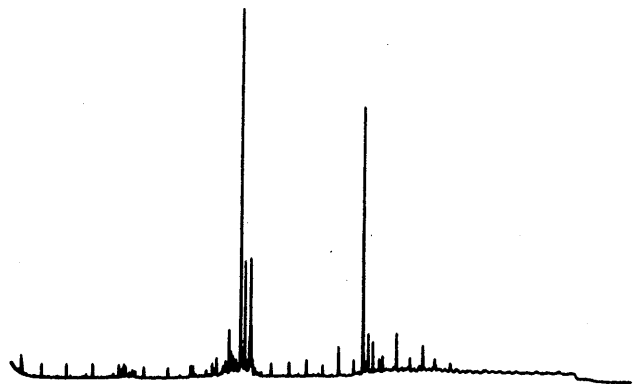
WELL: NORMANBY-1

LOCATION: AUSTRALIA

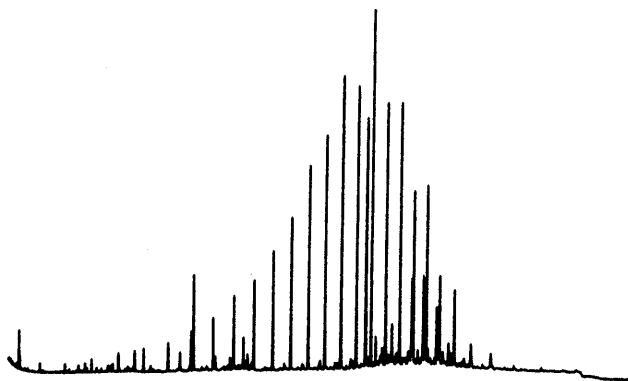
DEPTH (m)	FORMATION/AGE	TOC (%)	TSE (%)	TSE (mg/gC)	SAC (mg/gC)	SAC (%)	AROM (%)	RES (%)	ASPH (%)	CPI	PR/PH	PR/C17	PH/C18
1160.00	DILWYN	4.8	0.036	7	4	47.8	29.8	22.4		1.60	1.90	0.60	0.40
1715.10	PAARATTE	64.6	0.984	15	1	7.9	32.7	59.4		1.20	9.30	3.10	0.30
3225.10	WAARRE	61.4	0.705	11	4	37.9	15.3	46.8					



SAMPLE : 1180



SAMPLE : 1715.1



SAMPLE : 3225.1

GEOCHEMISTRY BRANCH, BP SUNBURY

SAC FRACTION GAS CHROMATOGRAMS

Fig. 5

TABLE 7

C A R B O N I S O T O P E R A T I O S

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	PICKED LITHOLOGY	SAMPLE	ISOTOPE RATIO (per mil)
1160.00	SILTSTONE	KEROGEN	-26.2
1715.10	COAL	KEROGEN	-23.8
3225.10	COAL	KEROGEN	-25.4

C-12/C-13 ISOTOPIC RATIOS ARE RELATIVE TO
PDB STANDARD:NBS-22 AT -29.8 per mil

TABLE 8a

MOLECULAR SOURCE ROCK INDICATORS

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	H1	H2	H3	H4	H5	H6	H7	H8	H9	S1	S2	S3	S4	S5
1160.00	0.48	0.23	0.85		100:186:52:35:18:19	0.41	0.52	0.63	0.62	0.35	0.60	37:18:45	24:26:50	23.70
1715.10		0.13	0.78			0.12				0.12		9:18:73		24.20
3225.10	0.50	0.60	0.85		100:94:45:21:8:3	0.10	0.52	0.52	0.48	0.51	0.47	18:21:61	7:23:70	16.30

TABLE 8b

M O L E C U L A R S O U R C E R O C K I N D I C A T O R S

WELL: NORMANBY-1

LOCATION: AUSTRALIA

DEPTH (m)	A1	A2	A3	A4	A5	A6	M1	M2	M3	M4	M5
1160.00 1715.10 3225.10								0.46	0.37	65.70 69.60 83.60	

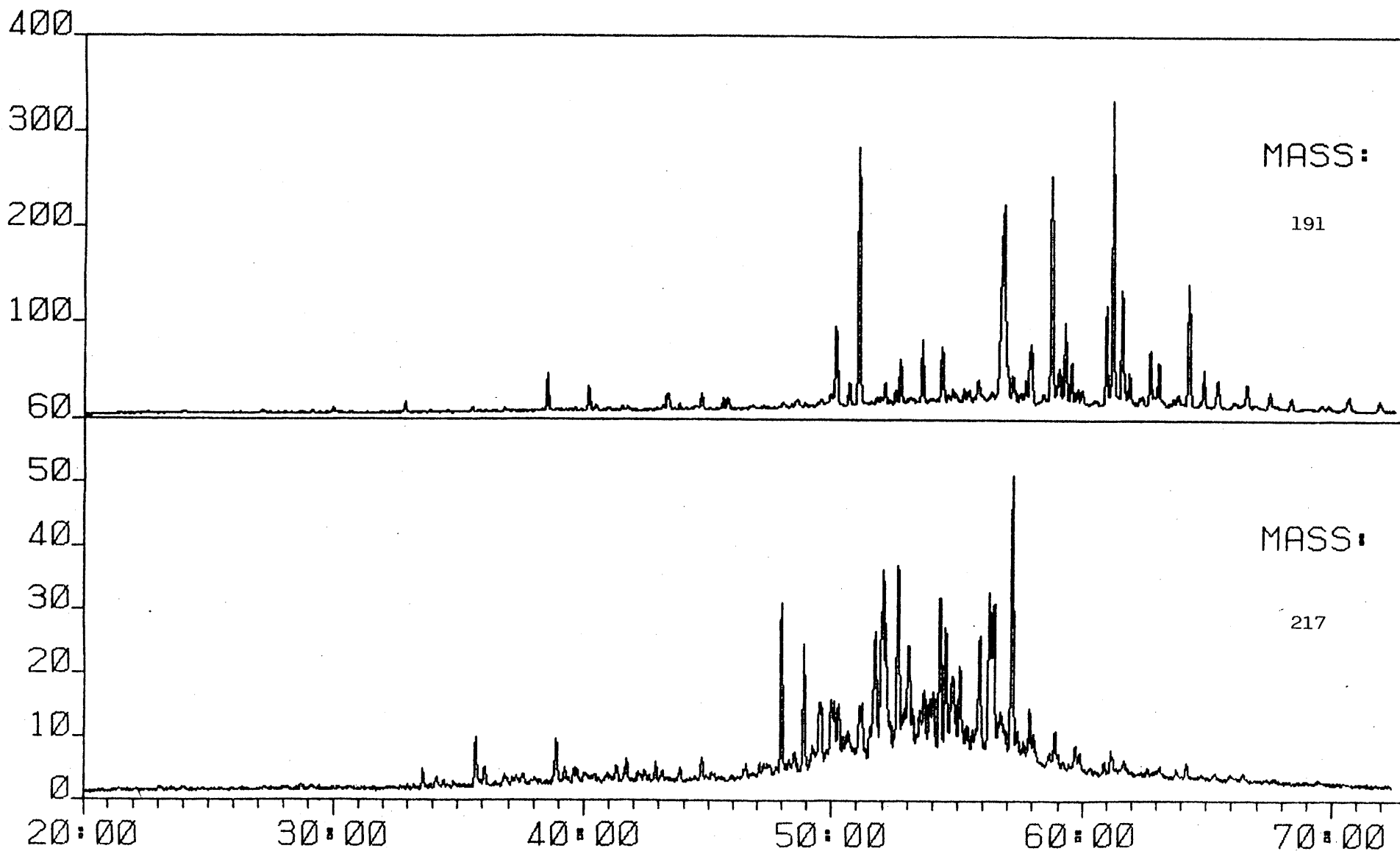
ANALYSIS NAME: DM00.[300,301]V427.MIS:2

V04.0 WINDOW:

TITLE: SATS EX NORMANBY-1 1160M

OPERATOR:

DATE: 23-SEP-86



ANALYSIS NAME: DM00.[300,301]V428.MIS,1

V04.0 WINDOW:

TITLE: SATS EX NORMANBY-1 1715M

OPERATOR:

DATE: 23-SEP-86

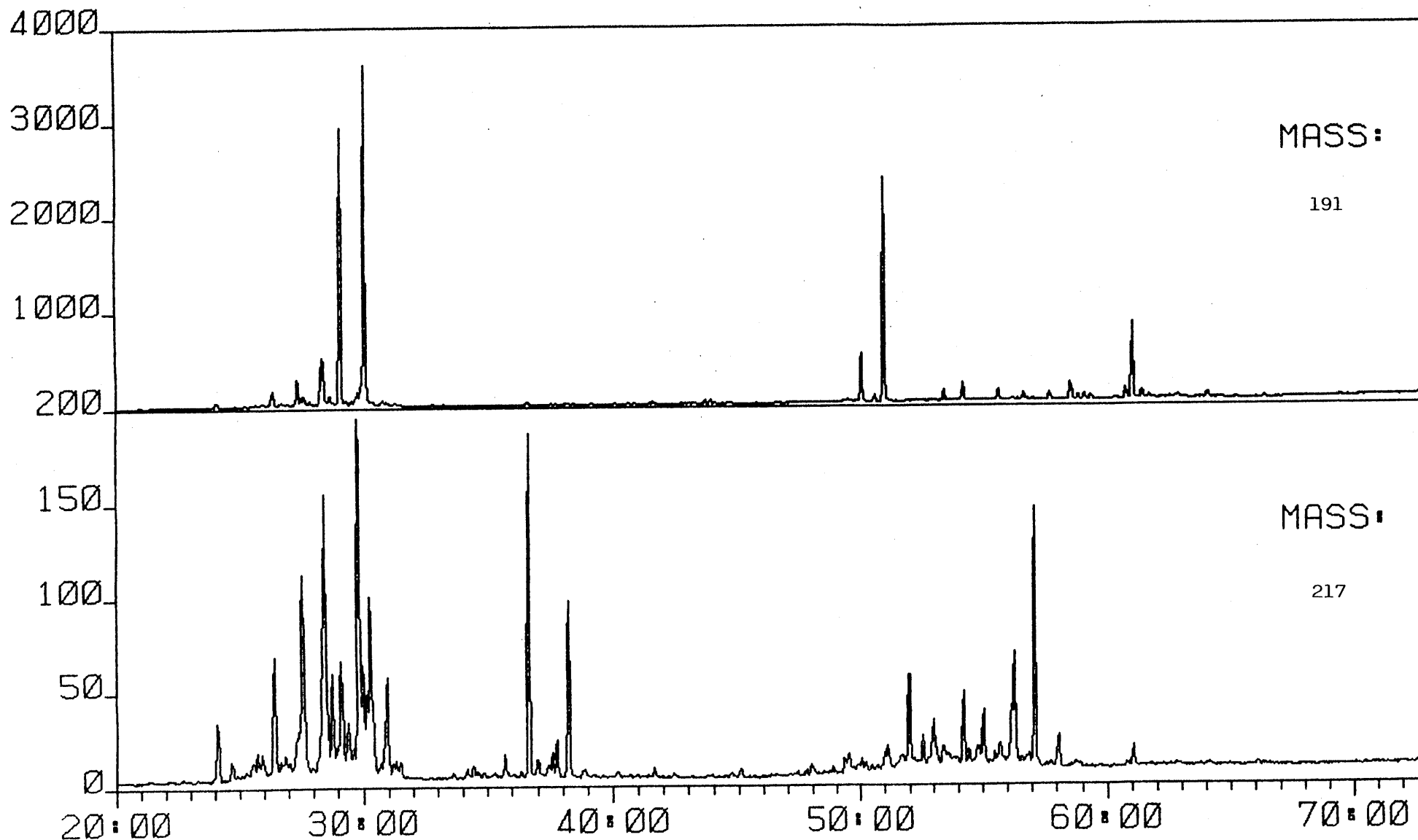


Fig. 7

ANALYSIS NAME: DM00.[300,301]V429.MIS:2

V04.0 WINDOW:

TITLE: SATS EX NORMANBY-1 3225M

OPERATOR:

DATE: 23-SEP-86

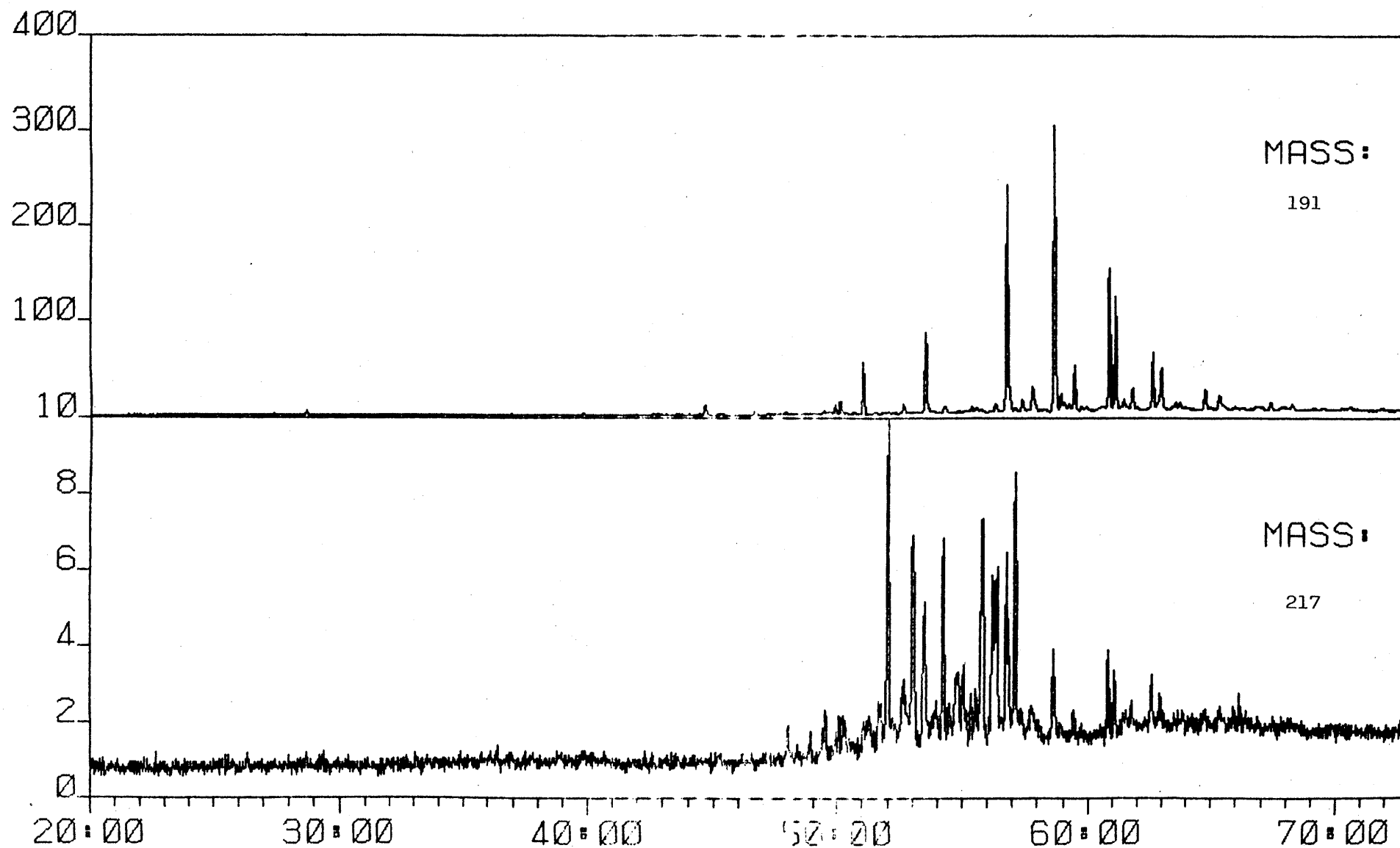


Fig. 8

ANALYSIS NAME: DM00.[300.301]V430.MIS:1

V04.0 WINDOW:

TITLE: AROMS EX NORMANBY-1 3225M

OPERATOR:

DATE: 23-SEP-86

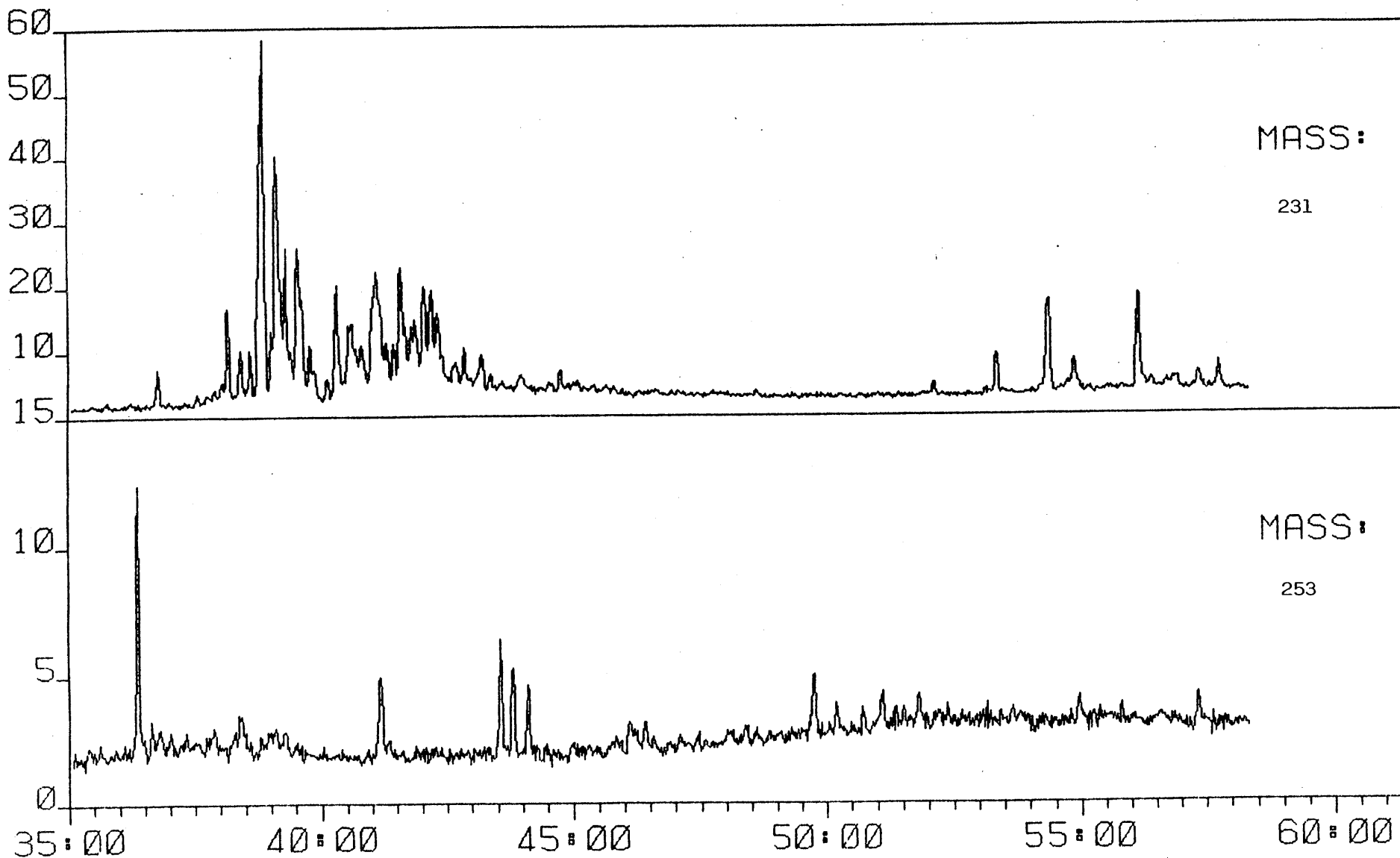


Fig. 9

ANALYSIS NAME: DM00:[300,301]V430.MIS:1

V04.0 WINDOW:

TITLE: AROMS EX NORMANBY-1 3225M

OPERATOR:

DATE: 23-SEP-86

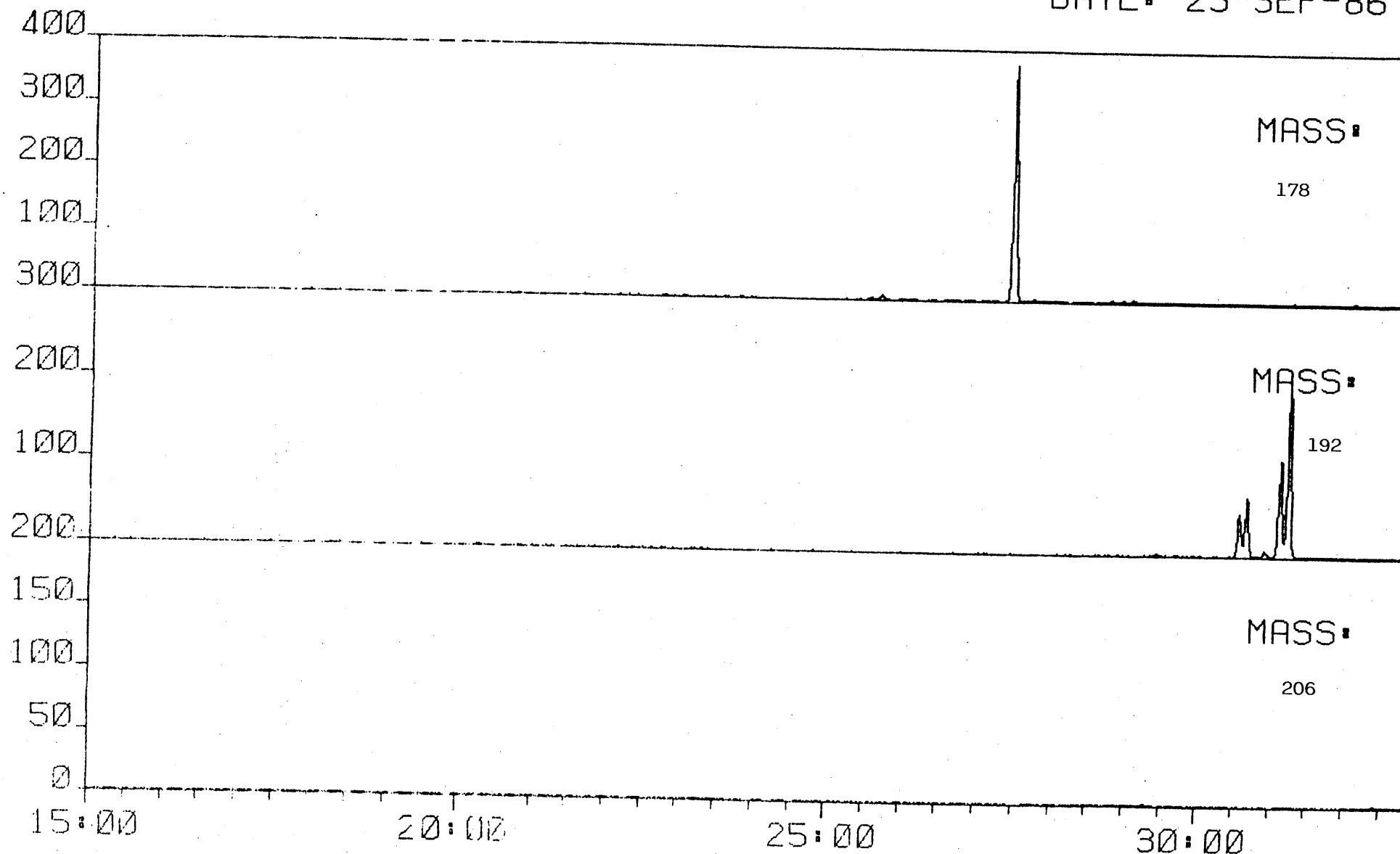


Fig. 10

TABLE 9a

G E O C H E M I C A L D A T A

WELL: NORMANBY-1
 LOCATION: AUSTRALIA

DEPTH (m)	QCNALK	QCNC20	QCC29ST	QCC30HO	QCC32HO	QCMONAR	QCTRIAR	QCMEPH
1160.00	501	31	2	2	1	0	4	104
3225.10	356	11	1	10	6			

* Units of measurement are microg/g Carbon ie ppm

TABLE 9b

G E O C H E M I C A L D A T A

WELL: NORMANBY-1
 LOCATION: AUSTRALIA

DEPTH (m)	QSNALK	QSN20	QSC29ST	QSC30HO	QSC32HO	QAMONAR	QATRIAR	QAMEPH
1160.00	141335	8665	431	426	282			
1715.10			331	184	124			
3225.10	81999	2452	319	2311	1311	87	2182	59722

* Units of measurement are ppm