MINORA
RESOURCES NL

PEP 111
OTWAY BASIN
VICTORIA

WINDERMERE-2

WELL COMPLETION REPORT
VOLUME II

(W992)

Minora Resources NL

APPENDIX F

APPENDIX F

CORE ANALYSIS

MINORA RESOURCES N.L.

CORE ANALYSIS REPORT For

WINDERMERE No. 2

Unit 17/19 Musgrave Avenue, Welland, S.A. 5007 Telephone (08) 46 4759 Telex AA87137

GEARHART CORE DATA

. GEARHART CORE DATA PTY. LTD.
UNIT 2, 17-19 MUSGRAVE AVENUE
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CORE ANALYSIS RESULTS

ᑐompany MINORA RESOURCES N.L. | Formation HEATHFIELD | File CD-SA-310
Vell WINDERMERE No. 2 | Date Report 03.04.1989
ield APPRAISAL | Analysts DS, PA
tate VICTORIA | Location OTWAY BASIN

Lithological Abbreviations

AND — SD	DOLOMITE — DOL	ANNHYDRAITE — ANHY	SANDY — SDY	FINE — FN	CRYSTALLINE — XLN	BROWN — BRN	FRACTURED — FRAC	SLIGHTLY — SLI
ALE — SH	CHERT — CH	CONGLOMERATE — CONG	SHALY — SHY	MEDIUM — MED	GRAIN — GRN	GRAY — GY	LAMINATION — LAM	VERY — VI
ME — LM	GYPSUM — GYP	FOSSILIFEROUS — FOSS	LIMY — LMY	COARSE — CSE	GRANULAR — GRNL	VUGGY — VGY	STYLOLITIC — STY	WITH — WI

MPLE O.	DEPTH Metres	PERMEABILITY MILLIDARCYS K.A.	POROSITY % He inj	RESIDUAL SATURATION % PORE OIL	WATER	GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
1	1743.83	0.087	13.4			2.63		SST: grnish gy, f-med grn, mod hd, mod srt, 10% wht cly, mod hd sil cmt, sbang-mnr sbrnd, abnt lt-dk gy lith grns, occ altered felds, tr biotite & chlorite, pr visual por.
2	1744.43	0.112	13.6			2.65		SST: grnish gy, f-occ med grn, mod hd, mod srt, 10% wht cly mtx, mod hd sil cmt, sbang-mnr sbrnd, 20-30% lt gy-occ blk frm lith grns, pred trans quartz, occ pink & green grns, pr visual porosity.
3	1745.03	0.058	13.7			2.65		SST: greenish gy, f-med grn, mod hd, mod-pr srt, v arg mtx, mod hd sil cmt, sbang-sbrnd, a/a.
4	1745.64	0.097	13.7			2.63		SST: a/a.
5	1746.24	0.213	15.3			2.67		SST: greenish gy, f-med grn, mod hd, mod srt, abnt wht arg mtx, a/a.
6	1777.02	0.059	11.5			2.63		SST: a/a, occ f carb grns.
7	1777.60	0.007	3.2			2.65		SST: greenish gy, med-f grn, mod hd-hd, mod srt, comm arg mtx, hd sil cmt, sbang-sbrnd, a/a, v pr visual porosity.
8	1778.21	0.157	16.2			2.63		SST: greenish gy, med-f grn, mod hd, mod srt, abnt wht arg mtx, mod hd sil cmt, sbang-sbrnd, abnt lt-dk gy lith grns, occ lt green lith grns, pr visual porosity.
9	1778.79	0.141	15.2			2.64		SST: a/a.
10	1779.43	0.064	13.6			2.60		SST: a/a, occ biotite flakes.
11	1780.00	0.071	14.9			2.61		SST: greenish gy, f-occ med gy, mod hd, mod srt, abnt wht arg mtx, mod hd sil cmt, sbang-sbrnd, a/a.
12	1780.66	0.076	13.7			2.60		SST: a/a, comm biotite flakes.

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SAND — SD	DOLOMITE — DOL	ANNHYDRAITE — ANHY	SANDY — SDY	FINE — FN	CRYSTALLINE — XLN	BROWN — BRN	FRACTURED — FRAC	SLIGHTLY — SLI
SHALE — SH	CHERT — CH	CONGLOMERATE — CONG	SHALY — SHY	MEDIUM — MED	GRAIN — GRN	GRAY — GY	LAMINATION — LAM	VERY — VI
LIME — LM	GYPSUM — GYP	FOSSILIFEROUS — FOSS	LIMY — LMY	COARSE — CSE	GRANULAR — GRNL	VUGGY — VGY	STYLOLITIC — STY	WITH — WI

SAMPLE No.	DEPTH Metres	PERMEABILITY MILLIDARCYS K.A.	POROSITY % He inj	RESIDUAL SATURATION % PORE		GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
				OIL	WATER			
13	1781.20	0.117	14.9			2.61		SST: greenish gy, f-rr med grn, mod hd, v arg mtx, mod sil cmt, sbang-occ ang, abnt lt-dk gy lithic grns, occ tan & wht altered felds, pr visual porosity.
14	1781.88	0.122	11.9			2.62		SST: greenish gy, f-rr crse grn, hd, pr srt, v arg mtx, mod sil cmt, sbrnd-occ cong-ang.
34	1782.06	3.1	7.9	0.0	72.3	2.63		SST: greenish gy & wht-clr, f-v crse cong lenses, hd, pr srt, argill & calc in cong, mod sil cmt, sbrnd-ang, comm sft greenish gy clyst incl, lithics, comm felds, rr mica.
15	1782.45	0.067	14.6			2.64		SST: greenish gy & wht-clr, f grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, a/a, w- occ v crse to pebbly clyst clasts.
35	1783.07	0.374	17.5	0.0	70.8	2.69		SST: greenish gy, f-med grn, occ crse lensed, mod srt, argill mtx, mod silc mtd, sbang-sbrnd, occ clyst incl, abnt gy lith, rr carb mica, comm weathered felds.
16	1783.18	0.260	15.4			2.65		SST: greenish gy, med-f grn, mod hd, mod-pr srt, mod arg mtx, mod sil cmt, sbang-sbrnd, abnt gy lithic grns, occ carb grns, pr visual porosity.
17	1783.70	0.657	14.5	0.0	66.2	2.64		SST: greenish gy, med, occ crse grn, mod hd, pr srt, v arg mtx, mod sil cmt, sbang-sbrnd, a/a w/ cong text w/ comm v crse qtz grns & pebbly clyst clasts.
18	1784.29	0.579	15.3	0.0	62.0	2.65		SST: greenish gy, med-f grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, a/a.
36	1784.67	2.0	17.0	0.4	78.2	2.68		SST: greenish gy, dom med, occ crse grn mod hd, mod-well srt, v arg mtx, tr sil cmt, sbang-sbrnd, abnt lt-dk gy liths, occ carb, felds, mica

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SHALE — SH	CHERT — CH	CONGLOMERATE — CONG	SHALY — SHY	MEDIUM — MED	GRAIN — GRN	GRAY — GY	LAMINATION — LAM	VERY — VI
LIME — LM	GYPSUM — GYP	FOSSILIFEROUS — FOSS	LIMY — LMY	COARSE — CSE	GRANULAR — GRNL	VUGGY — VGY	STYLOLITIC — STY	WITH — WI

SAMPLE No.	DEPTH Metres	PERMEABILITY MILLIDARCYS K.A.	POROSITY % He inj	RESIDUAL SATURATION % PORE OIL	RESIDUAL SATURATION % PORE WATER	GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
19	1785.00	0.081	13.5			2.61		SST: greenish gy, f-occ med grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, abnt lt-dk gy lith grns, occ carb grns, occ biotite flakes.
20	1785.60	0.179	12.5			2.60		SST: a/a.
21	1786.24	0.432	16.4	0.0	65.5	2.63		SST: a/a.
22	1786.83	0.088	15.0			2.64		SST: a/a.
23	1787.40	0.288	13.9			2.63		SST: a/a, f-med grn, w/ occ thin carb laminae and grns.
37	1787.47	0.510	15.5	0.0	70.3	2.66		SST: greenish gy, f-dom med grn, mod hd, mod-pr srt, v arg mtx, mod sil cmt, sbang-sbrnd, abnt lt-dk gy lithic grns, occ altered felds, occ carb grns, rr vf sst lenses.
24	1788.06	0.595	14.7	0.0	63.5	2.64		SST: greenish gy, f-med grn, mod hd, mod-pr srt, v arg mtx, mod sil cmt, sbang-mnr sbrnd, abnt lt-dk gy lithic grns, occ altered felds, occ carb grns, pr visual porosity.
25	1788.70	0.108	14.0			2.62		SST: a/a.
38	1789.05	0.278	16.2	0.0	69.2	2.67		SST: a/a.
26	1789.30	0.137	14.8			2.62		SST: greenish gy, f-med grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-mnr sbrnd, abnt lt-dk gy arg lith grns, comm carb grns, v pr visual porosity.
27	1789.91	0.122	15.2			2.64		SST: a/a, f grn, sbang-sbrnd.
39	1790.26	4.3	16.9	0.2	68.1	2.66		SST: greenish gy, med-dom crse, occ v crse grn, frm-mod hd, mod srt, v arg mtx, lightly sil cmtd, sbang-sbrnd, a/a.

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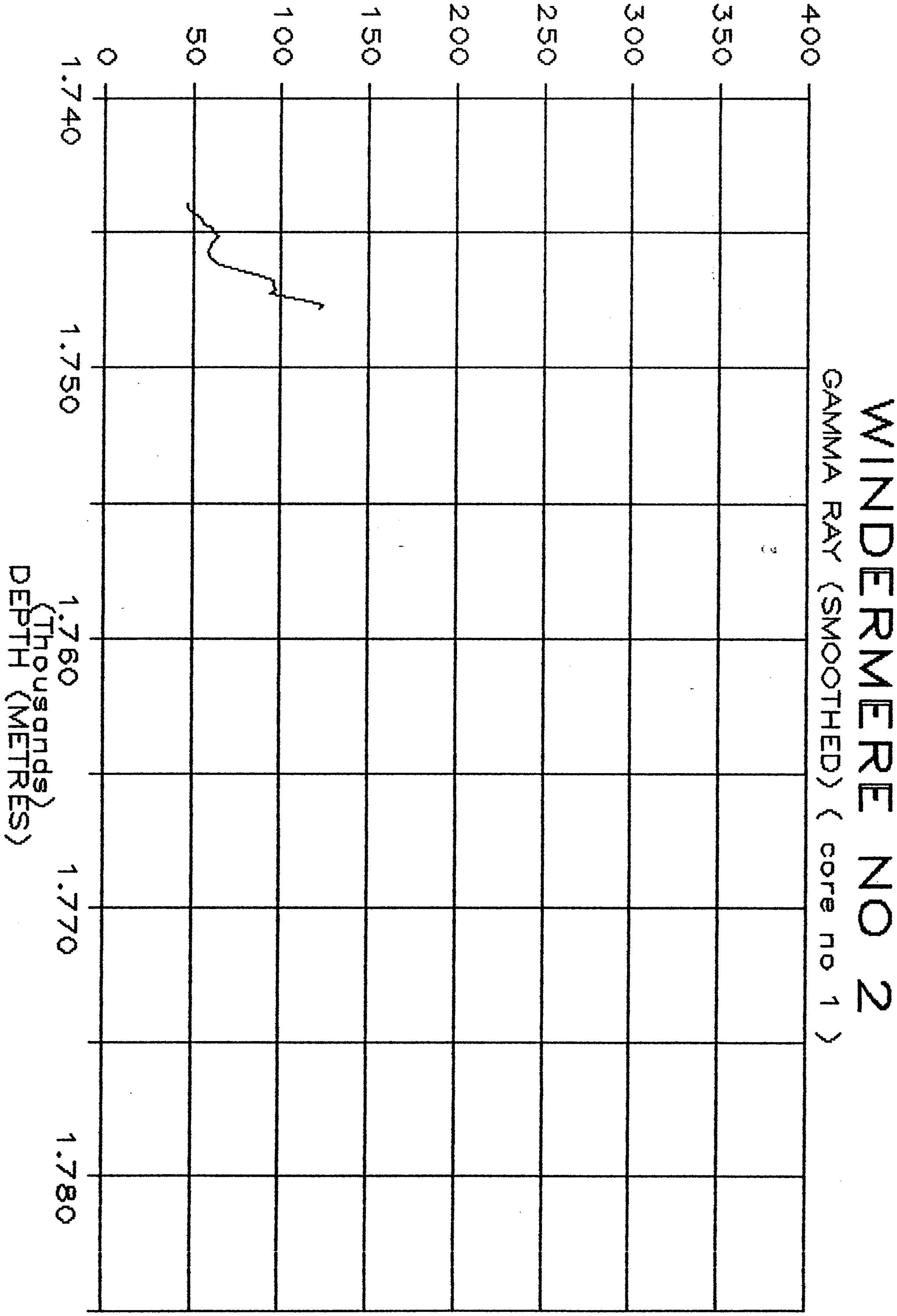
MPLE No.	DEPTH Metres	PERMEABILITY MILLIDARCYS K.A.	POROSITY % He inj	RESIDUAL SATURATION % PORE OIL	RESIDUAL SATURATION % PORE WATER	GRAIN DENSITY	VERT PERM	SAMPLE DESCRIPTIONS AND REMARKS
28	1790.51	2.5	17.1	0.0	58.8	2.66		SST: greenish gy, med-occ v crse grn, mod hd, pr-mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, abnt lt-dk gy arg lith grns, comm carb grns, conglomeratic i/p.
29	1791.11	0.057	14.0			2.61		SST: greenish gy, med-f grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, abnt lt-dk gy lith grns, pr visual porosity.
30	1791.72	0.047	15.2			2.62		SST: a/a.
31	1792.34	0.025	13.8			2.61		SST: greenish gy, f-occ med grn, mod hd, mod srt, v arg mtx, mod sil cmt, sbang-sbrnd, a/a, w/ occ vf carb /micac/laminae.
32	1792.94	0.045	13.7			2.62		SST: a/a, f-rr med grn.
33	1793.34	0.004	6.5			2.58		SST: greenish gy, f-v crse grn, mod hd, pr srt, v arg mtx, mod sil cmt, sbang-sbrnd, cong texture w/ pebbly clyst clasts.

EQUIVALENT API GR UNITS



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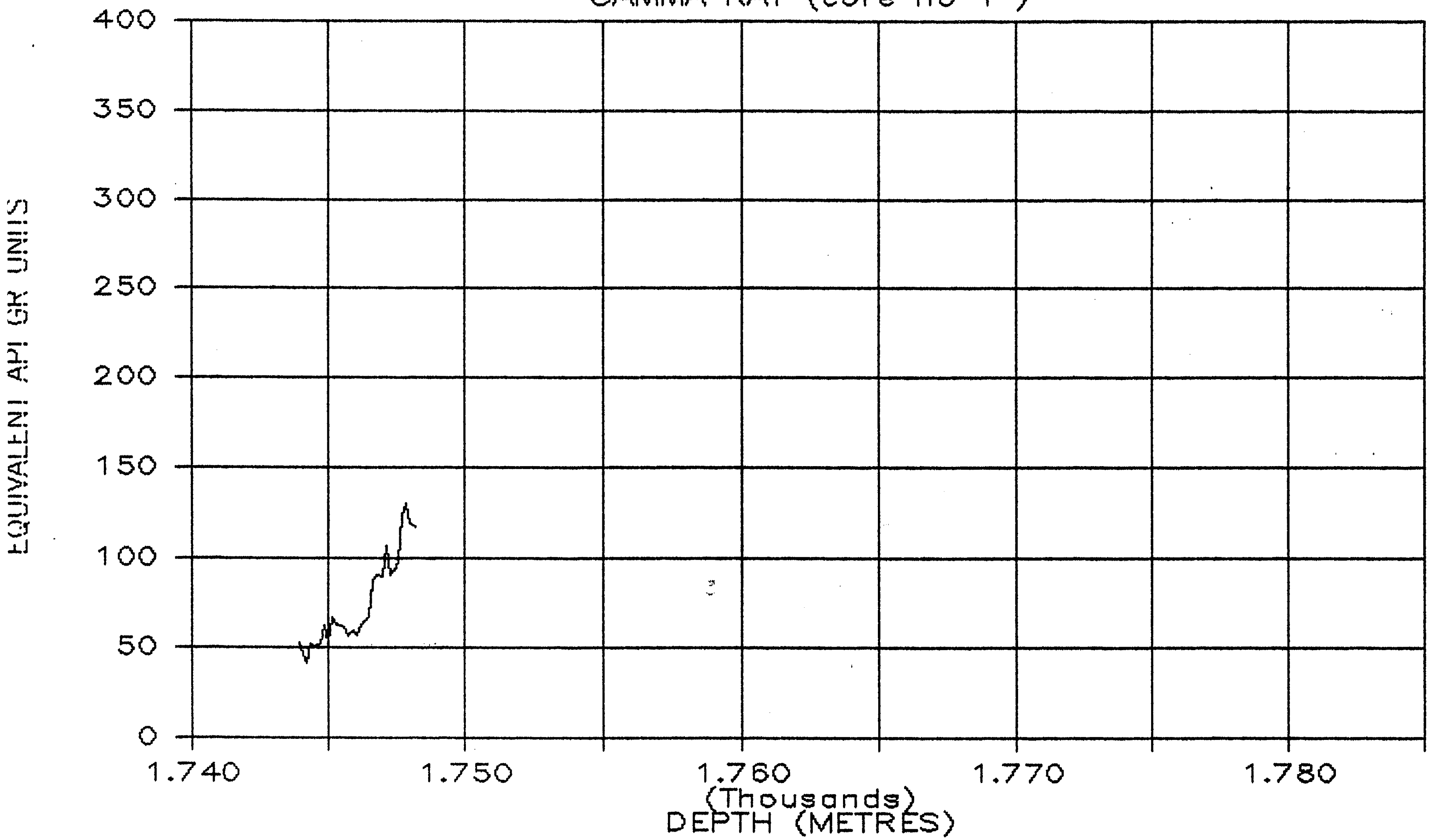
WINDERMERE NO 2

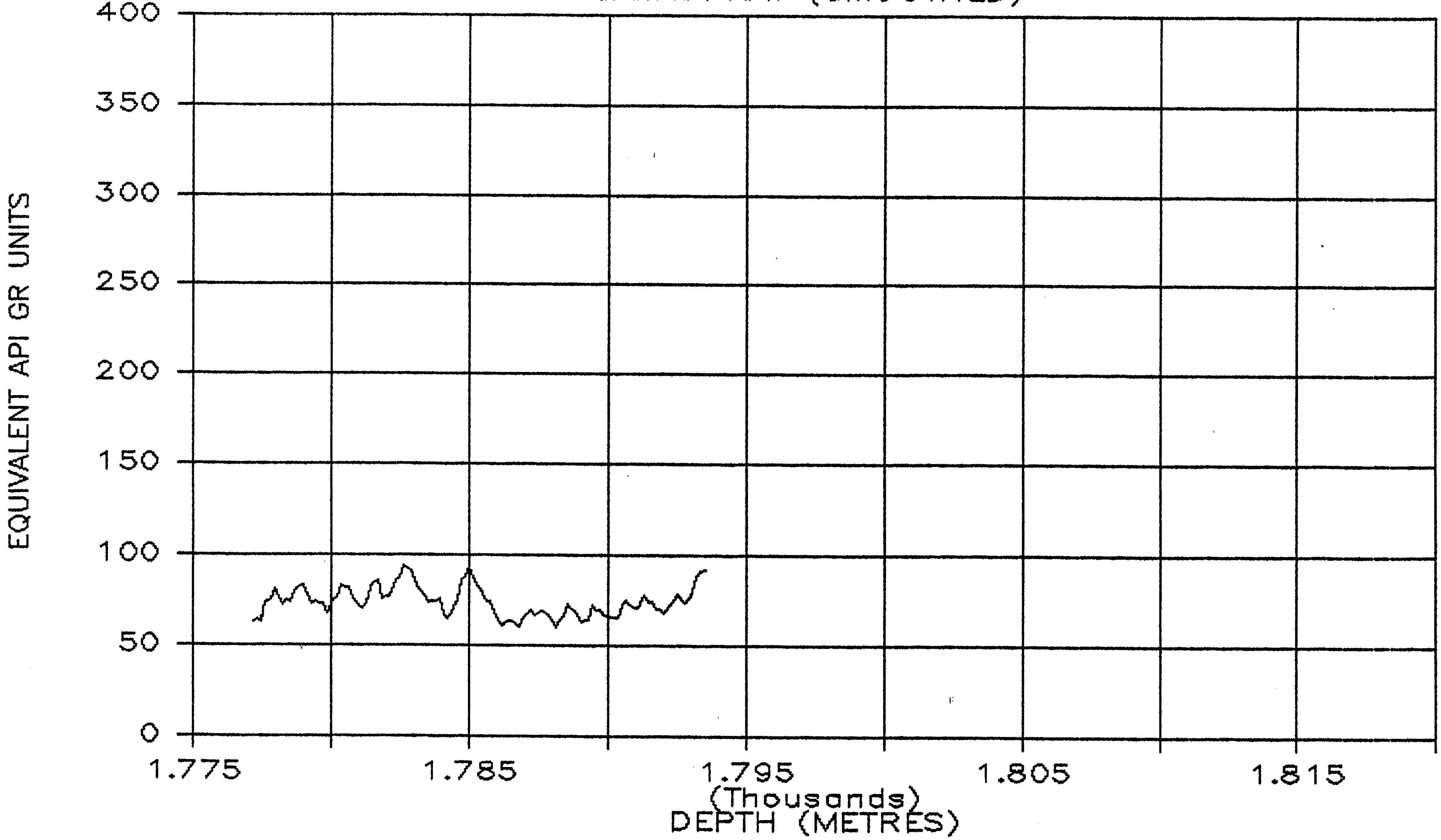
GAMMA RAY (core no 1)



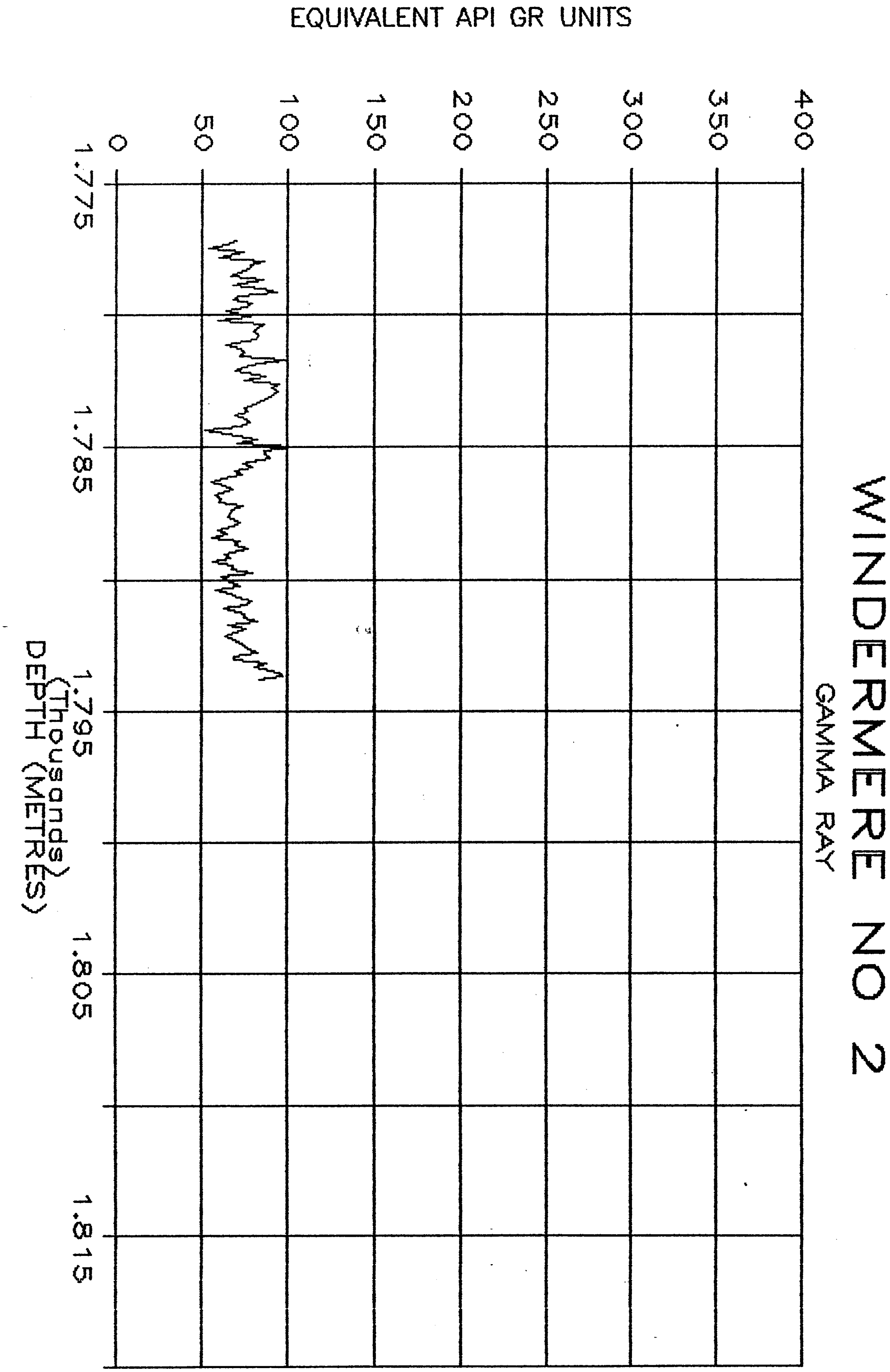
GEARHART AUSTRALIA

WINDERMERE NO 2

GAMMA RAY (SMOOTHED)



GEARHART AUSTRALIA



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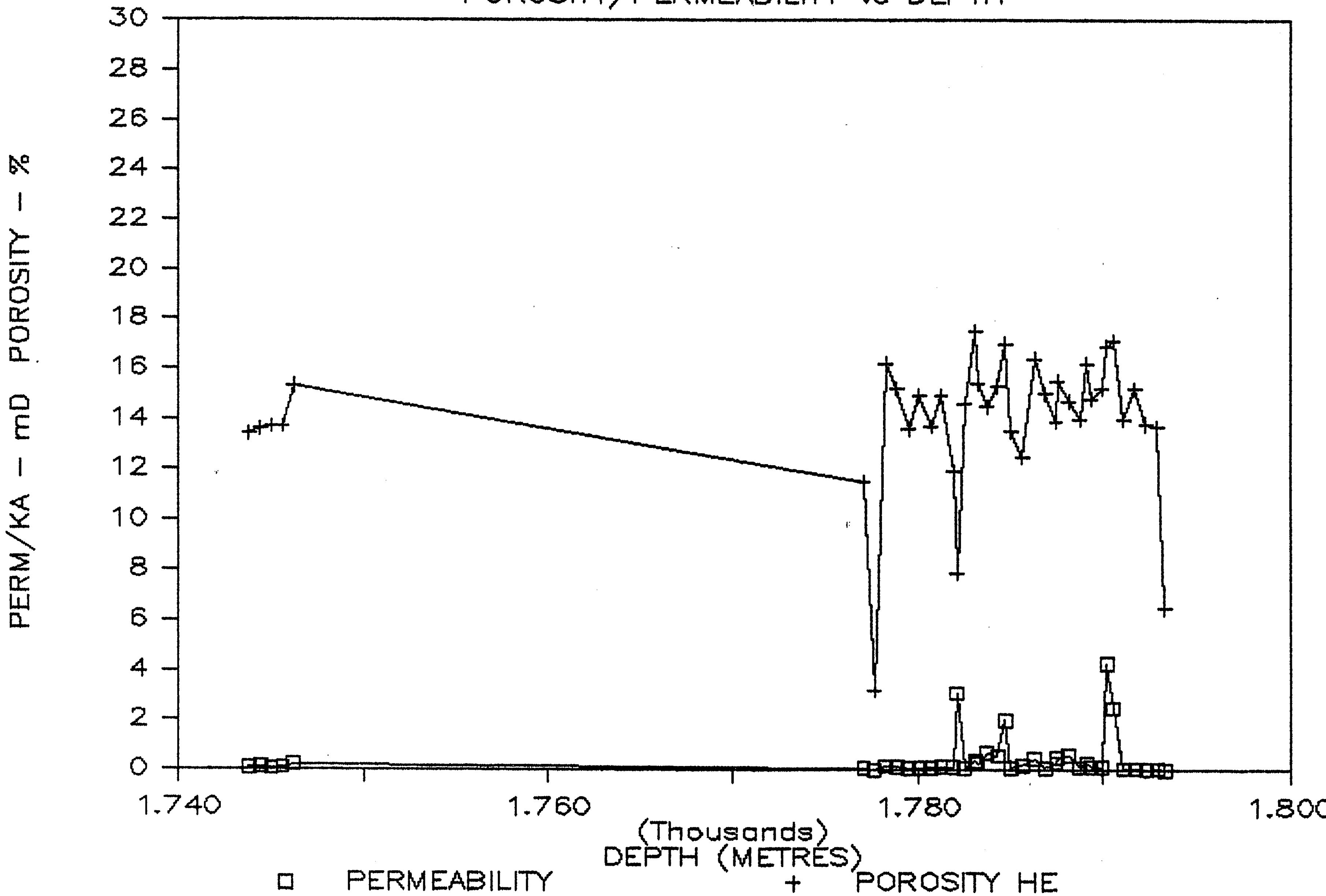
WINNDERMERE NO 2

POROSITY/PERMEABILITY vs DEPTH



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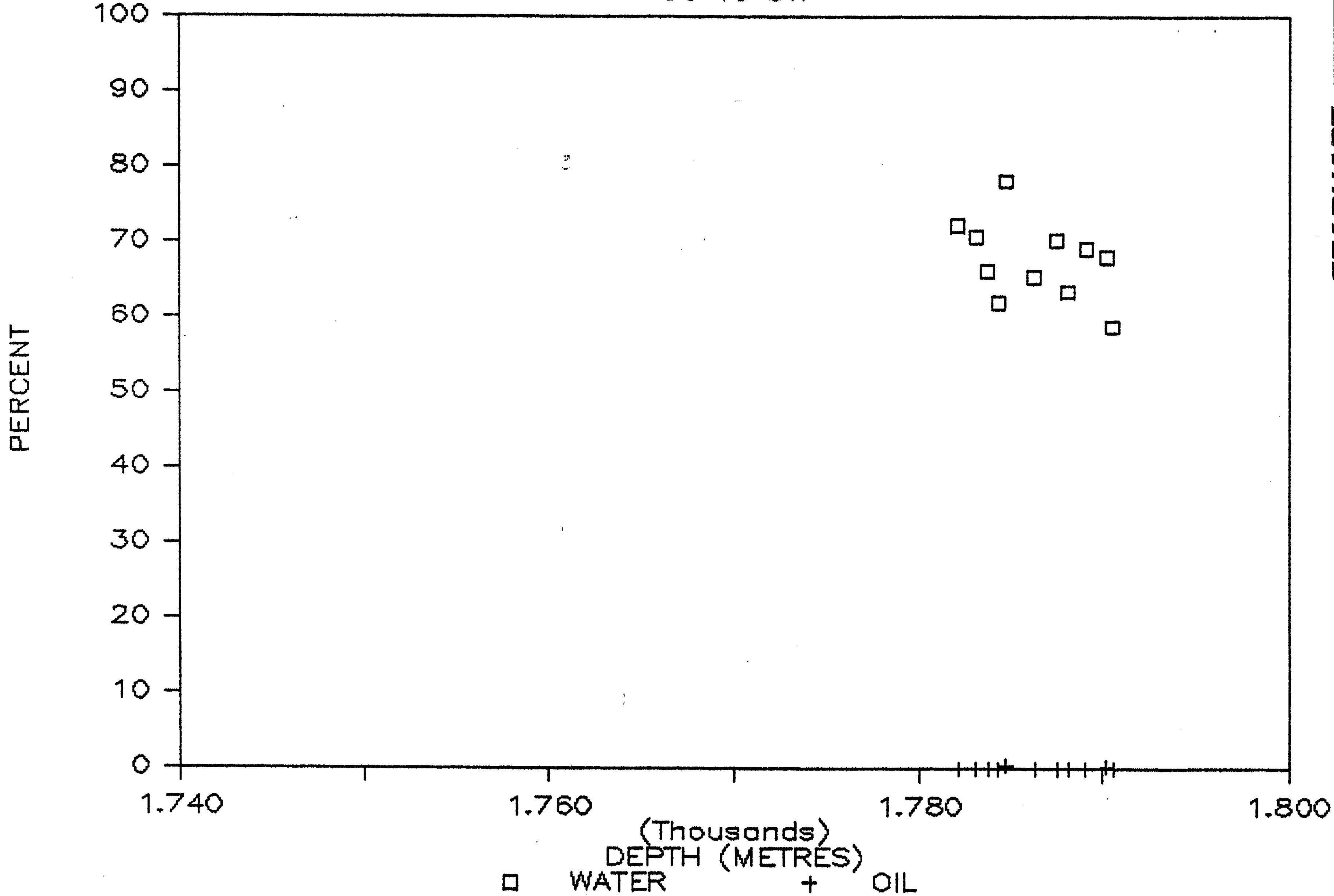
WINDERMERE NO 2

SO vs SW



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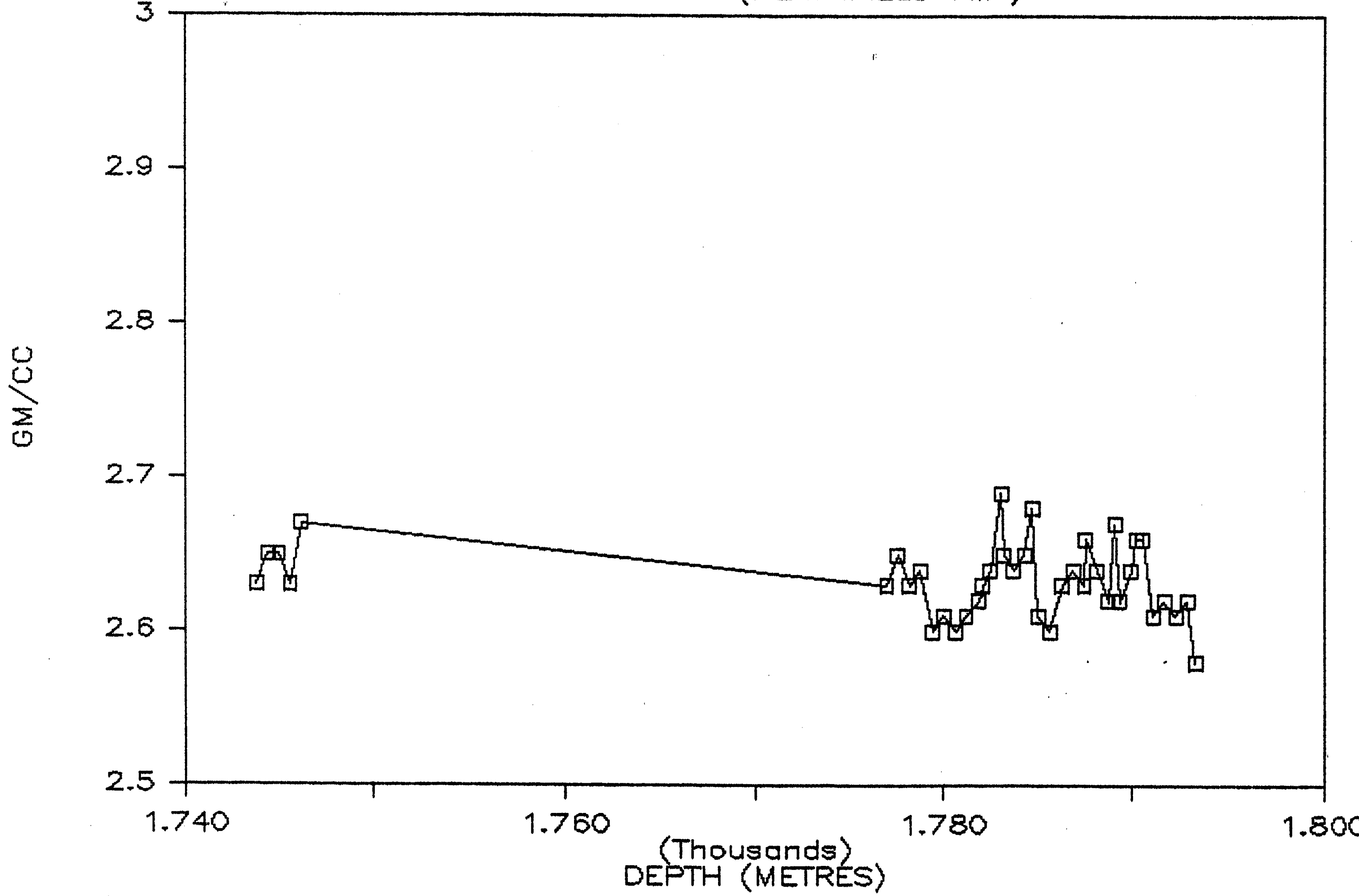
WINDERMERE NO 2

GRAIN DENSITY (HEATHFIELD FM)



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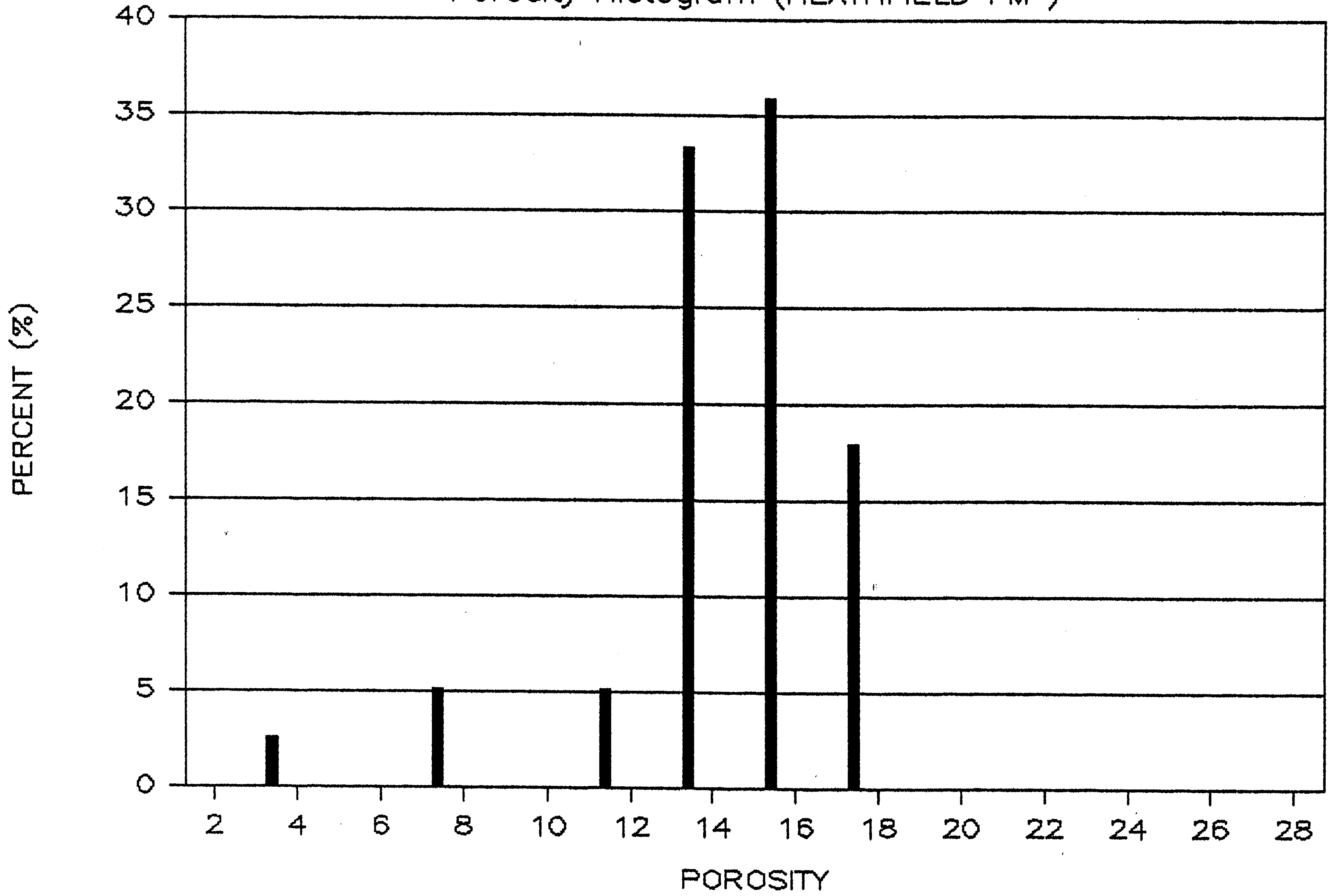
WINDERMERE NO 2

Porosity Histogram (HEATHFIELD FM)



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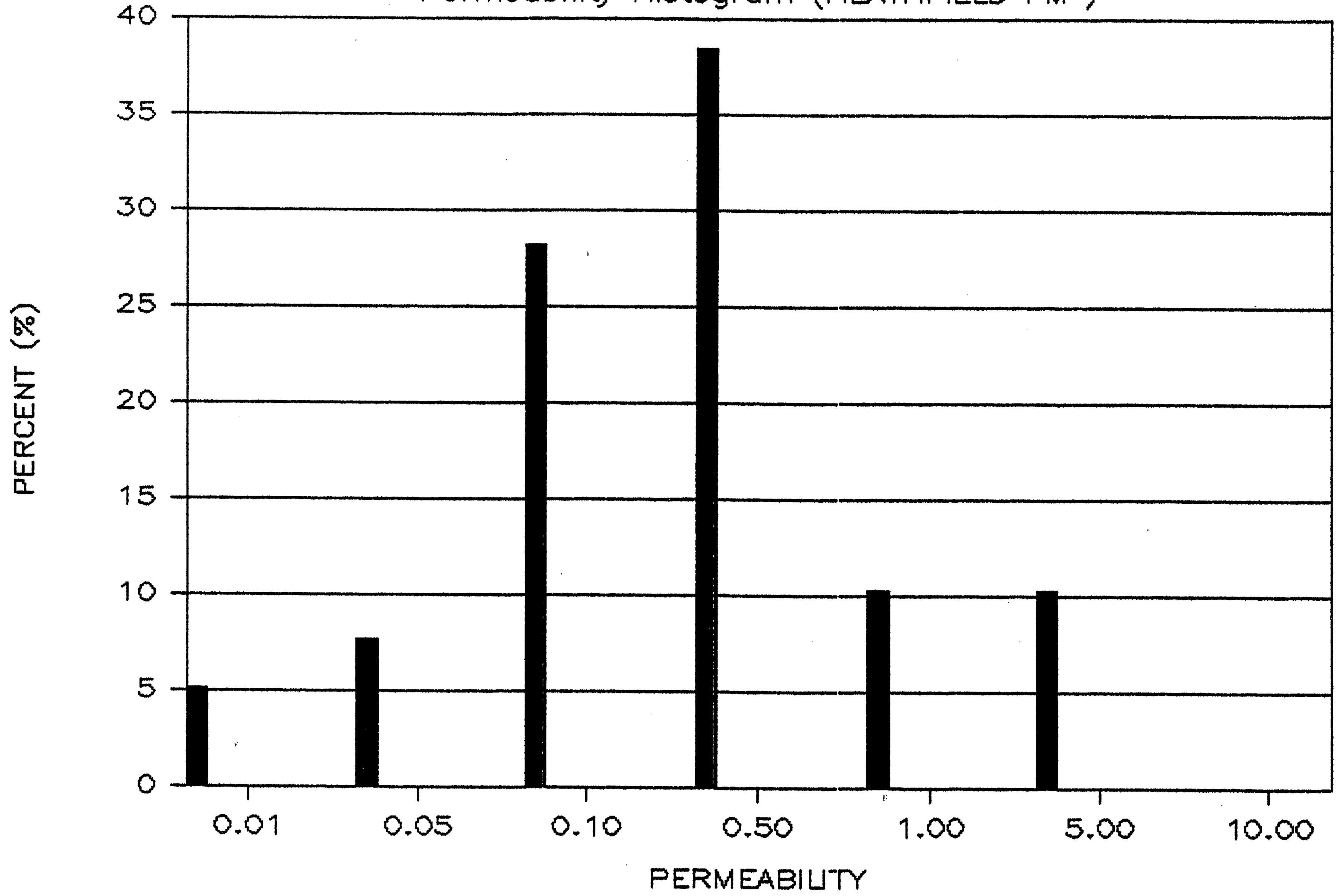
WINDERMERE NO 2

Permeability Histogram (HEATHFIELD FM)



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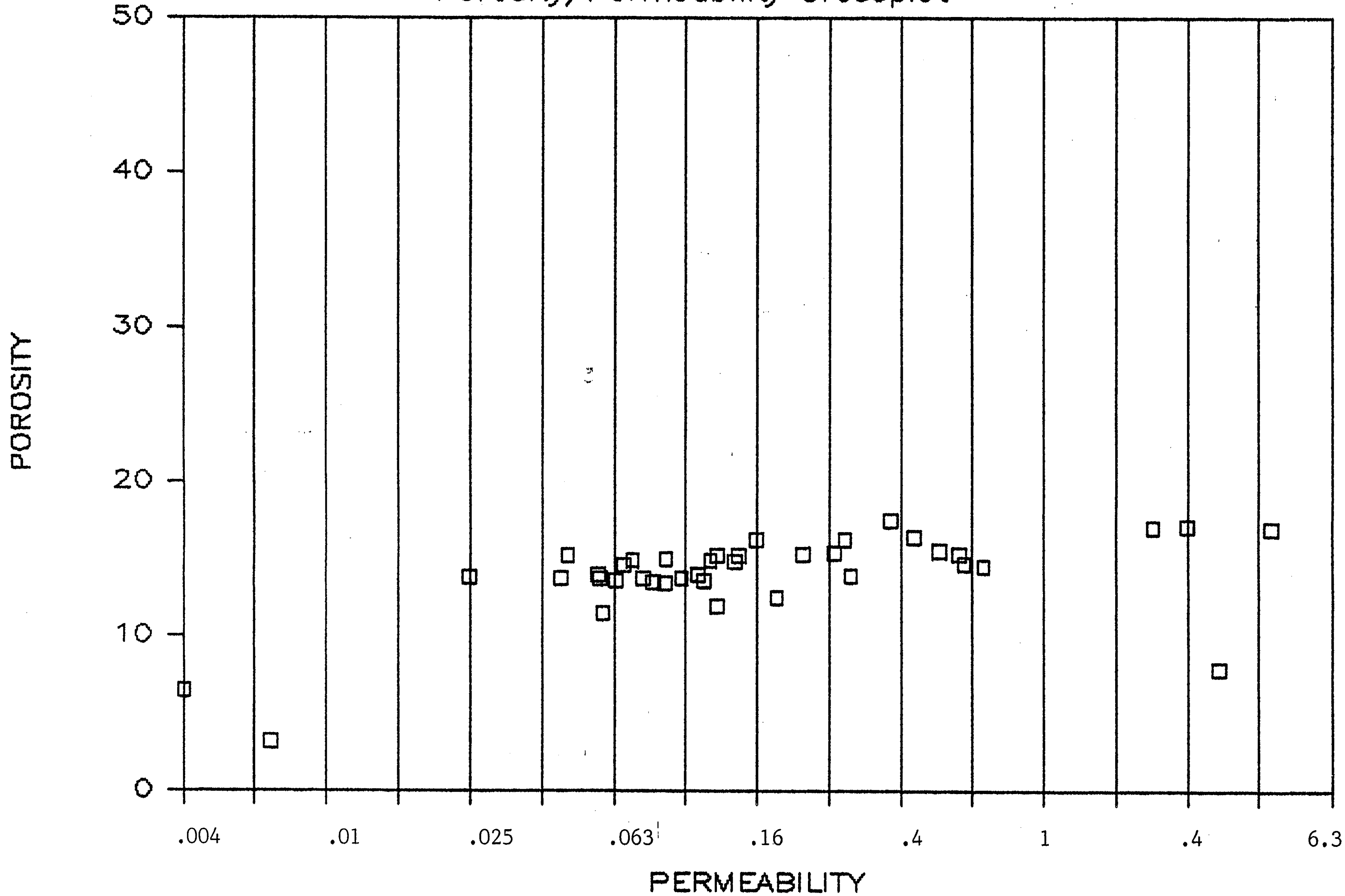
WINDERMERE NO 2

Porosity/Permeability Crossplot



GEARHART AUSTRALIA

APPENDIX K

APPENDIX K

SOURCE ROCK ANALYSIS AND PETROLEUM GEOCHEMISTRY

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SOURCE ROCK ANALYSIS AND PETROLEUM GEOCHEMISTRY,

WINDERMERE -2, PEP -111

OTWAY BASIN

MINORA RESOURCES NL

F3/0/0 - F 7565/89

July 1989

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27th July 1989

Minora Resources NL
GPO Box D164
PERTH WA 6001

Attention: T Scholefield

REPORT F 7565/89

CLIENT REFERENCE:	Fax message from T Scholefield, 10/4/89 and Data Transmittal from I Copp, 9/5/89
TITLE:	Source rock analysis and petroleum geochemistry, Windermere -2, PEP -111, Otway Basin
MATERIAL:	Oil (1 sample), Water (1 sample), Sidewall core (4 samples), Cuttings (13 samples).
LOCALITY:	WINDERMERE -2
IDENTIFICATION:	As in Table 1 of report
DATES RECEIVED:	12 April and 10 May, 1989
WORK REQUIRED:	Water: Water analysis (W2/1) Oil: Solvent extraction from water (R3.6a). Whole extract GC (R2.1). Liquid chromatography without deasphaltening (R3.8). GC of saturates (R3.9). Isolation and GC-MS of naphthenes (R3.13). Isolation (by TLC) and GC-MS of aromatics (R3.14). Cuttings: TOC content and Rock-Eval pyrolysis (R3.2). SWC and Selected Cuttings: Vitrinite reflectance. Organic petrology (R3.20). Pyrolysis-GC of solvent-washed cuttings (R3.19). Interpretation.

Investigation and Report by: Dr David M McKirdy and Brian L Watson

Dr Brian G Steveson
Manager, Petroleum Services Section

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1. INTRODUCTION

Water, oil and rock samples (sidewall cores, cuttings) from the Early Cretaceous sequence in Windermere -2 were submitted for geochemical and organic petrological analysis (Table 1).

The aims of the investigation were fourfold:

1) to evaluate the hydrocarbon source potential of organic-rich sediments within the lower Eumeralla Formation and underlying Crayfish Formation at Windermere -2;

2) to determine the type, source affinity and maturity of the Windermere -2 (basal Eumeralla) oil show;

3) to compare the Windermere -2 crude with oil recovered from the Heathfield Sandstone Member in Windermere -1 (McKirdy, 1987); and

4) to characterise the chemical composition, total dissolved solids, hardness, alkalinity and resistivity/conductivity of water obtained from the Heathfield Sandstone Member during DST 1 of Windermere -2.

Preliminary results were facsimilied to Minora Resources, Perth, in various progress reports dated 13 and 14 April, 16 and 28 June and 17 July.

2. ANALYTICAL METHODS

The analytical procedures were essentially as described for Windermere -1 (McKirdy, 1987) except that, GC-MS analysis of naphthenes and pyrolysis-GC of solvent-washed cuttings were undertaken at Curtin University, Perth.

3. RESULTS

Analytical data are summarised and presented herein as follows:

	Table	Figure	Appendix
Source Rock Analysis			
Formation tops	-	-	-
Vitrinite reflectance	2	1	2
TOC, Rock-Eval pyrolysis	3	2	-
Organic petrology	4-6	-	3
Whole-rock pyrolysis-GC	7,8	3	-
Oil Analysis			
C_{12+} composition	9	4	-
Whole-extract GC	-	5	-
GC of saturates	9	6,7	-
GC-MS of naphthenes	10,11	8,17	4
GC-MS of aromatics	12	18,19	-
Water Analysis	-	-	5

4. SOURCE ROCK ANALYSIS

4.1 Maturity

The stratigraphy of the Windermere -2 well section is given in Appendix 1. Vitrinite reflectance (VR) data plotted in Figure 1 show that Tertiary and Cretaceous sediments above 2435 metres depth are immature (VR < 0.5%).

The onset of gas and oil generation from Type III kerogen occurs at the following depths within the lower Eumeralla Formation:

Threshold	VR %	Depth m
top of gas window	0.6	2745
top of oil window	0.7	3002

At total depth in Windermere -2 the Crayfish Formation is optimally mature for oil generation (3595 m KB, VR = 0.97%).

Rock-Eval Tmax values on selected samples of the lower Eumeralla and Crayfish Formations (Fig 2) are in broad agreement with measured vitrinite reflectance.

Production index, another maturation indicator, increases steadily from 0.02 (immature) at 1950 metres to 0.20 (mature) at 3415 metres depth (Table 3).

4.2 Source Richness

Within the lower Eumeralla Formation both total organic carbon content (TOC) and genetic potential ($S_1 + S_2$) increase towards the base of the unit (Table 3) where coaly sediments reflect deposition in a paludal environment. The source richness of this siltstone/shale/coal lithofacies association is good to very good (TOC = 3.45 - 30.6%; $S_1 + S_2$ = 8-96 kg hydrocarbons/tonne).

Shale/siltstone from the basal sandstone member of the Eumeralla Formation also has good source richness (TOC = 3.8%; $S_1 + S_2$ = 8 kg hydrocarbons/tonne), in marked contrast to the underlying Crayfish Formation (TOC < 1%; $S_1 + S_2$ < 1 kg hydrocarbons/tonne: rating = poor).

4.3 Source Quality and Kerogen Type

Rock-Eval hydrogen indices in the range HI = 218 - 280 reflect the presence in the lower Eumeralla Formation of moderate quality, oil and gas-prone, Type II-III kerogen (Fig 2). Petrographic examination of three high-graded lower Eumeralla samples reveals that their maceral assemblages are dominated by vitrinite.

Depth	V : I : E	HI	Rock Type
2805 - 2810	65 : 20 : 15	265	sh, 10-20% coal
2955 - 2960	75-80 : 10 : 10-15	233	silt/sh, 10-20% coal
3060 - 3065	65-70 : 10 : 20-25	273	coal, 30-40% sh

Sporinite is the dominant exinite in each case. A similar correlation between vitrinite content and hydrogen index was observed in coal from the lower Eumeralla Formation in Windermere -1 (McKirdy, 1987).

Source quality deteriorates downwards through the basal sandstone member of the Eumeralla Formation (HI = 182) and into the upper Crayfish Formation (HI = 85-91). Dispersed organic matter in both of these units is predominantly inertinitic (I = 85-90% : Table 4).

In order to further assess their oil-generative potential, coal-rich cuttings from 3060-3065 metres depth in Windermere -2 were analysed by pyrolysis-GC. The pyrolysate has a low gas: oil ratio (C_{1-5} : C_{5-31} ≃ 1 : 3 : Table 8) consistent with the moderately oil-prone character indicated by Rock-Eval pyrolysis. However, close inspection of the P-GC trace (Fig 3) reveals a number of features which together suggest the potential for generations of gas and condensate-type liquids only, viz.

1) a dominance of condensate-range components (C_5 - C_{14} = 55% of total pyrolysate),

2) a low proportion of C_{15+} components (21% of total pyrolysate),

3) a high abundance of aromatic compounds (eg. benzene, toluene, m + p-xylene, naphthalene, methylnaphthalenes, dimethylnaphthalenes) relative to aliphatic components, and

4) high alkane/alkene ratios in the C_{13+} range.

5. OIL GEOCHEMISTRY

5.1 General Characteristics

In view of its mode of recovery (extracted from DST 2A water sample by shaking with dichloromethane), the Windermere -2 oil cannot be compared with the Windermere -1 (DST 1) crude in terms of its physical properties (specific gravity, viscosity and pour point). Nevertheless, the two oils (C_{12+} fraction) do have similar paraffinic bulk compositions (Table 9, Fig 4) and both are moderately waxy (Fig 5; McKirdy, 1987, Fig 1).

The enhanced concentration of the C_{25} n-alkane in the Windermere -2 whole-oil chromatogram (Fig 5) is not repeated in the saturates chromatogram (Fig 6), and may be due to coelution of an aromatic compound.

5.2 Maturity and Migration

Maturation-dependent ratios based on isoprenoid alkane, sterane and triterpane biomarkers (Table 10) and triaromatic hydrocarbons (Table 12) concur in highlighting the normal maturity of the Windermere -2 crude. Its MPI-derived maturity (VR_{calc} = 0.97%) represents the maturation level of its source rock at the time of primary migration. Comparison of its VR_{calc} value with the present vitrinite reflectance of the host reservoir (VR_{meas} = 0.79%) confirms that the oil is appreciably out-of-place in terms of maturity.

The marked maturity difference between the Windermere -1 (Heathfield) and Windermere -2 (basal Eumeralla) oils, clearly evident from parameters 4, 6, 9, 10, 12, 16 and 17 (Table 10 : see also Fig 7), is consistent with the latter's origin from a second, more deeply buried source rock.

Unlike the Windermere -1 (Heathfield) crude which originated more or less in situ (McKirdy, 1987), the Windermere -2 (basal Eumeralla) oil does display some biomarker evidence of long-distance migration (parameter 6, Table 10). Another migration-sensitive parameter, the C_{29} diasterane/sterane ratio (parameter 7,

Table 10) is anomalously low, but this may simply reflect the coaly nature of its source rock.

5.3 Source Affinity

The terrestrial source affinity of the Windermere -2 oil is evident from aspects of its C_{12+} composition (Fig 17). The oil originated from higher plant remains (C_{29}/C_{27} sterane > 1.50 which were deposited in a partly oxic aquatic environment (pr/ph > 2). This primary land plant detritus was reworked (degraded) by aerobic bacteria (and ?fungi) during early diagenesis. Bacteria were the precursors of the C_{27}-C_{35} hopanes found in the oil (m/z 191, Fig 13). These hopanes (pentacyclic triterpanes), representing a primary input of bacterial lipids to the source material, in turn underwent yet further bacterial degradation to drimanes (bicyclic sesquiterpanes) prior to burial of the organic-rich sediment below the zone of microbiological activity. This accounts for the low hopane/sterane ratio and high drimane/hopane ratio of the Windermere -2 oil (Table 11).

The C_{27}-C_{29} sterane and diasterane distributions of the Windermere -2 oil are dominated by C_{29} homologues of higher plant origin (Fig 8). This is a characteristic feature of most Australian non-marine crude oils (see e.g. Vincent *et al.*, 1985; Philp and Gilbert, 1986).

The oil's diterpane distribution (Figs 15, 16) is dominated by the C_{18} - C_{20} labdanes (bicyclic) and the C_{19} - C_{20} isopimaranes (tricyclic). These diterpenoid alkanes are derived from resins of the type synthesized by Araucariacean conifers (kauri pines : Alexander *et al.*, 1988). As in the Lindon -1 (Pebble Point) and Windermere -1 (Heathfield) oils, the tetracyclic diterpanes (beyerane, phyllocladane, kaurane) are subordinate. This feature distinguishes these Otway Basin oils from the Gippsland Basin crude oils examined by Alexander *et al.*, (1988).

6. CONCLUSIONS

1. Tertiary and Cretaceous sediments above 2435 metres depth in Windermere - 2 are thermally immature (VR < 0.5%).

2. Maturation thresholds for the onset of hydrocarbon generation from resinite-poor terrestrial organic matter in the Windermere -2 Early Cretaceous sequence are located within the lower Eumeralla Formation, as follows:

	VR %	Depth m
top of gas window	0.6	2745
top of oil window	0.7	3002

   The Crayfish Formation has attained optimal maturity for oil generation at total depth in Windermere -2 (3595 m, VR = 0.97%).

3. Organic-rich sediments (TOC = 3.5 - 31%; S_1 + S_2 = 7.7 - 96 kg hydrocarbons/tonne; HI = 218-280) occur throughout the lower Eumeralla Formation. Vitrinite-rich coals at the base of this unit (2985-3080

metres depth) contain gas and condensate-prone Type II-III kerogen that is initially mature for hydrocarbon generation (VR = 0.75 - 0.80 %).

4. Cuttings from the underlying upper Crayfish Formation are organically lean (TOC < 0.9%, $S_1 + S_2 < 1$ kg hydrocarbons/tonne). Their kerogen is inertinite-rich (I = 85-90% of DOM) and dry gas-prone (HI < 100).

5. Trace amounts of paraffinic, moderately waxy oil were recovered with water during a drill-stem test (DST 2A, 3174-3230.7 m) of the basal sandstone member of the Eumeralla Formation.

6. Like the paraffinic crude from the stratigraphically higher Heathfield sandstone member in Windermere -1, this Windermere -2 oil is of terrestrial (land plant) origin. However, the two Windermere oils differ in terms of:

   1) Their maturity (VR_{calc} = 0.97%, Windermere -2 cf. 0.57%, Windermere -1), and

   2) Specific aspects of their biomarker geochemistry (notably C_{29}/C_{27} sterane, C_{30} hopane/C_{29} sterane and drimane + homodrimane/C_{30} hopane ratios),

   and therefore appear to have originated from different Cretaceous source rocks.

7. The most likely source of the Windermere -2 oil show is the superjacent coal of the lower Eumeralla Formation, with the actual source kitchen being located basinward of the Windermere -2 well locality.

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TABLE 1

SAMPLES SUBMITTED FOR GEOCHEMICAL ANALYSIS, WINDERMERE -2

Sample Type	Test	Depth m	Unit
Water	DST 1	1775.2 - 1802.3	Heathfield sst. member, Eumeralla Formation
Oil and Water	DST 2A	3174.0 - 3230.7	Basal sst. member, Eumeralla Formation
Sidewall cores	# 24	1876	Lower Eumeralla Formation
	# 19	2352	
	# 13	2697	
	# 9	3015	
Cuttings		1950 - 1955	Lower Eumeralla Formation
		2735 - 2740	
		2805 - 2810	
		2955 - 2960	
		3060 - 3065	
		3075 - 3080	
		3220 - 3225	Basal sst. member, Eumeralla Formation
		3245 - 3250	
		3335 - 3340	
		3415 - 3420	Crayfish Formation
		3505 - 3510	
		3565 - 3570	

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TABLE 2

SUMMARY OF VITRINITE REFLECTANCE MEASUREMENTS, WINDERMERE -2

Depth (m)	Mean Maximum Reflectance	Standard Deviation	Range	Number of Determinations
1876	0.34	0.06	0.26 - 0.43	6
2352	0.50	0.07	0.37 - 0.63	27
2697	0.55	0.05	0.42 - 0.73	19
2805 - 2810	0.77«(0.70)	0.07	0.61 - 0.91	33
2955 - 2960	0.78«(0.74)	0.09	0.62 - 0.94	13
3015	0.87«(0.78)	0.09	0.72 - 1.04	17
3245 - 3250	0.79	0.07	0.66 - 0.91	15
3335 - 3340	0.91	0.09	0.77 - 1.07	11
3505 - 3510	0.81*(0.89)	0.07	0.69 - 0.91	34

« Influenced by reworked vitrinite
* Influenced by carved cuttings
() Preferred Value

TABLE 3

AMDEL

Rock-Eval Pyrolysis 01/01/80

Client: MINORA RESOURCES NL

Well: WINDERMERE-2

Depth (m)	T Max	S1	S2	S3	S1+S2	PI	S2/S3	PC	TOC	HI	OI
1950	429	0.18	7.54	1.58	7.72	0.02	4.77	0.64	3.45	218	45
2735	434	0.86	17.12	0.94	17.98	0.05	18.21	1.49	7.05	242	13
2805	434	1.17	22.07	0.58	23.24	0.05	38.05	1.93	8.30	265	6
2955	440	2.50	24.02	0.79	26.52	0.09	30.40	2.21	10.30	233	7
2985	440	7.43	59.54	1.48	66.97	0.11	40.22	5.58	21.20	280	6
3060	444	11.95	83.70	1.55	95.65	0.12	54.00	7.97	30.60	273	5
3075	444	11.35	83.40	1.25	94.75	0.12	66.72	7.89	30.50	273	4
3220	443	0.81	6.93	0.35	7.74	0.10	19.80	0.64	3.80	182	9
3415	444	0.17	0.68	0.47	0.85	0.20	1.44	0.07	0.74	91	63
3505	444	0.11	0.73	0.30	0.84	0.13	2.43	0.07	0.85	85	35

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TABLE 4

PERCENTAGE OF VITRINITE, INERTINITE AND EXINITE IN

DISPERSED ORGANIC MATTER, WINDERMERE-2

Depth (m)	Percentage of		
	Vitrinite	Inertinite	Exinite
1876	5	95	<5
2352	5	85	10
2697	5	85 - 90	5 - 10
2805 - 2810	65	20	15
2955 - 2960	75 - 80	10	10 - 15
3015	5	90	5
3060 - 3065	65 - 70	10	20 - 25
3245 - 3050	5	90	5
3335 - 3340	5	85 - 90	5 - 10
3505 - 3510	<5	85	10
3565 - 3570	<5	85 - 90	5 - 10

TABLE 5

ORGANIC MATTER TYPE AND ABUNDANCE, WINDERMERE-2

Depth (m)	Estimated Volume of DOM (%)	Estimated Volume of Exinites	Exinite Macerals
1876	≈0.5	Vr	lipto, spo, cut
2352	0.5-1	Ra	lipto, lama, spo, cut, res
2697	≈1	Ra	lipto, lama, bmite spo, cut, res, ?oil.
2805 - 2810	5-10	Co-Ab	spo, lipto, cut, res, lama.
2955 - 2960	5-10	Co	spo, cut, lipto, lama, bmite, res, ?oil.
3015	0.5-1	Ra-Vr	lipto, lama, spo, ?oil.
3060 - 3065	>30	Ab	spo, lipto, sub, res, lama, bmite, cut, exs
3245 - 3250	0.5-1	Ra-Vr	lipto, lama, cut.
3335 - 3340	0.5-1	Ra	bmite, lipto, cut, lama.
3505 - 3510	≈0.5	Ra	bmite, lipto.
3565 - 3570	≈0.5	Ra	bmite, lipto.

TABLE 6

EXINITE MATERIAL ABUNDANCE AND FLUORESCENCE CHARACTERISTICS,

WINDERMERE-2

Depth (m)	Exinite Macerals	Lithology/Comments
1876	lipto(Vr;mY-mO), spo(Vr;mO), cut(Tr;mO)	Siltstone.
2352	lipto(Ra;mY-mO), lama(Ra;mO-dO), spo(Ra-Vr;mO-dO), cut(Vr;mO-dO), res(Tr;mO).	Shale; some exinites are oxidised.
2697	lipto(Ra;mO-dO), lama(Ra-Vr;mO-dO), bmite(Ra-Vr;dB), spo(Ra-Vr;mO-dO), cut(Vr;mO-dO), res(Tr;mO), ?oil(Tr;iY).	Siltstone; ?oil is commonly associated with bituminite. Some exinites appear to be slightly oxidised.
2805	spo(Co-Ab;mO-dO), lipto(Sp-Co;mO-dO), cut(Ra;mO-dO), res(Ra;mY-dO), lama (Ra;mO-dO).	Chiefly shale, 10-20% coal (clarite, duroclarite); some coals contain up to 25% exinite.
2955	spo(Sp-Co;mO-dO), cut(sp-Co;mO-dO), lipto(Sp;mO-dO); ?lama(Ra;mO), bmite (Ra;dO), res(Vr;mO), sub(Vr;nofl), ?oil(Tr;iG).	Chiefly siltstone and shale, 10-20% coal (duroclarite and clarite); some coals contain up to 25% exinite. Oil generally occurs in the siltstones.
3015	lipto(Ra-Vr;mO), ?lama(Vr;mO-dB), spo(Tr;mO), ?oil(Tr;iY-iG).	Shale.
3065	spo(Ab;mO-dO), lipto(Ab;dO), sub(Co-Ab; nofl),res(Co;dO-nofl), lama(Sp;mO), bmite(Sp;dB), cut(Ra;dO-dB), exs(Ra;mO-dB).	Chiefly coal, 30-40% shale.
3245	lipto(Ra-Vr;mO), ?lama(Vr;dO), cut(Tr;dO).	Shale; some organic rich cavings contain 10-20% exinite.
3335	bmite(Ra;dO), lipto(Ra;mO), cut(Vr;dO), lama(Vr;mO).	Shale with minor coaly stringers.
3505	bmite(Ra-Sp;dO), lipto(Vr;mO-dO).	Siltstone.
3565	bmite(Ra;dO-dB), lipto(Ra;mO-dO).	Shale.

KEY TO DISPERSED ORGANIC MATTER DESCRIPTIONS

MACERAL GROUPS

V	Vitrinite
I	Inertinite
E	Exinite

EXINITE MACERALS

spo	Sporinite
cut	Cutinite
res	Resinite
sub	Suberinite
lipto	Liptodetrinite
fluor	Fluorinite
terp	Terpenite
exs	Exsudatinite
phyto	Phytoplankton
tela	Telalginite
lama	Lamalginite
bmite	Bituminite
bmen	Bitumen
thuc	Thucholite

ABUNDANCE (by vol.)

Ma	Major	>15%
Ab	Abundant	2-15%
Co	Common	1-2%
Sp	Sparse	0.5-1%
Ra	Rare	0.1-0.5%
Vr	Very Rare	≃0.1%
Tr	Trace	<0.1

FLUORESCENCE COLOUR AND INTENSITY

G	Green	i	Intense
Y	Yellow	m	Moderate
O	Orange	d	Dull
B	Brown	nofl	No Visible Fluorescence

TABLE 7

ALKANE AND ALKENE COMPONENT ANALYSIS FROM PYROLYSIS-GC

Well name: UNDISCLOSED

Date: 1989

Sample: 3065

Carbon No.	----Alkane + Alkene-----			---------Alkane---------			---------Alkene---------			Alkane/Alkene
	A	B	C	A	B	C	A	B	C	
1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
4	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
5	2.209	1.8489	0.0604	1.467	1.2279	0.0401	0.742	0.6211	0.0203	1.98
6	1.267	1.0605	0.0347	0.500	0.4185	0.0137	0.767	0.6420	0.0210	0.65
7	1.073	0.8981	0.0293	0.583	0.4880	0.0159	0.490	0.4101	0.0134	1.19
8	1.062	0.8889	0.0290	0.502	0.4202	0.0137	0.560	0.4687	0.0153	0.90
9	0.988	0.8270	0.0270	0.478	0.4001	0.0131	0.510	0.4269	0.0139	0.94
10	1.193	0.9985	0.0326	0.736	0.6160	0.0201	0.457	0.3825	0.0125	1.61
11	1.995	1.6698	0.0546	0.351	0.2938	0.0096	1.644	1.3760	0.0450	0.21
12	0.584	0.4888	0.0160	0.257	0.2151	0.0070	0.327	0.2737	0.0089	0.79
13	1.417	1.1860	0.0388	1.221	1.0220	0.0334	0.196	0.1641	0.0054	6.23
14	1.638	1.3710	0.0448	1.638	1.3710	0.0448	nd	nd	nd	nd
15	2.072	1.7343	0.0567	1.570	1.3141	0.0429	0.502	0.4202	0.0137	3.13
16	1.595	1.3350	0.0436	1.398	1.1701	0.0382	0.197	0.1649	0.0054	7.10
17	1.153	0.9651	0.0315	0.975	0.8161	0.0267	0.178	0.1490	0.0049	5.48
18	1.110	0.9291	0.0304	0.922	0.7717	0.0252	0.188	0.1574	0.0051	4.90
19	0.688	0.5759	0.0188	0.578	0.4838	0.0158	0.110	0.0921	0.0030	5.25
20	0.617	0.5164	0.0169	0.451	0.3775	0.0123	0.166	0.1389	0.0045	2.72
21	0.453	0.3792	0.0124	0.400	0.3348	0.0109	0.053	0.0444	0.0014	7.55
22	0.277	0.2318	0.0076	0.230	0.1925	0.0063	0.047	0.0393	0.0013	4.89
23	0.234	0.1959	0.0064	0.204	0.1707	0.0056	0.030	0.0251	0.0008	6.80
24	0.154	0.1289	0.0042	0.137	0.1147	0.0037	0.017	0.0142	0.0005	8.06
25	0.129	0.1080	0.0035	0.104	0.0870	0.0028	0.025	0.0209	0.0007	4.16
26	0.065	0.0544	0.0018	0.055	0.0460	0.0015	0.010	0.0084	0.0003	5.50
27	0.048	0.0402	0.0013	0.048	0.0402	0.0013	nd	nd	nd	nd
28	0.020	0.0167	0.0005	0.020	0.0167	0.0005	nd	nd	nd	nd
29	0.014	0.0117	0.0004	0.014	0.0117	0.0004	nd	nd	nd	nd
30	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
31	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

nd = no data
A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC

TABLE 8

PARAMETER SUMMARY FOR PYROLYSIS GAS CHROMATOGRAPHY

Well name: UNDISCLOSED

Date: 1989

Sample: 3065

Parameter	Value A	Value B	Value C	Value D
C1-C4 abundance (all compounds)	24.18	20.239	0.661	
C5-C8 abundance (all compounds)	13.95	11.676	0.382	
C5-C8 abundance (alkanes+alkenes)	5.61	4.696	0.153	
C9-C14 abundance (all compounds)	40.95	34.275	1.120	
C9-C14 abundance (alkanes+alkenes)	7.82	6.541	0.214	
C15-C31 abundance (all compounds)	20.92	17.510	0.572	
C15-C31 abundance (alkanes+alkenes)	8.63	7.222	0.236	
C5-C31 abundance (all compounds)	75.82	63.461	2.074	
C5-C31 abundance (alkanes+alkenes)	22.06	18.460	0.603	
C5-C31 alkane abundance	14.84	12.420	0.406	
C5-C31 alkene abundance	7.22	6.040	0.197	
C5-C8 alkane/alkene				1.193
C9-C14 alkane/alkene				1.494
C15-C31 alkane/alkene				4.666
C5-C31 alkane/alkene				2.056
C1-C4 abundance/S2				0.242
C5-C31 abundance/S2				0.758
(C1-C5)/C6+ abundance				0.365
R	29.65	24.818	0.811	
PI x PC x TOC				30.35

nd = no data
A = % of S2
B = mg/g Rock
C = (mg/g Rock)/TOC
D = (no units)
R = [(C1-C4)+(Proportion alkenes x (C5-C31))]
N.B. C1-C4 and C5-C31 are for all compounds
PI = Production index
PC = Pyrolysable carbon
S2 = Rock-Eval S2 value
TOC = Total Organic Carbon

TABLE 9

COMPARATIVE OIL ANALYSES, WINDERMERE -1 & 2

Well & Test	Depth m	Formation	C_{12+} Composition					Alkane Ratios			
			N + Iso	Naph	Arom	Res	Asph	Np/Pr	Pr/Ph	Pr/n-C_{17}	Ph/n-C_{18}
Windermere -1 DST -1	1791-1858	Eumeralla (Heathfield sst mbr)	54.1	29.2	8.4	7.6	0.07	0.25	6.1	1.14	0.17
Windermere -2 DST -2A	3174-3230.7	Eumeralla (basal sst mbr)	48.9	30.7	15.9	-- 4.5 --		0.33	5.7	0.86	0.14

* Data from McKirdy (1987)

TABLE 10

BIOMARKER PARAMETERS OF SOURCE, MATURITY, MIGRATION AND BIODEGRADATION IN OILS FROM WINDERMERE -1 & 2

Well & Formation	Test & Depth (m)	Steranes							Terpanes						Acyclic Alkanes			
Parameter*		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Windermere -1 Eumeralla (Heathfield sst member)**	DST 1 1791-1838	-	6.8	11.1	0.82	1.1	0.90	0.57	0.08	3.7	0.05	1.4	0.17	0.04	6.1	0.43	1.1	0.17
Windermere -2 Eumeralla (basal sst member)	DST 2A 3174-3230.7	-	3.7	4.6	0.97	1.3	1.4	0.49	0.25	1.2	0.24	1.4	0.08	-	5.7	0.55	0.86	0.14

* See key (next page) for derivation and specificity of each parameter

** Data from McKirdy (1987)

KEY TO BIOMARKER PARAMETERS OF SOURCE, MATURITY, MIGRATION AND BIODEGRADATION

Parameter	* Derivation	Specificity
1	C_{27} : C_{28} : C_{29} 5α(H)14α(H)17α(H) 20R steranes	Source
2	C_{29} 5α(H)14α(H)17α(H) 20R sterane / C_{27} 5α(H)14α(H)17α(H) 20R sterane	Source
3	C_{29} 13β(H)17α(H) 20R diasterane / C_{27} 13β(H)17α(H) 20R diasterane	Source
4	C_{29} 5α(H)14α(H)17α(H) 20S sterane / C_{29} 5α(H)14α(H)17α(H) 20R sterane	Maturity, Biodegradation
5	C_{27} 13β(H)17α(H) 20S diasterane / C_{27} 13β(H)17α(H) 20R diasterane	Maturity
6	C_{29} 5α(H)14β(H)17β(H) 20R sterane / C_{29} 5α(H)14α(H)17α(H) 20R sterane	Maturity, Migration
7	C_{29} 13β(H)17α(H) 20R+20S diasteranes / C_{29} 5α(H) steranes	Migration, Source
8	C_{30} pentacyclic terpane/C_{30} 17α(H)21β(H) hopane	Source
9	C_{27} 17α(H)-22,29,30-trisnorhopane / C_{27} 18α(H)-22,29,30-trisnorhopane (T_m/T_s)	Maturity, Source
10	T_s / C_{30} 17α(H)21β(H) hopane	Maturity
11	C_{32} 17α(H)21β(H) 22S homohopane / C_{32} 17α(H)21β(H) 22R homohopane	Maturity
12	C_{30} 17β(H)21α(H) moretane / C_{30} 17α(H)21β(H) hopane	Maturity
13	C_{29} 17α(H)-25-norhopane / C_{29} 17α(H)-30-norhopane	Biodegradation
14	pristane / phytane	Source
15	2,6,10-trimethyltridecane / pristane	Maturity
16	pristane / n-heptadecane	Source, Biodegradation, Maturity
17	phytane / n-octadecane	Source, Biodegradation, Maturity

* Ratios calculated from peak areas as follows:

Parameters 1-6 m/z = 217 mass fragmentogram
Parameter 7 m/z = 217, 259 mass fragmentograms
Parameters 8-13 m/z = 191 mass fragmentogram
Parameters 14-17 capillary gas chromatogram of alkanes or whole oil/extract

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TABLE 11

SUPPLEMENTARY SOURCE-DEPENDENT BIOMARKER RATIOS IN OILS FROM WINDERMERE -1 AND 2

Well and Formation	Test and Depth (m)	C_{30} Hopane / C_{29} Steranes	C_{15}, C_{16} Drimanes / C_{30} Hopane	C_{20} Isopimarane / 16βH-Phyllocladane
Windermere -1 Heathfield sst member Eumeralla Fm**	DST 1 1791-1838	4.4	0.49	6.0
Windermere -2 Basal sst mbr, Eumeralla Fm	DST 2A 3174-3230.7	0.33	23.1	2.5
* Parameter		18	19	20

* Measured from mass fragmentograms as follows:

Parameter 18 m/z 191, 217
Parameter 19 m/z 123, 191
Parameter 20 m/z 123

** Data from McKirdy (1987)

TABLE 12

OIL MATURITY BASED ON AROMATIC HYDROCARBON DISTRIBUTIONS *

WINDERMERE -1 & 2

Well & Test	Depth m	MPI	MPR	MPDF	DNR	VR calc (a)	(b)	(c)	(d)	(e) √	(f)
Windermere -1 DST 1**	1791-1838	0.49	0.81	nd	nd	0.70	N/A	0.85	N/A	0.57	nd
Windermere -2 DST 2A	3174-3230.7	1.07	1.04	0.511	4.39	1.04	N/A	0.96	1.09	0.97	0.98

* See key (next page) for determination of listed parameters
** = Data from McKirdy (1987)
nd = Not determined
N/A = Not applicable
√ = Preferred value

KEY TO AROMATIC MATURITY INDICATORS

Methylphenanthrene index (MPI), methylphenanthrene ratio (MPR), dimethylnaphthalene ratio (DNR) and calculated vitrinite reflectance (VR_{calc}) are derived from the following equations (after Radke and Welte, 1983; Radke *et al.*, 1984):

$$MPI = \frac{1.5\ (2\text{-}MP + 3\text{-}MP)}{P + 1\text{-}MP + 9\text{-}MP}$$

$$VR_{calc}\ (a) = 0.6\ MPI + 0.4\ (\text{for } VR < 1.35\%)$$

$$VR_{calc}\ (b) = -0.6\ MPI + 2.3\ (\text{for } VR > 1.35\%)$$

$$MPR = \frac{2\text{-}MP}{1\text{-}MP}$$

$$VR_{calc}\ (c) = 0.99\ \log_{10} MPR + 0.94\ (VR = 0.5\text{-}1.7\%)$$

$$DNR = \frac{2,6\text{-}DMN + 2,7\text{-}DMN}{1,5\text{-}DMN}$$

$$VR_{calc}\ (d) = 0.046\ DNR + 0.89\ (\text{for } VR = 0.9\text{-}1.5\%)$$

Where	P	=	phenanthrene
	1-MP	=	1-methylphenanthrene
	2-MP	=	2-methylphenanthrene
	3-MP	=	3-methylphenanthrene
	9-MP	=	9-methylphenanthrene
	1,5-DMN	=	1,5-dimethylnaphthalene
	2,6-DMN	=	2,6-dimethylnaphthalene
	2,7-DMN	=	2,7-dimethylnaphthalene

Peak areas measured from m/z 156 (dimethylnaphthalene), m/z 178 (phenanthrene) and m/z 192 (methylphenanthrene) mass fragmentograms of diaromatic and triaromatic hydrocarbon fraction isolated by thin layer chromatography.

Recalibration of the methylphanthrene index using data from a suite of Australian coals has given rise to another equation for calculated vitrinite reflectance (after Boreham *et al.*, 1988):

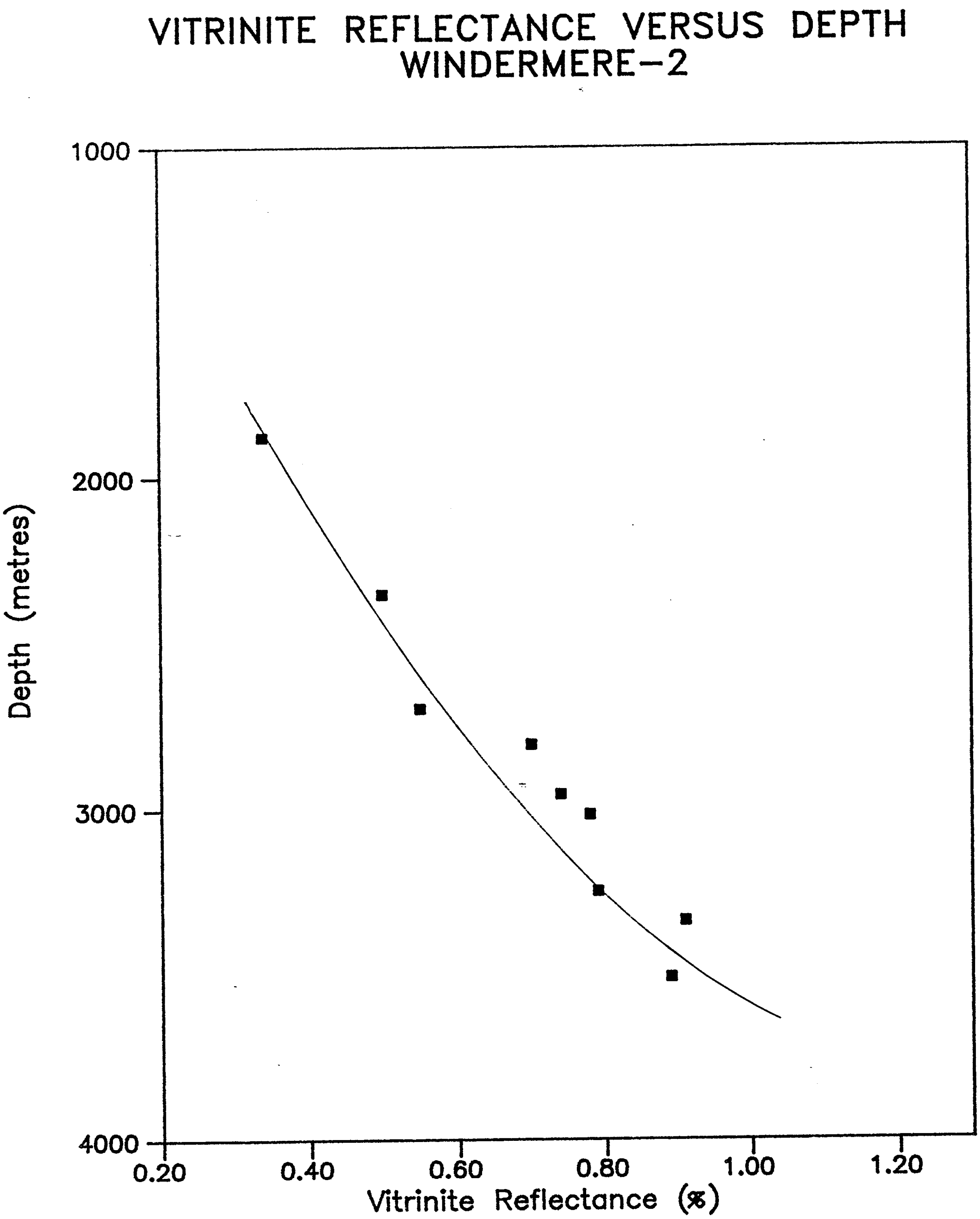
$$VR_{calc}\ (e) = 0.7\ MPI + 0.22\ (\text{for } VR < 1.7\%)$$

The methylphenanthrene distribution ratio (MPDF) and calculated vitrinite reflectance VR_{calc} (f) is derived from the following equation (after Kvalheim *et al.*, 1987):

$$MPDF = \frac{(2\text{-}MP + 3\text{-}MP)}{(2\text{-}MP + 3\text{-}MP + 1\text{-}MP + 9\text{-}MP)}$$

$$VR_{calc}\ (f) = -0.166 + 2.242\ MPDF$$

FIGURE 1



VITRINITE REFLECTANCE VERSUS DEPTH
WINDERMERE-2
1000
2000
3000
4000
Depth (metres)
0.20
0.40
0.60
0.80
1.00
1.20
Vitrinite Reflectance (%)

FIGURE 2

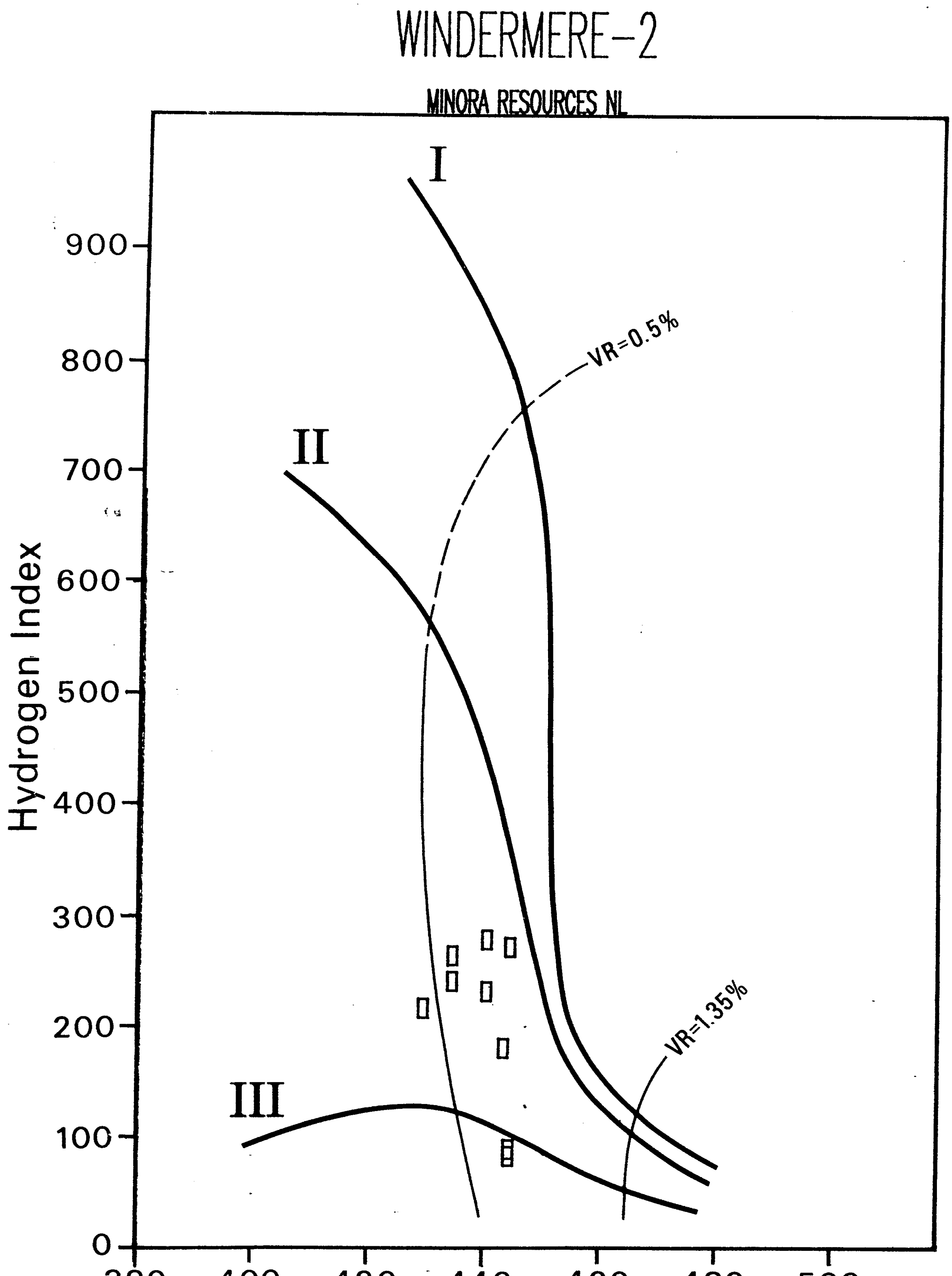

WINDERMERE-2
MINORA RESOURCES NL
I
II
III
VR=0.5%
VR=1.35%
Hydrogen Index
900
800
700
600
500
400
300
200
100
0
380
400
420
440
460
480
500
T max °C

FIGURE 3

3065

Pyrolysis Gas Chromatogram

Instrument: Varian 2700

Column: 25m BP-1 0.22mm ID

Injector temperature: 280°C

Detector temperature: 320°C

Column temperature: -20° to 280° at 4°/min

Carrier gas: Helium

Pyrolysis temperature setting: 750

* Aromatic Hydrocarbon

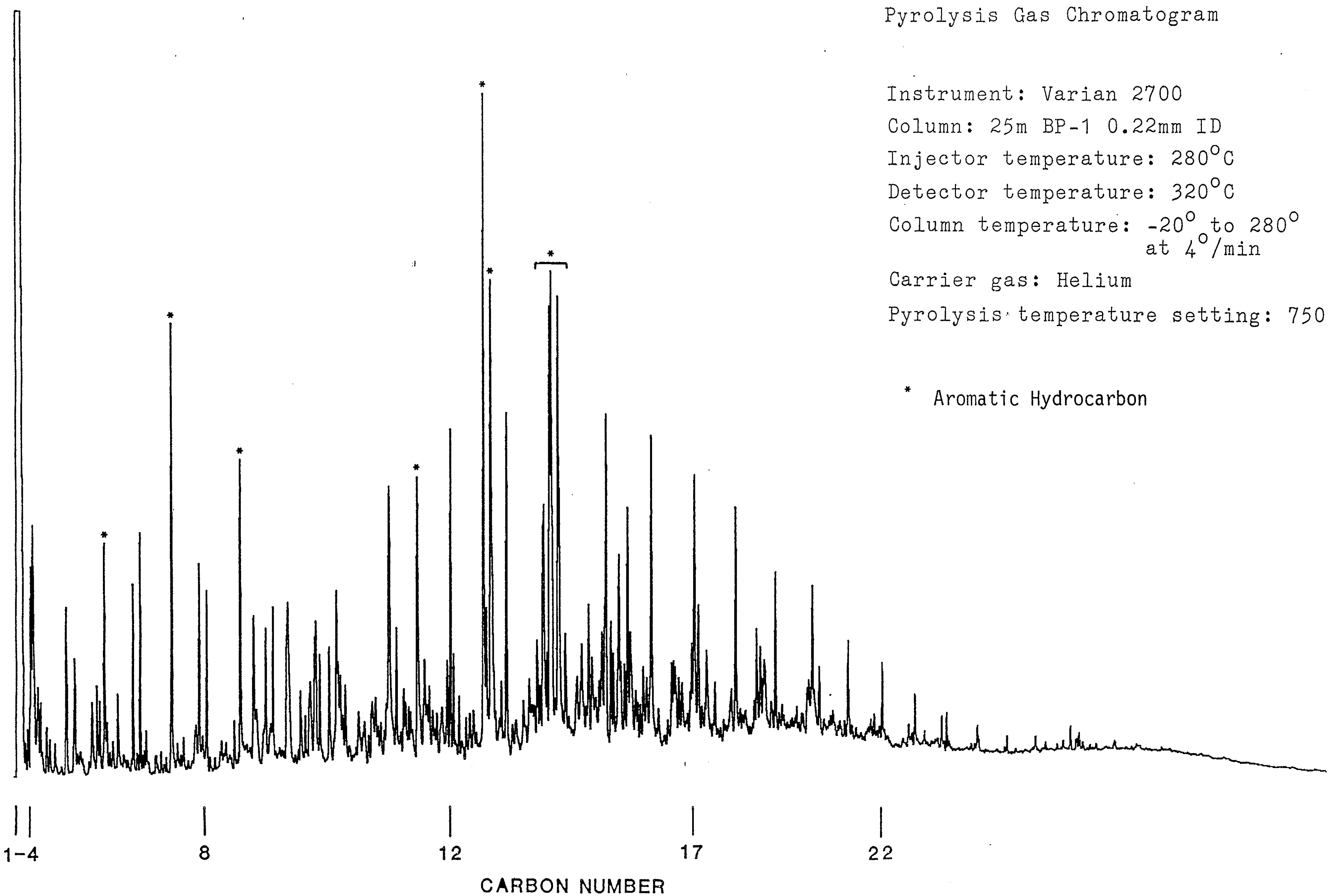


FIGURE 4

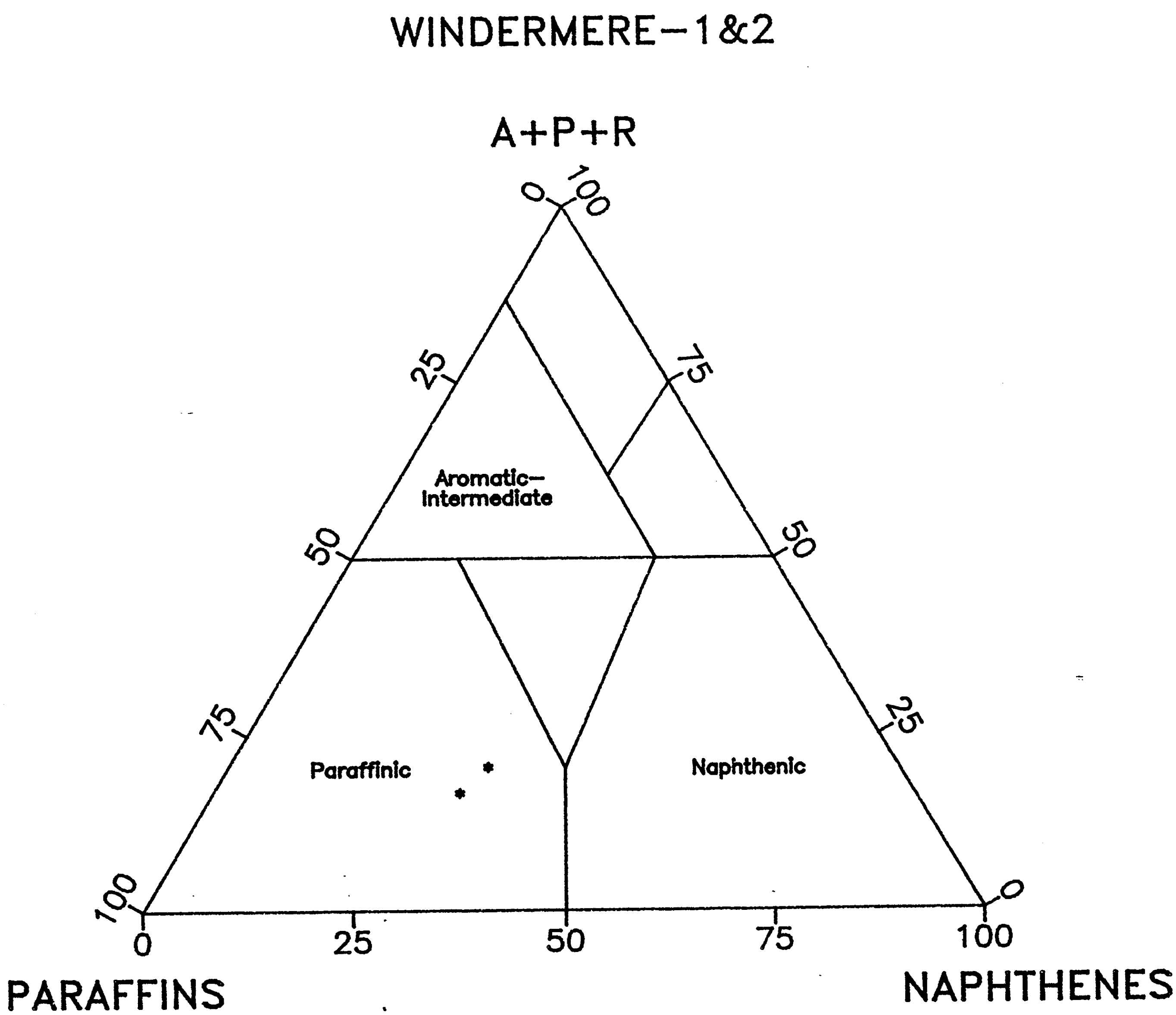

WINDERMERE-1&2
A+P+R
0
100
25
75
50
50
75
25
100
0
Aromatic-
Intermediate
Paraffinic
Naphthenic
0
25
50
75
100
PARAFFINS
NAPHTHENES

FIGURE 5

WINDERMERE -2
DST 2A
GC OF EOM

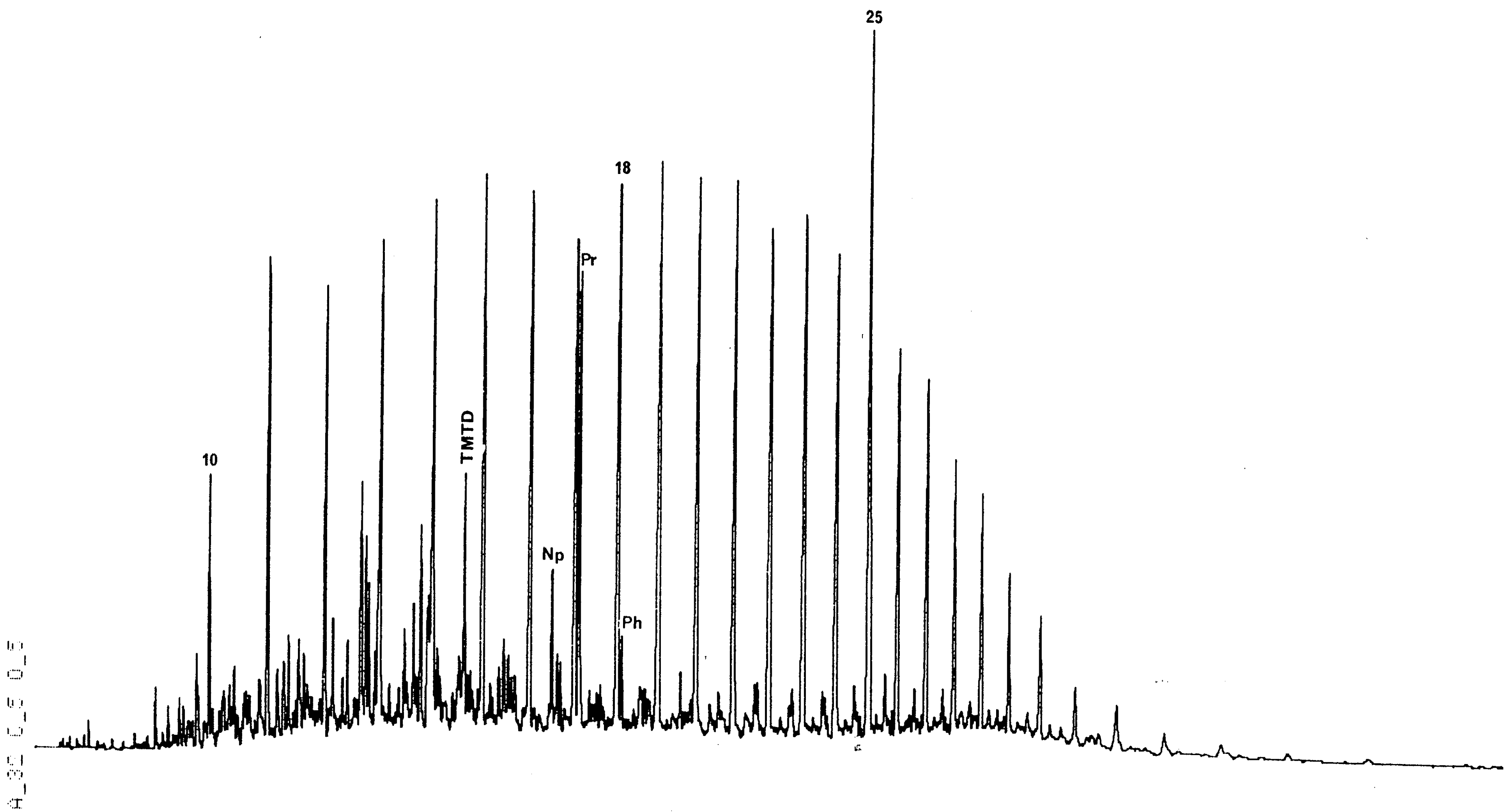


FIGURE 6

WINDERMERE -2

DST 2A

GC of Saturated Hydrocarbons

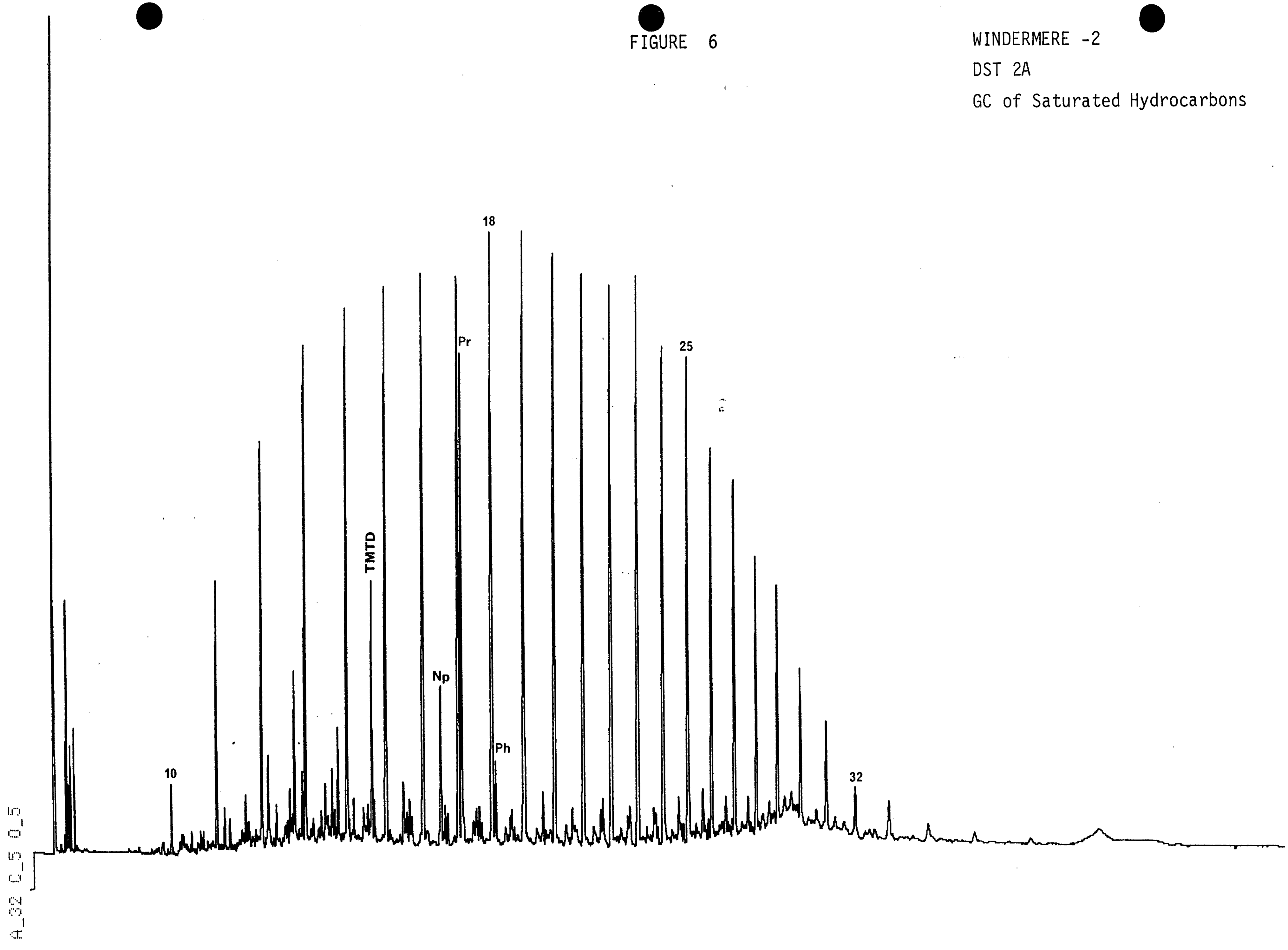
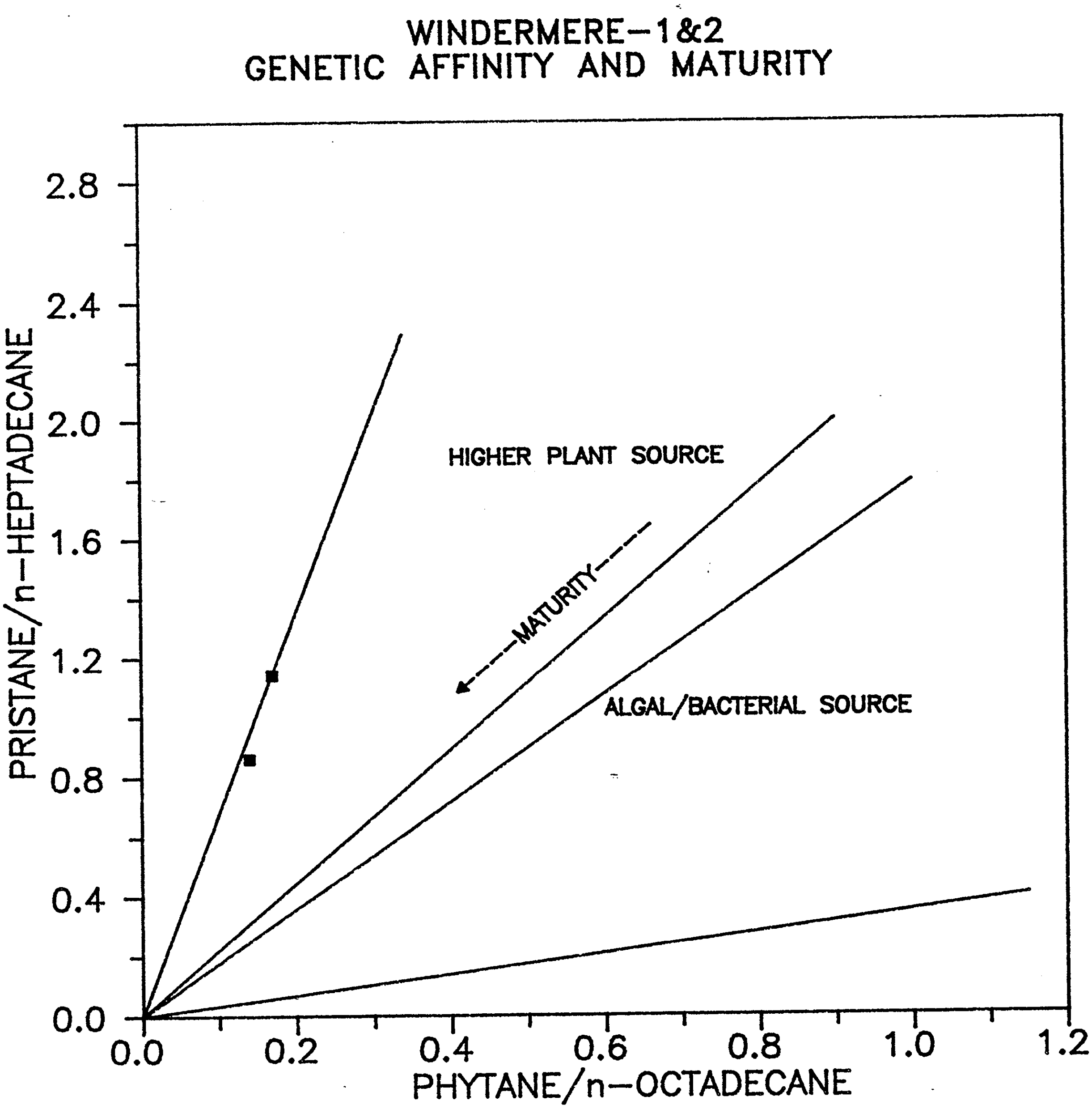


FIGURE 7


WINDERMERE-1&2
GENETIC AFFINITY AND MATURITY
PRISTANE/n-HEPTADECANE
PHYTANE/n-OCTADECANE
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
HIGHER PLANT SOURCE
MATURITY
ALGAL/BACTERIAL SOURCE

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KEY TO AROMATIC MATURITY INDICATORS

Methylphenanthrene index (MPI), methylphenanthrene ratio (MPR), dimethylnaphthalene ratio (DNR) and calculated vitrinite reflectance (VR_{calc}) are derived from the following equations (after Radke and Welte, 1983; Radke *et al.*, 1984):

$$MPI = \frac{1.5\ (2\text{-}MP + 3\text{-}MP)}{P + 1\text{-}MP + 9\text{-}MP}$$

$$VR_{calc}\ (a) = 0.6\ MPI + 0.4\ (\text{for } VR < 1.35\%)$$

$$VR_{calc}\ (b) = -0.6\ MPI + 2.3\ (\text{for } VR > 1.35\%)$$

$$MPR = \frac{2\text{-}MP}{1\text{-}MP}$$

$$VR_{calc}\ (c) = 0.99\ \log_{10} MPR + 0.94\ (VR = 0.5\text{-}1.7\%)$$

$$DNR = \frac{2,6\text{-}DMN + 2,7\text{-}DMN}{1,5\text{-}DMN}$$

$$VR_{calc}\ (d) = 0.046\ DNR + 0.89\ (\text{for } VR = 0.9\text{-}1.5\%)$$

Where
- P = phenanthrene
- 1-MP = 1-methylphenanthrene
- 2-MP = 2-methylphenanthrene
- 3-MP = 3-methylphenanthrene
- 9-MP = 9-methylphenanthrene
- 1,5-DMN = 1,5-dimethylnaphthalene
- 2,6-DMN = 2,6-dimethylnaphthalene
- 2,7-DMN = 2,7-dimethylnaphthalene

Peak areas measured from m/z 156 (dimethylnaphthalene), m/z 178 (phenanthrene) and m/z 192 (methylphenanthrene) mass fragmentograms of diaromatic and triaromatic hydrocarbon fraction isolated by thin layer chromatography.

Recalibration of the methylphanthrene index using data from a suite of Australian coals has given rise to another equation for calculated vitrinite reflectance (after Boreham *et al.*, 1988):

$$VR_{calc}\ (e) = 0.7\ MPI + 0.22\ (\text{for } VR < 1.7\%)$$

The methylphenanthrene distribution ratio (MPDF) and calculated vitrinite reflectance VR_{calc} (f) is derived from the following equation (after Kvalheim *et al.*, 1987):

$$MPDF = \frac{(2\text{-}MP + 3\text{-}MP)}{(2\text{-}MP + 3\text{-}MP + 1\text{-}MP + 9\text{-}MP)}$$

$$VR_{calc}\ (f) = -0.166 + 2.242\ MPDF$$

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FIGURES 8 - 16

MASS FRAGMENTOGRAMS OF NAPHTHENES IN WINDERMERE -2, DST 2A, OIL SHOW

Figs 8,9	m/z	217, 259	Steranes, diasteranes
Figs 10	m/z	231	4-methyl steranes
Figs 11	m/z	83	Alkylcyclohexanes
	m/z	183	Isoprenoid alkanes
Figs 12,13	m/z	191	Tricyclic & Tetracyclic Terpanes
Fig 14	m/z	123	Drimanes, rearranged drimanes
Figs 15,16	m/z	123	Diterpanes

FIGURE 8

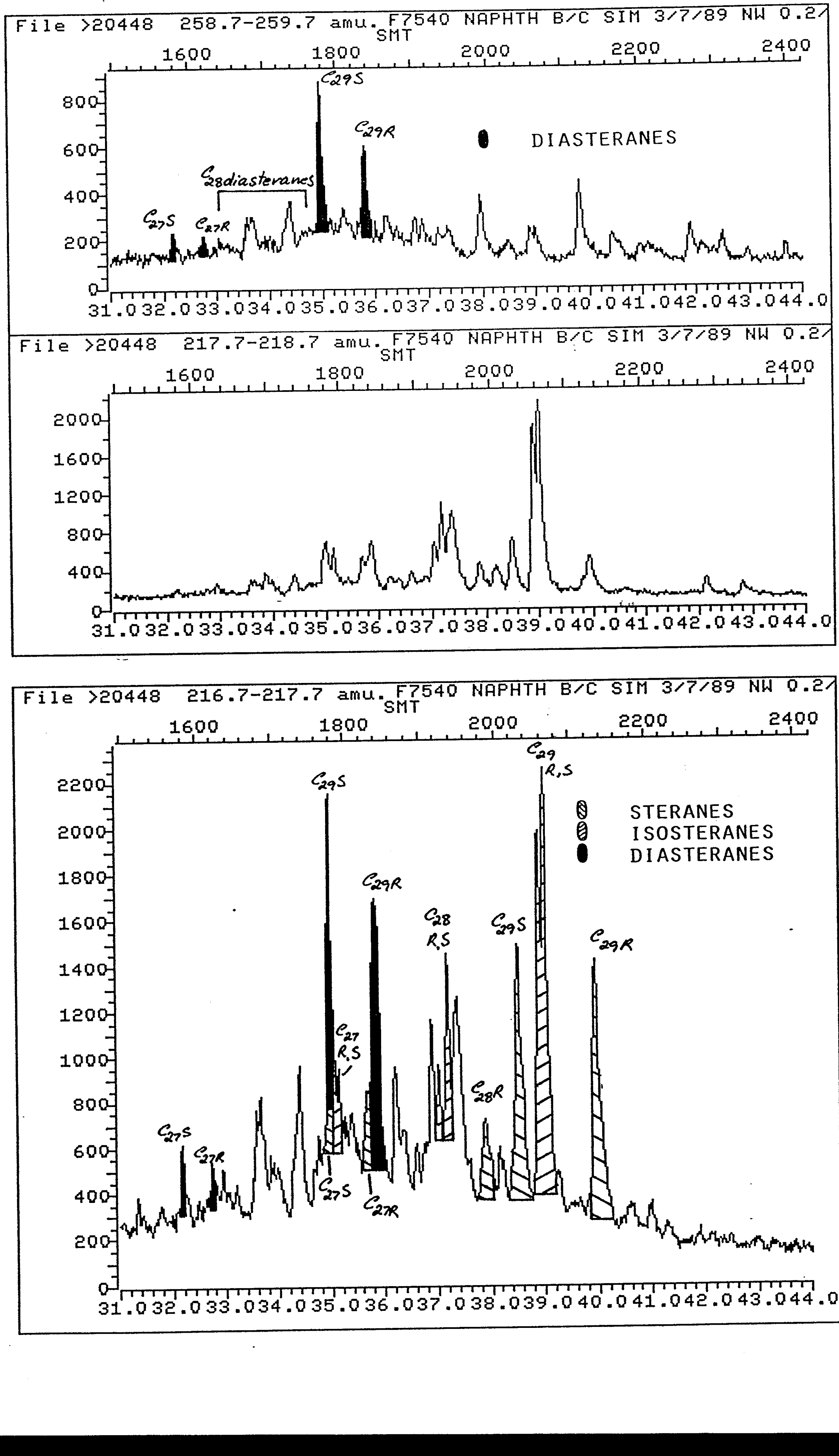

File >20448 258.7-259.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
1600 1800 2000 2200 2400
0 200 400 600 800
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
C29S
C29R
C28diasteranes
C27S
C27R
DIASTERANES
File >20448 217.7-218.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
1600 1800 2000 2200 2400
0 400 800 1200 1600 2000
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
File >20448 216.7-217.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
1600 1800 2000 2200 2400
0 200 400 600 800 1000 1200 1400 1600 1800 2000 2200
31.0 32.0 33.0 34.0 35.0 36.0 37.0 38.0 39.0 40.0 41.0 42.0 43.0 44.0
STERANES
ISOSTERANES
DIASTERANES
C29S
C29R
C28 R,S
C29S
C29 R,S
C29R
C27 R,S
C28R
C27S
C27R
C27S
C27R

FIGURE 9

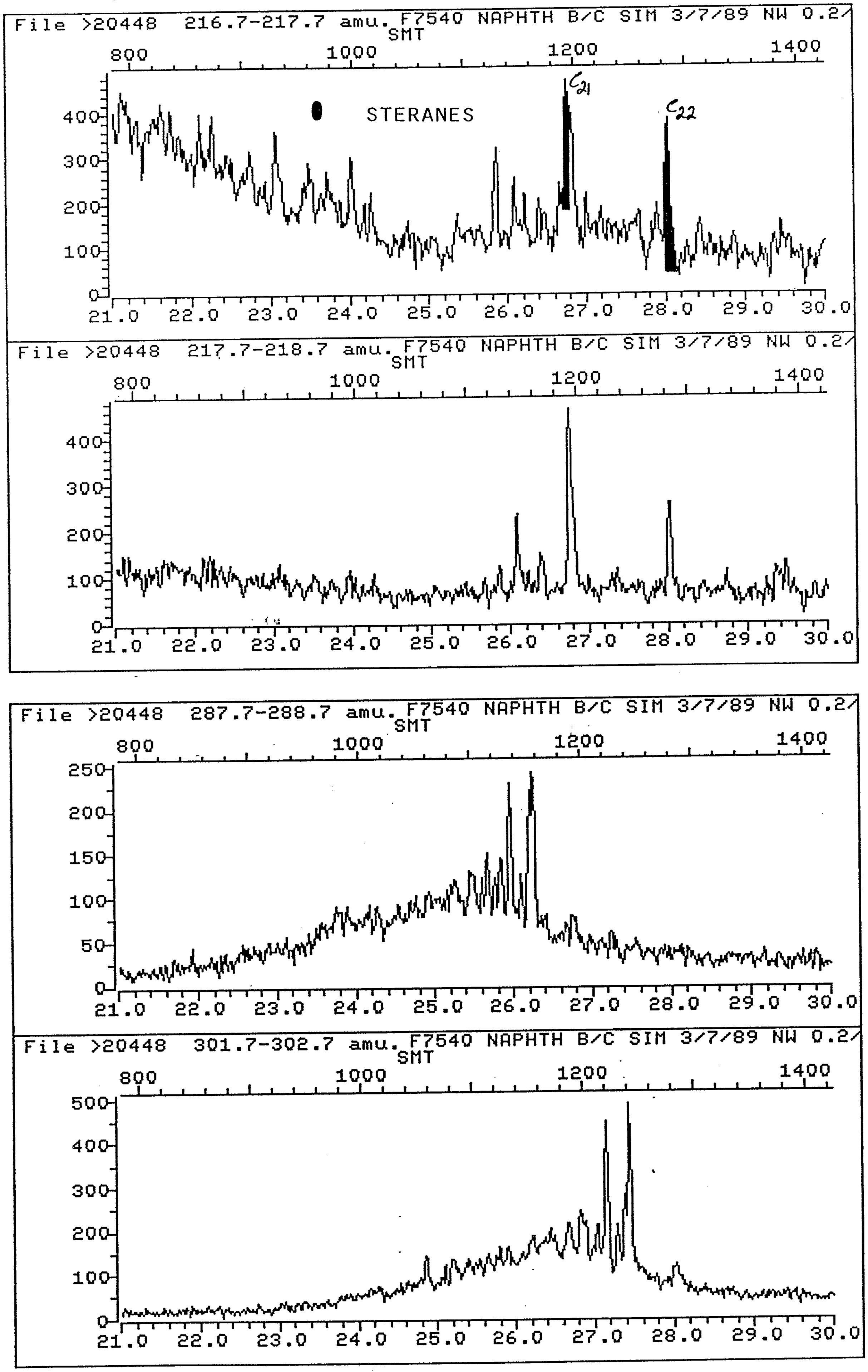
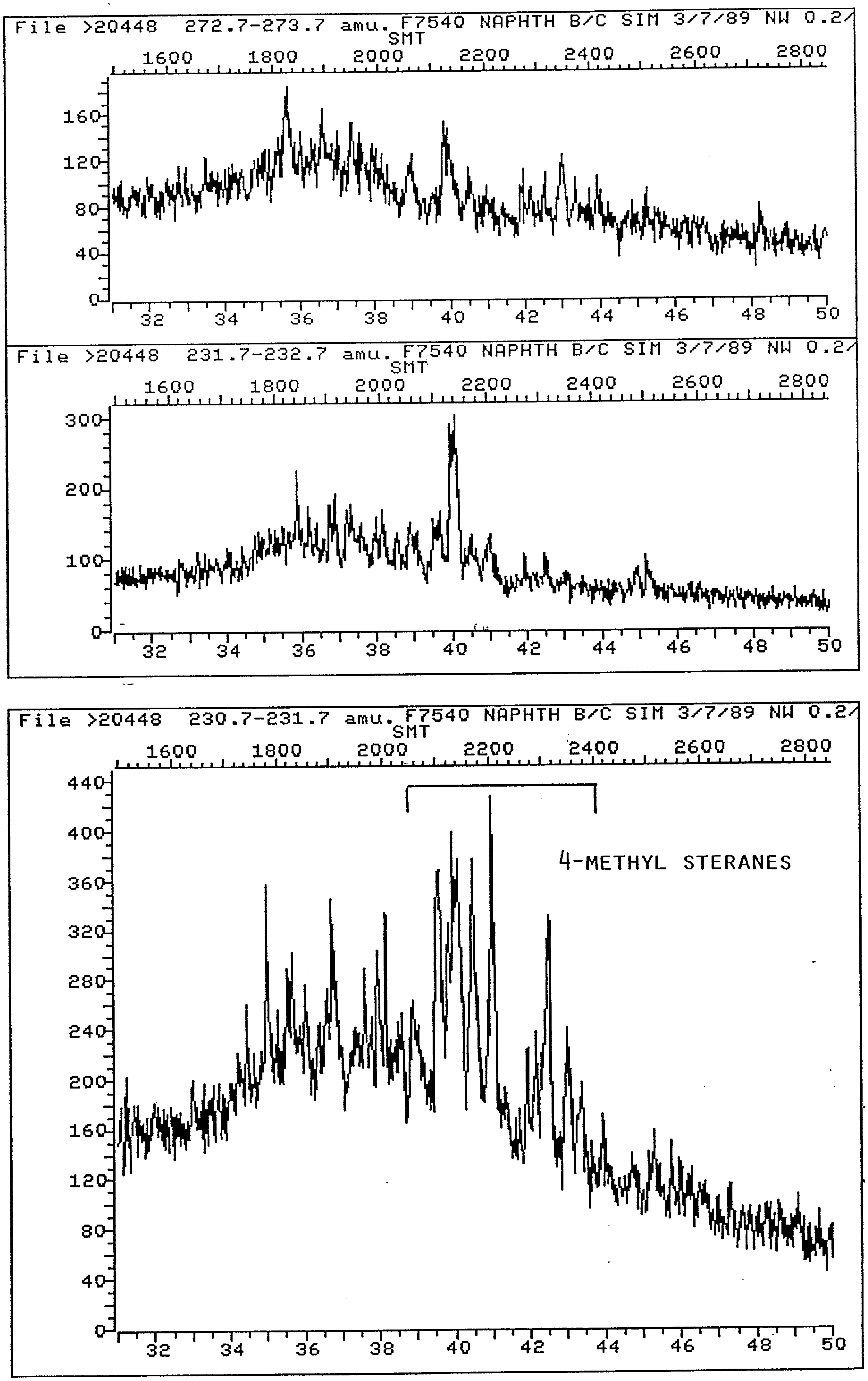
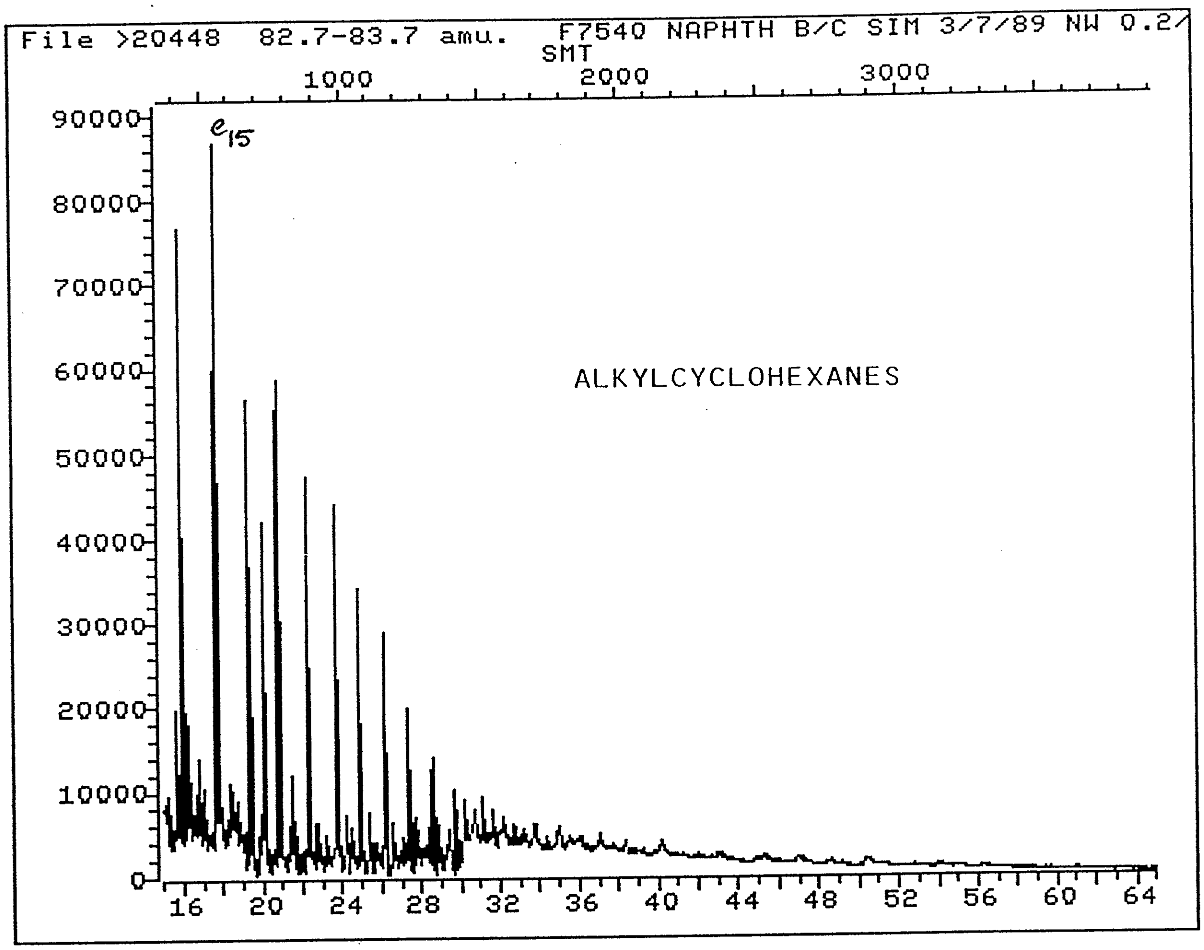

File >20448 216.7-217.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
STERANES
C21
C22
File >20448 217.7-218.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 287.7-288.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 301.7-302.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
800
1000
1200
1400
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0
30.0

FIGURE 10



File >20448 272.7-273.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 231.7-232.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 230.7-231.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
4-METHYL STERANES

FIGURE 11


File >20448 82.7-83.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
1000
2000
3000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
16
20
24
28
32
36
40
44
48
52
56
60
64
ALKYLCYCLOHEXANES

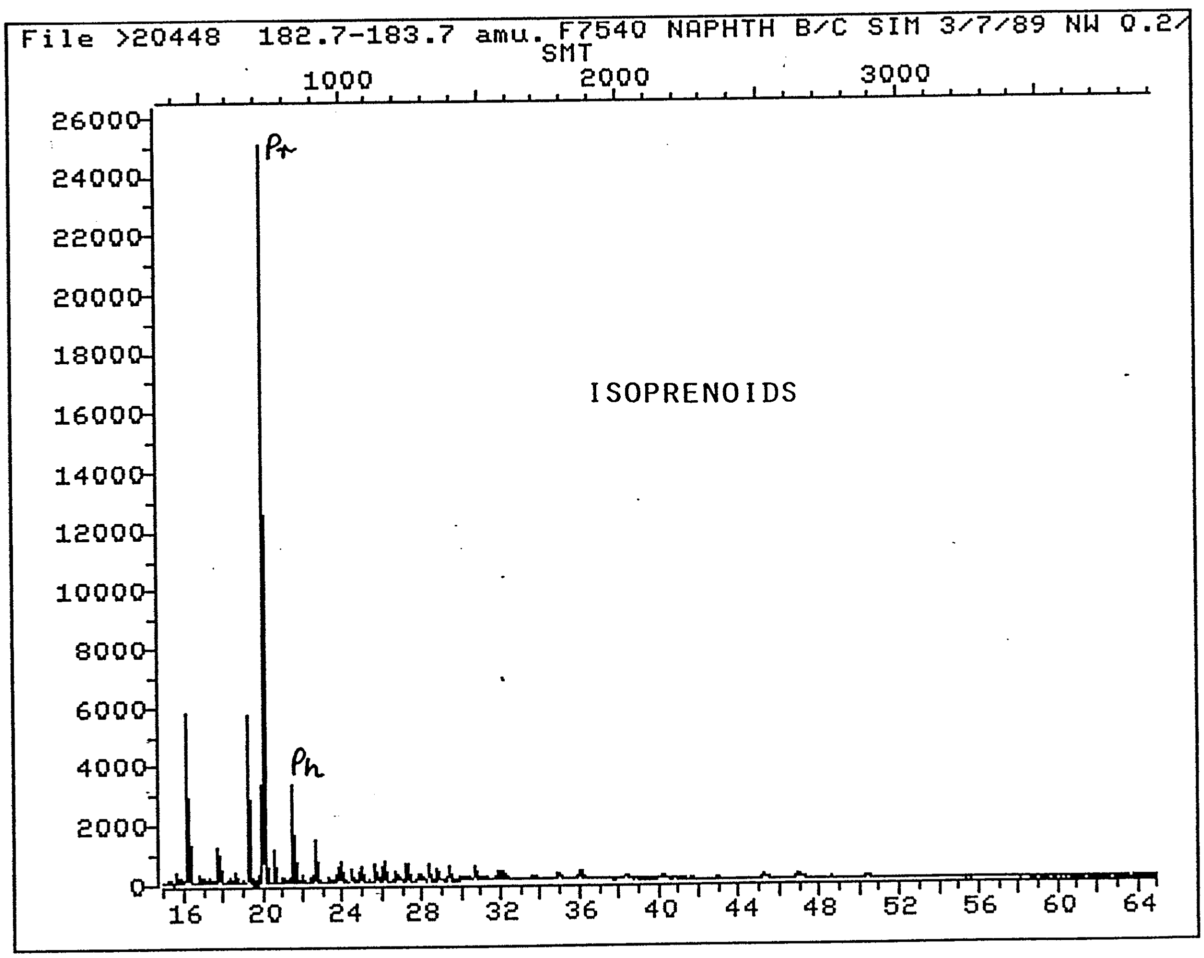

File >20448 182.7-183.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
1000
2000
3000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
16
20
24
28
32
36
40
44
48
52
56
60
64
ISOPRENOIDS

FIGURE 12

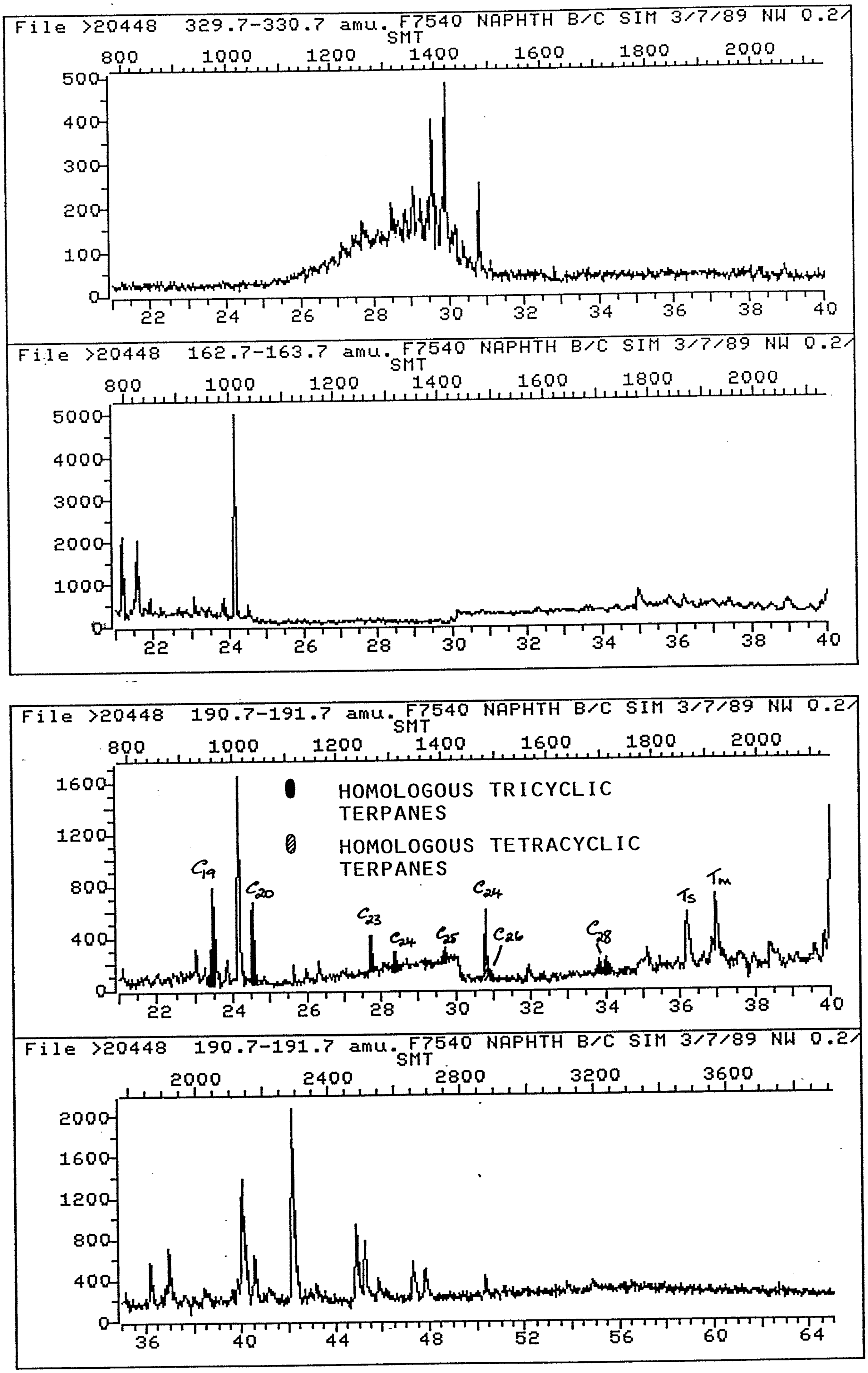

File >20448 329.7-330.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 162.7-163.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 190.7-191.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
HOMOLOGOUS TRICYCLIC TERPANES
HOMOLOGOUS TETRACYCLIC TERPANES
C19
C20
C23
C24
C25
C24
C26
C28
Ts
Tm
File >20448 190.7-191.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT

FIGURE 13

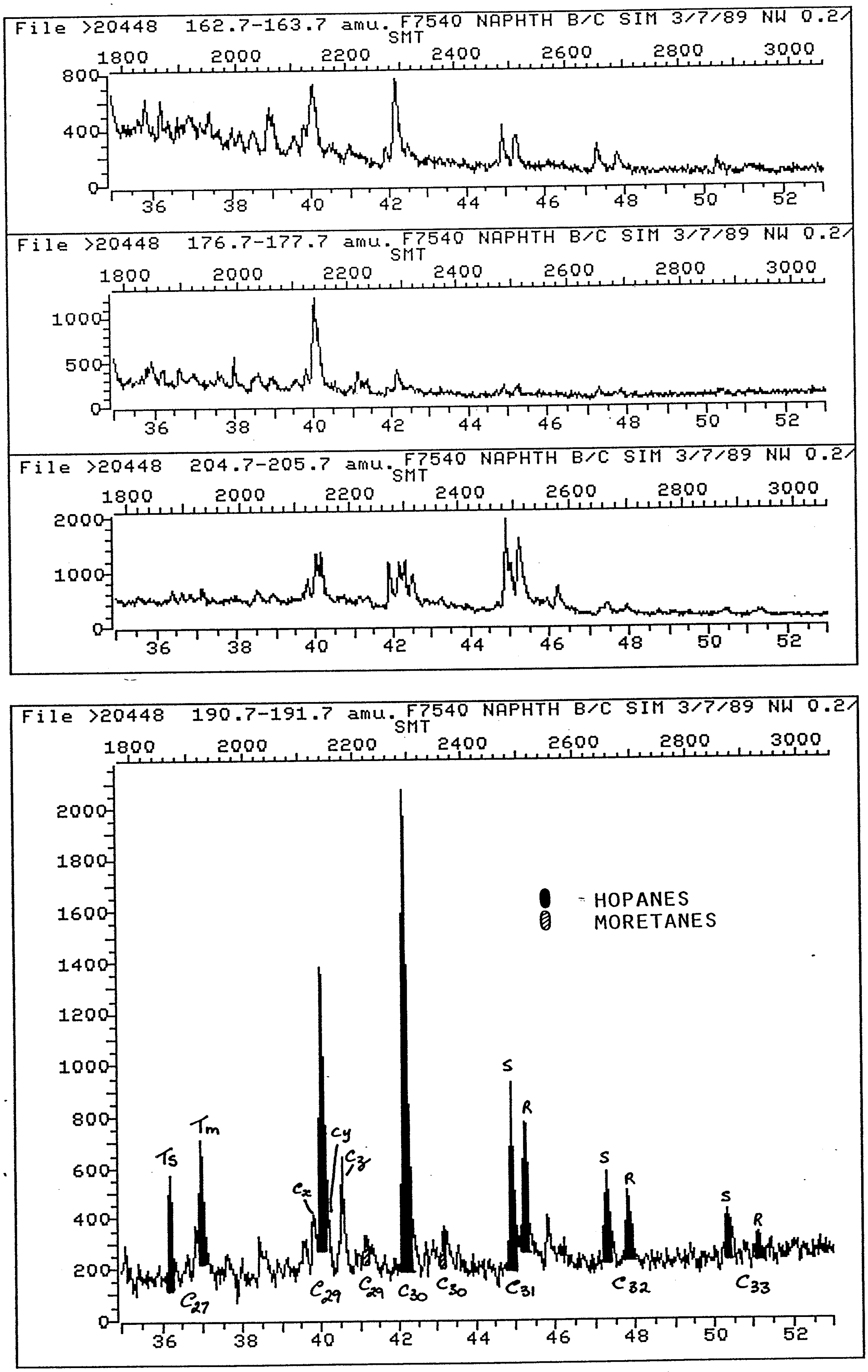

File >20448 162.7-163.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/ SMT
File >20448 176.7-177.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/ SMT
File >20448 204.7-205.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/ SMT
File >20448 190.7-191.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/ SMT
HOPANES
MORETANES
Ts
Tm
C27
Cx
Cy
Cz
C29
C29
C30
C30
S
R
C31
S
R
C32
S
R
C33

FIGURE 14

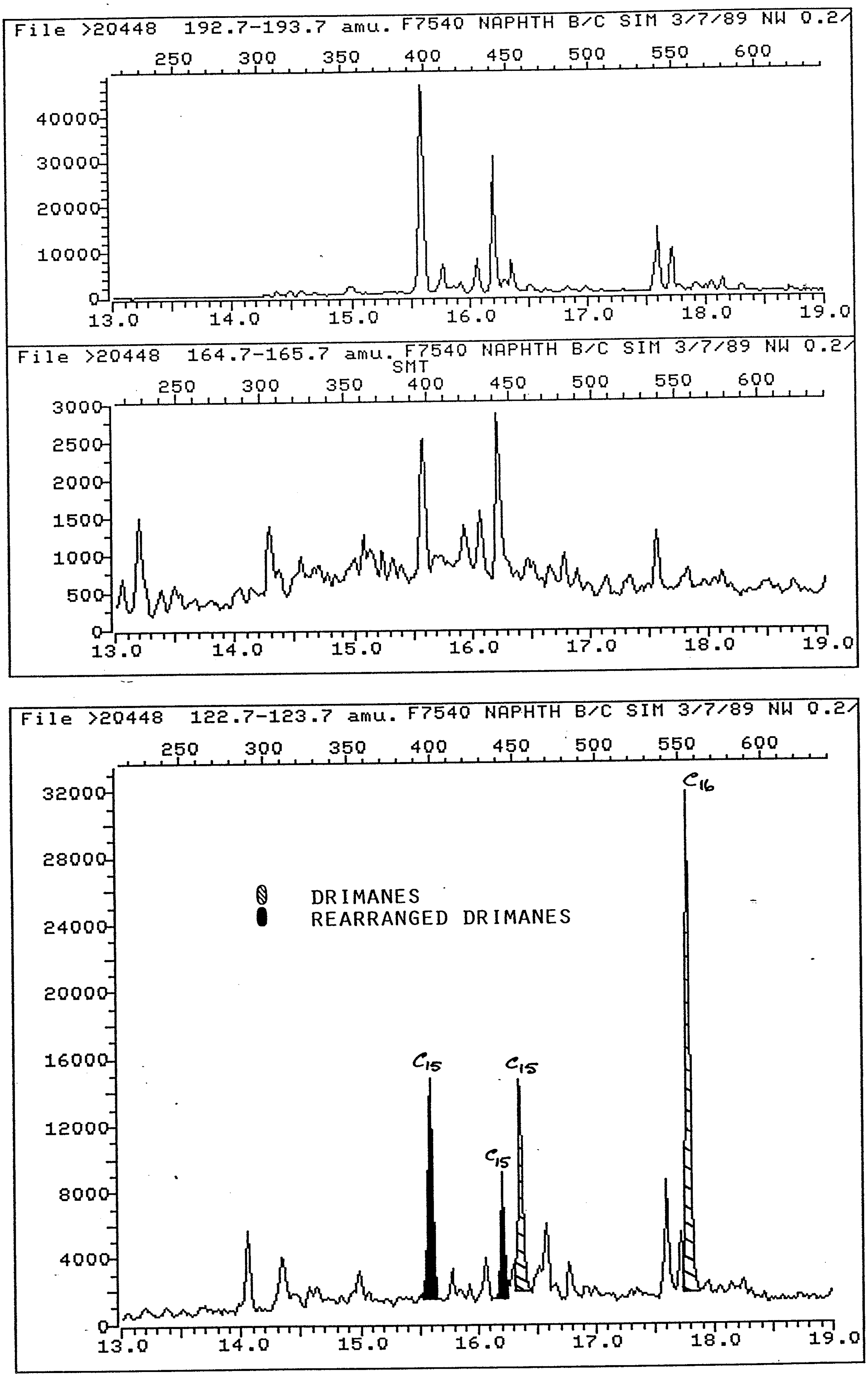
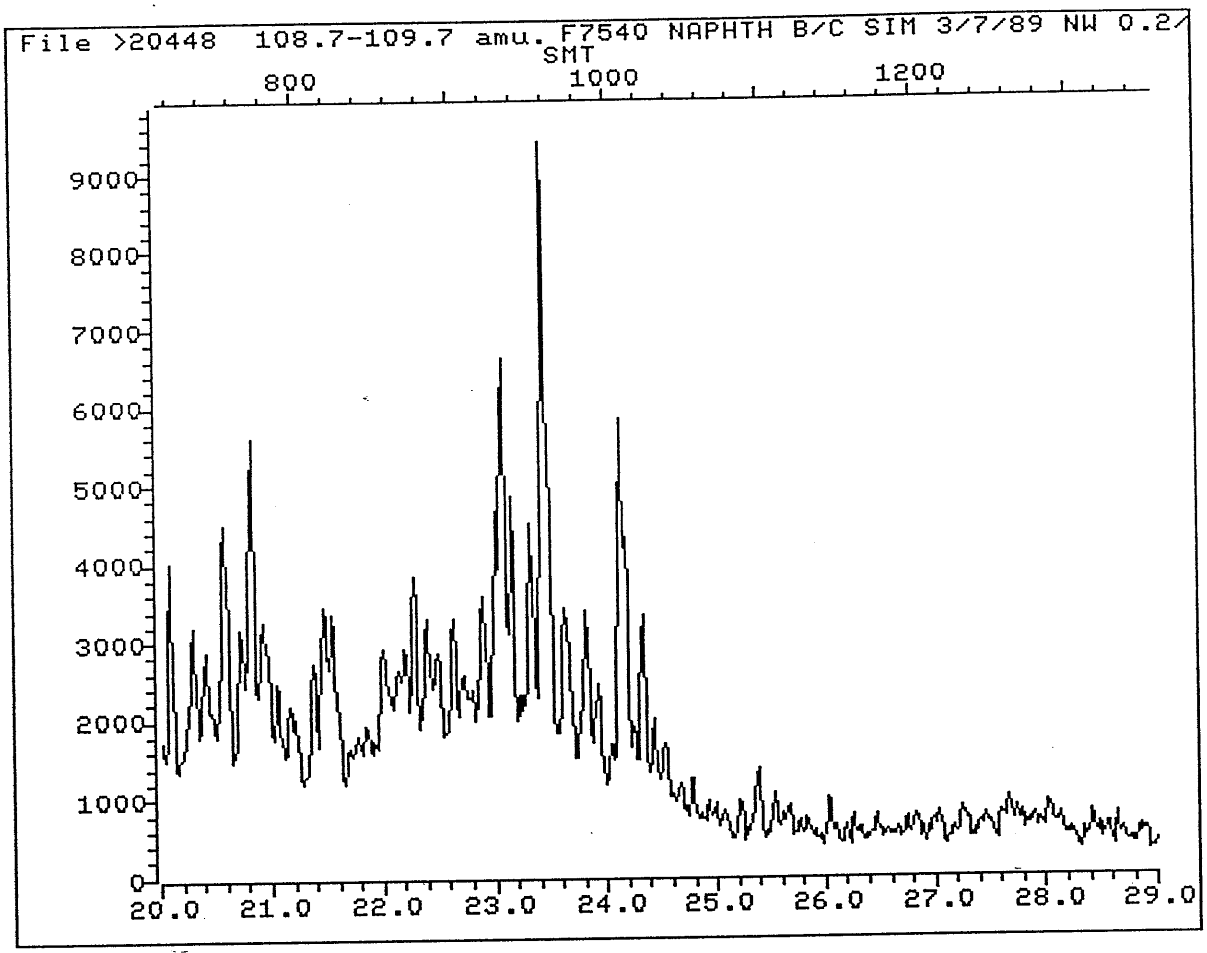
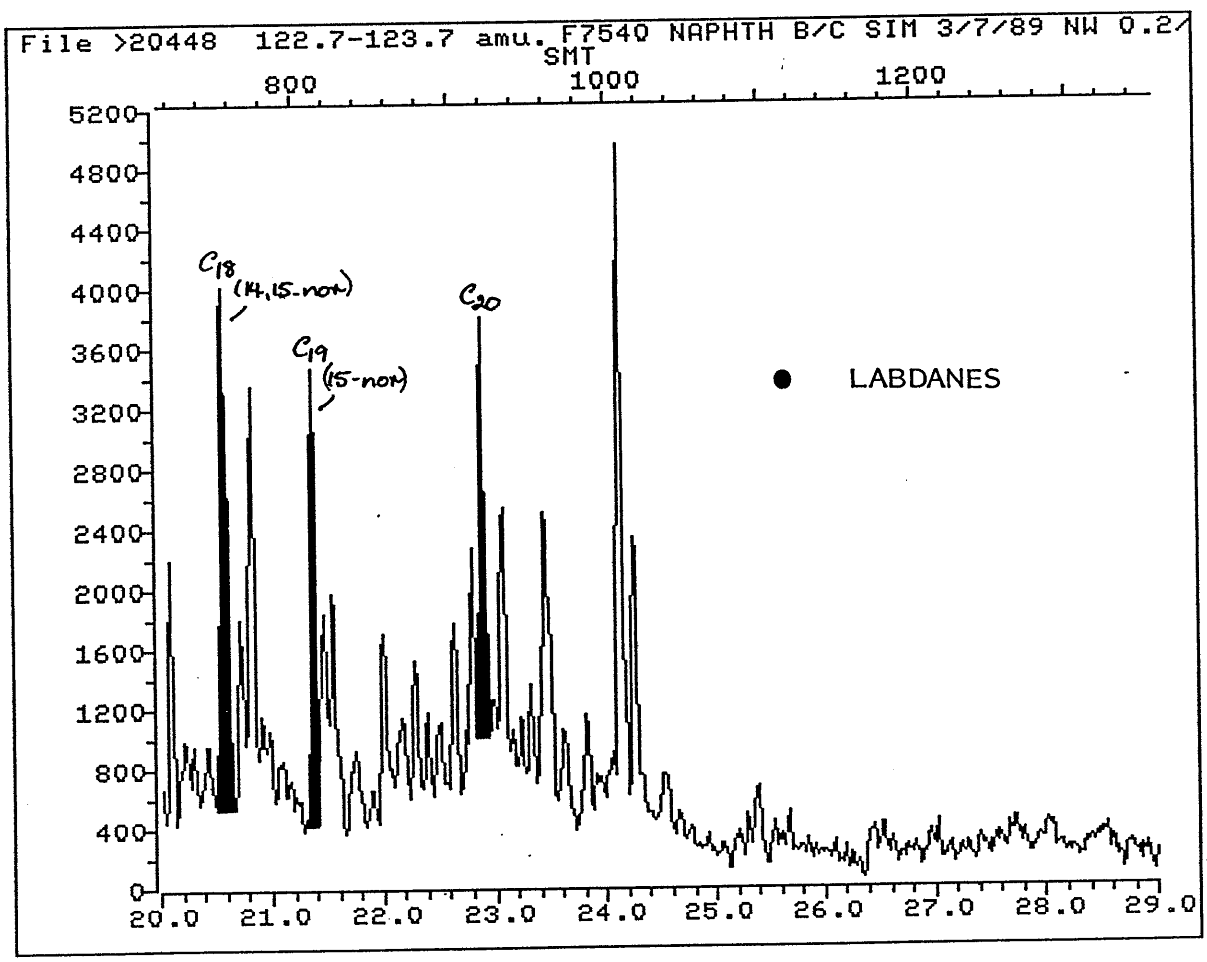

File >20448 192.7-193.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
250 300 350 400 450 500 550 600
40000 30000 20000 10000 0
13.0 14.0 15.0 16.0 17.0 18.0 19.0
File >20448 164.7-165.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
250 300 350 400 450 500 550 600
3000 2500 2000 1500 1000 500 0
13.0 14.0 15.0 16.0 17.0 18.0 19.0
File >20448 122.7-123.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
250 300 350 400 450 500 550 600
32000 28000 24000 20000 16000 12000 8000 4000 0
DRIMANES
REARRANGED DRIMANES
C15
C15
C15
C16
13.0 14.0 15.0 16.0 17.0 18.0 19.0

FIGURE 15



File >20448 108.7-109.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
800
1000
1200
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0



File >20448 122.7-123.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
800
1000
1200
5200
4800
4400
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
C18 (14,15-nor)
C19 (15-nor)
C20
● LABDANES
20.0
21.0
22.0
23.0
24.0
25.0
26.0
27.0
28.0
29.0

FIGURE 16

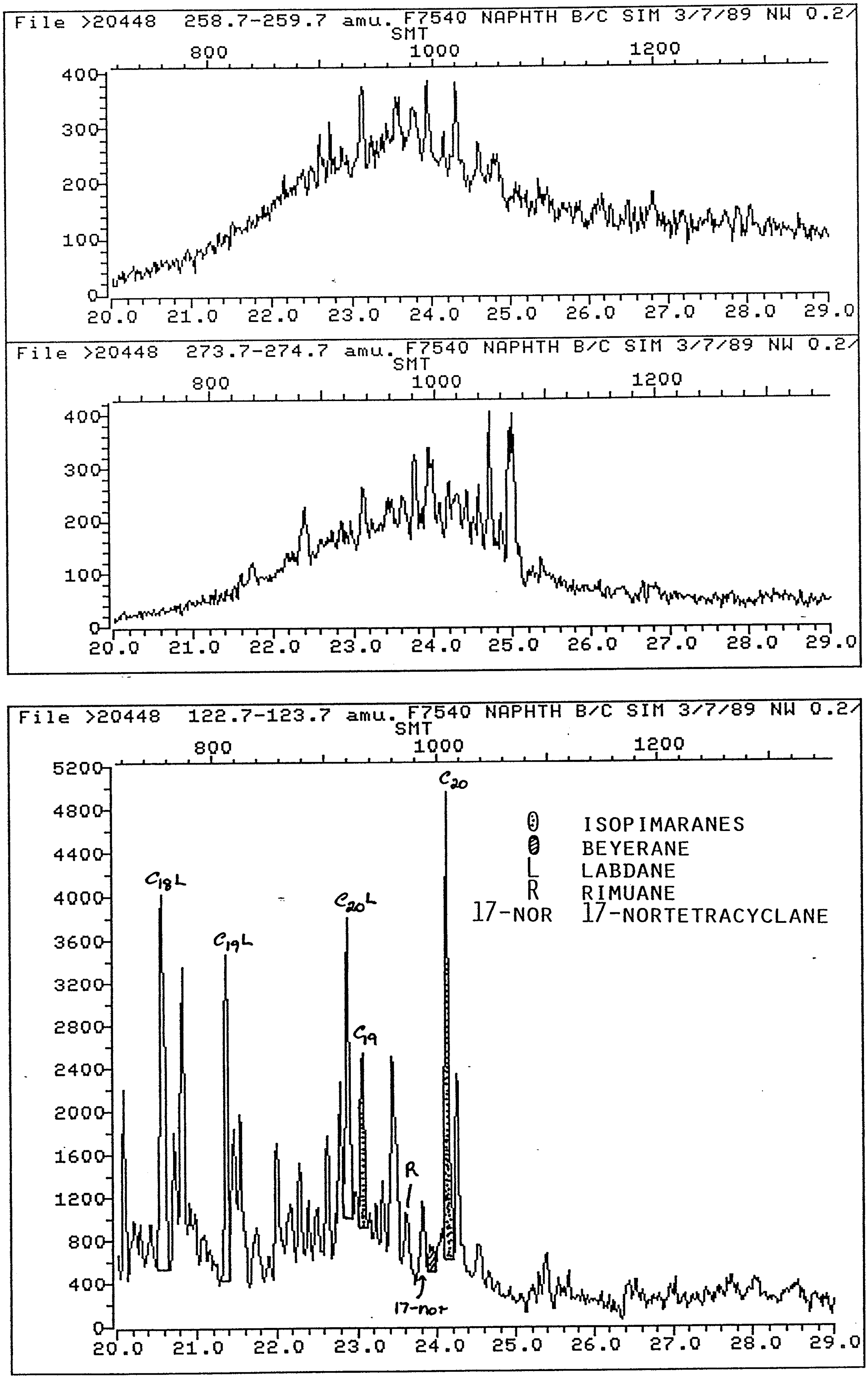
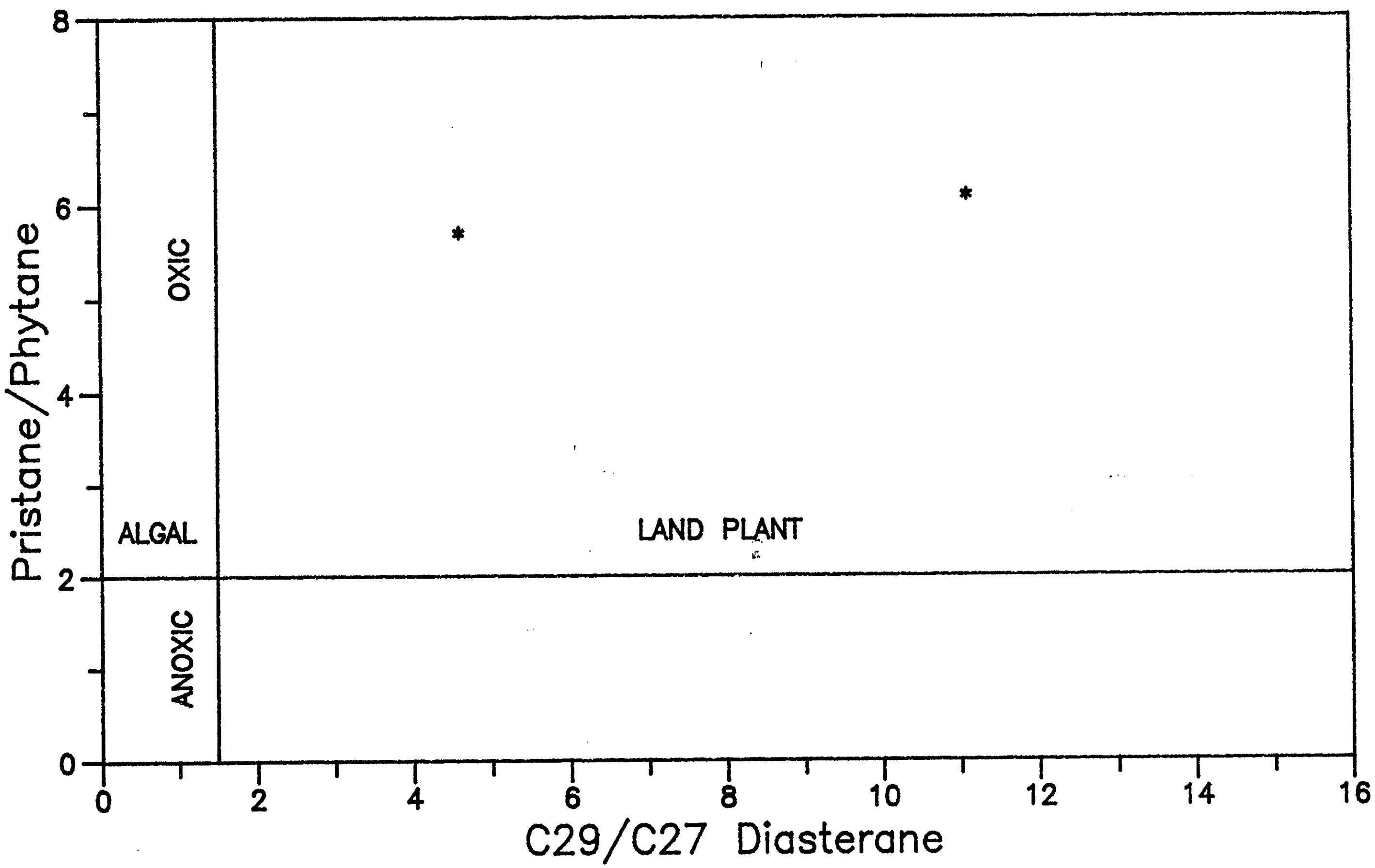

File >20448 258.7-259.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 273.7-274.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
File >20448 122.7-123.7 amu. F7540 NAPHTH B/C SIM 3/7/89 NW 0.2/
SMT
ISOPIMARANES
BEYERANE
L LABDANE
R RIMUANE
17-NOR 17-NORTETRACYCLANE
C18L
C19L
C20L
C19
C20
R
17-nor

FIGURE 17

WINDERMERE-1&2
OIL SOURCE AFFINITY



FIGURES 18, 19

MASS FRAGMENTOGRAMS OF AROMATIC HYDROCARBONS IN WINDERMERE -2,

DST 2A, OIL SHOW

Fig 18	m/z 178 + 191 + 192 + 205 + 206	
	phenanthrene, methylphenanthrenes, dimethylphenanthrenes	
Fig 19	m/z 156 + 169 + 170	
	dimethylnaphthalenes, trimethylnaphthalenes	

FIGURE 18

Chromatogram C:\ITD\GEN-156 Acquired: Jun-14-1989 21:43:14
Comment: WINDEMERE MPI RUN
Scan Range: 2780 - 3300 Scan: 2780 Int = 537 @ 46:21 100% = 58848

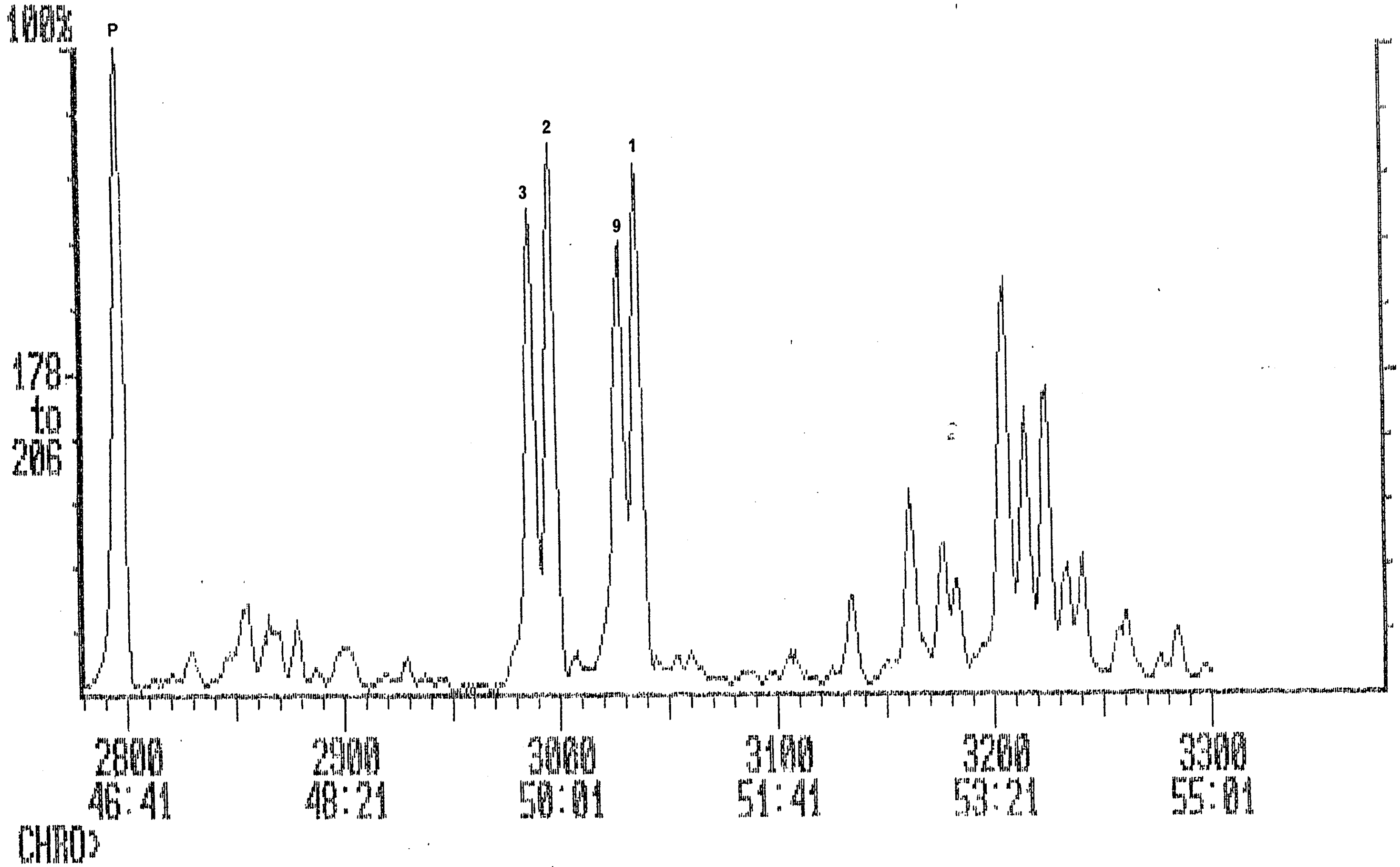
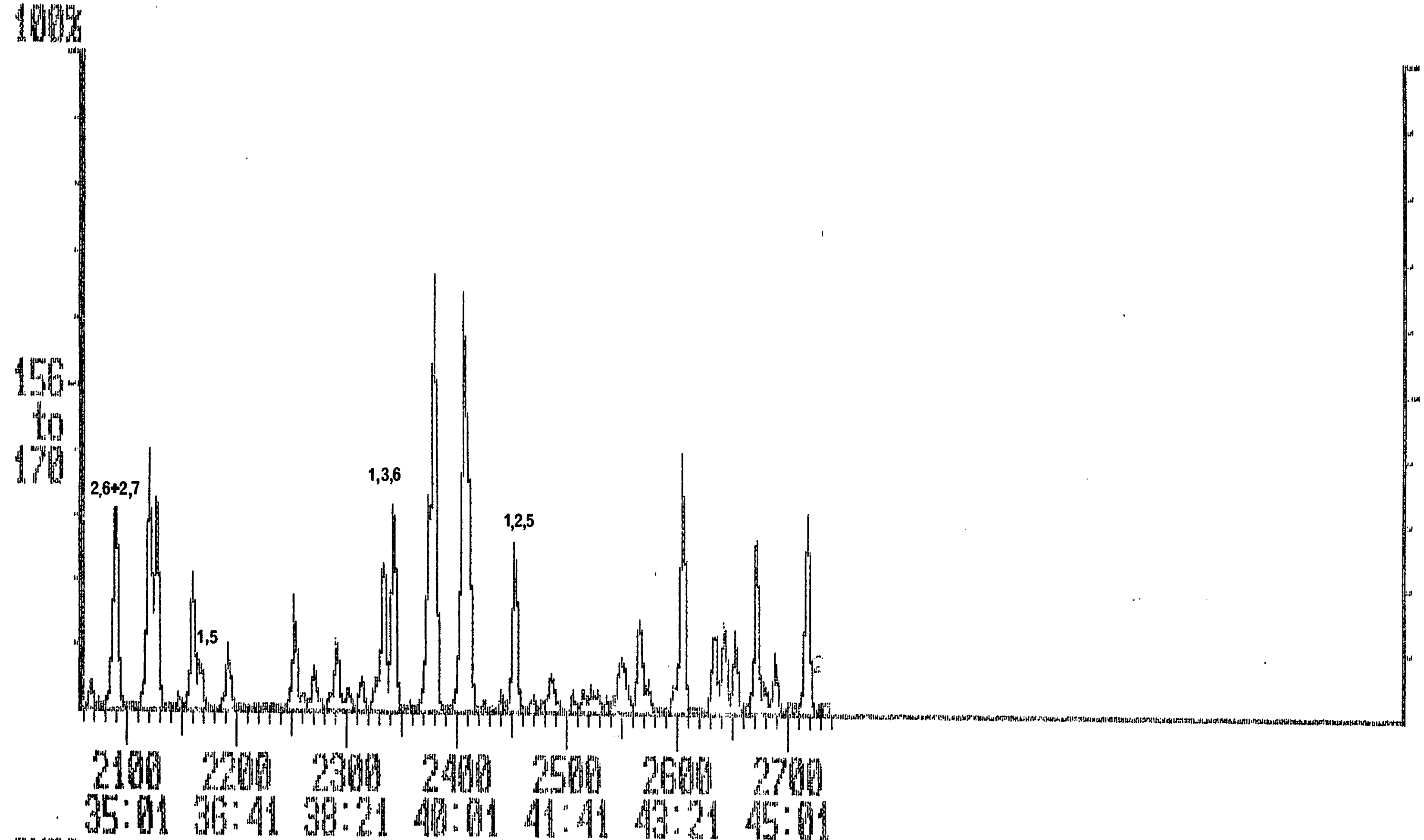


FIGURE 19

Chromatogram C:\ITD\GEN-15G Acquired: Jun-14-1989 21:43:14
Comment: WINDEMERE MPI RUN
Scan Range: 2060 - 2740 Scan: 2060 Int = 29 @ 34:21 100% = 14712



CHRO>

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APPENDIX 1

FORMATION TOPS, WINDERMERE -2

Unit	Depth (KB) metres
Gellibrnad Marl	100
Clifton Fm	357
Dilwyn Fm	425
Pember Mudstone	667.2
Pebble Point Fm	715.5
Paaratte Fm	750
Belfast Mudstone	950
Eumeralla Fm	
- Upper	1009.3
- Middle	1170
- Heathfield sst Mbr	?1671
- Lower	1806.6
- Basal sst Mbr	?3187
Crayfish Fm	?3359
TD	3595

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APPENDIX 2

HISTOGRAMS OF VITRINITE REFLECTANCE MEASUREMENTS, WINDERMERE -2

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 1876 m

Sorted List

0.26
0.30
0.32
0.32
0.43
0.43

Number of values= 6

Mean of values 0.34
Standard Deviation 0.06

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

26-28	*
29-31	*
32-34	**
35-37	
38-40	
41-43	**

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 2352 m

Sorted List

0.37	0.48	0.53
0.39	0.49	0.54
0.40	0.49	0.54
0.40	0.49	0.58
0.41	0.51	0.61
0.42	0.51	0.62
0.46	0.52	0.63
0.46	0.53	
0.47	0.53	
0.47	0.53	

Number of values= 27

Mean of values 0.50
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

37-39	**
40-42	****
43-45	
46-48	*****
49-51	*****
52-54	*****
55-57	**
58-60	*
61-63	***

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 2697 m

Sorted List

0.42	0.56
0.42	0.56
0.44	0.58
0.45	0.60
0.48	0.61
0.50	0.63
0.50	0.65
0.51	0.70
0.54	0.73
0.54	

Number of values= 19

Mean of values 0.55
Standard Deviation 0.09

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

42-44	***
45-47	*
48-50	***
51-53	*
54-56	**
57-59	***
60-62	**
63-65	**
66-68	
69-71	*
72-74	*

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 2805-2810 m

Sorted List

0.61	0.73	0.80	0.86
0.65	0.74	0.80	0.87
0.67	0.74	0.80	0.91
0.68	0.74	0.81	
0.68	0.75	0.82	
0.69	0.76	0.82	
0.71	0.76	0.82	
0.71	0.79	0.83	
0.73	0.79	0.84	
0.73	0.80	0.86	

Number of values= 33

Mean of values 0.77
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

61-63	*
64-66	*
67-69	****
70-72	**
73-75	*******
76-78	**
79-81	*******
82-84	*****
85-87	***
88-90	
91-93	*

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 2955-2960

Sorted List

0.62	0.87
0.67	0.91
0.69	0.93
0.71	
0.76	
0.76	
0.79	
0.81	
0.82	
0.84	

Number of values= 13

Mean of values 0.78
Standard Deviation 0.09

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

62-64	*
65-67	*
68-70	*
71-73	*
74-76	**
77-79	*
80-82	**
83-85	*
86-88	*
89-91	*
92-94	*

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 3015 m

Sorted List

0.72	0.91
0.74	0.92
0.75	0.95
0.80	0.97
0.80	0.97
0.82	0.97
0.82	1.04
0.85	
0.87	
0.91	

Number of values= 17

Mean of values 0.87
Standard Deviation 0.09

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

72-74	**
75-77	*
78-80	**
81-83	**
84-86	*
87-89	*
90-92	***
93-95	*
96-98	***
99-101	
102-104	*

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 3245-3250 m

Sorted List

0.66	0.82
0.70	0.82
0.72	0.87
0.73	0.90
0.74	0.91
0.76	
0.76	
0.79	
0.80	
0.81	

Number of values= 15

Mean of values 0.79
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

66-68	*
69-71	*
72-74	***
75-77	**
78-80	**
81-83	***
84-86	
87-89	*
90-92	**

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 3335-3340 m

Sorted List

0.77	1.07
0.82	
0.84	
0.87	
0.88	
0.89	
0.89	
0.90	
1.03	
1.04	

Number of values= 11

Mean of values 0.91
Standard Deviation 0.09

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

77-79	*
80-82	*
83-85	*
86-88	**
89-91	***
92-94	
95-97	
98-100	
101-103	*
104-106	*
107-109	*

VITRINITE REFLECTANCE VALUES

Well Name: WINDERMERE-2
Depth: 3505-3510 m

Sorted List

0.69	0.75	0.83	0.88
0.70	0.76	0.84	0.90
0.71	0.76	0.84	0.91
0.71	0.78	0.85	0.91
0.72	0.81	0.86	
0.73	0.81	0.87	
0.74	0.81	0.87	
0.75	0.81	0.87	
0.75	0.83	0.87	
0.75	0.83	0.88	

Number of values= 34

Mean of values 0.81
Standard Deviation 0.07

HISTOGRAM OF VALUES
Reflectance values multiplied by 100

69-71	****
72-74	***
75-77	******
78-80	*
81-83	*******
84-86	****
87-89	******
90-92	***

amdel

APPENDIX 3

PHOTOMICROGRAPHS OF DISPERSED ORGANIC MATTER, WINDERMERE -2

PE907892

This is an enclosure indicator page.
The enclosure PE907892 is enclosed within the container PE902151 at this location in this document.

The enclosure PE907892 has the following characteristics:

ITEM_BARCODE =	PE907892
CONTAINER_BARCODE =	PE902151
NAME =	SEM Core Photograph
BASIN =	OTWAY
PERMIT =	PEP 111
TYPE =	WELL
SUBTYPE =	CORE_PHOTO
DESCRIPTION =	SEM Core Photographs Plate 1 & 2 (Enclosure from Appendix G--Petrological Report--of Well Completion Report vol.2) for Windermere-2
REMARKS =	
DATE_CREATED =	
DATE_RECEIVED =	9/11/89
W_NO =	W992
WELL_NAME =	Windermere-2
CONTRACTOR =	Amdel
CLIENT_OP_CO =	Minora Resources NL

(Inserted by DNRE - Vic Govt Mines Dept)

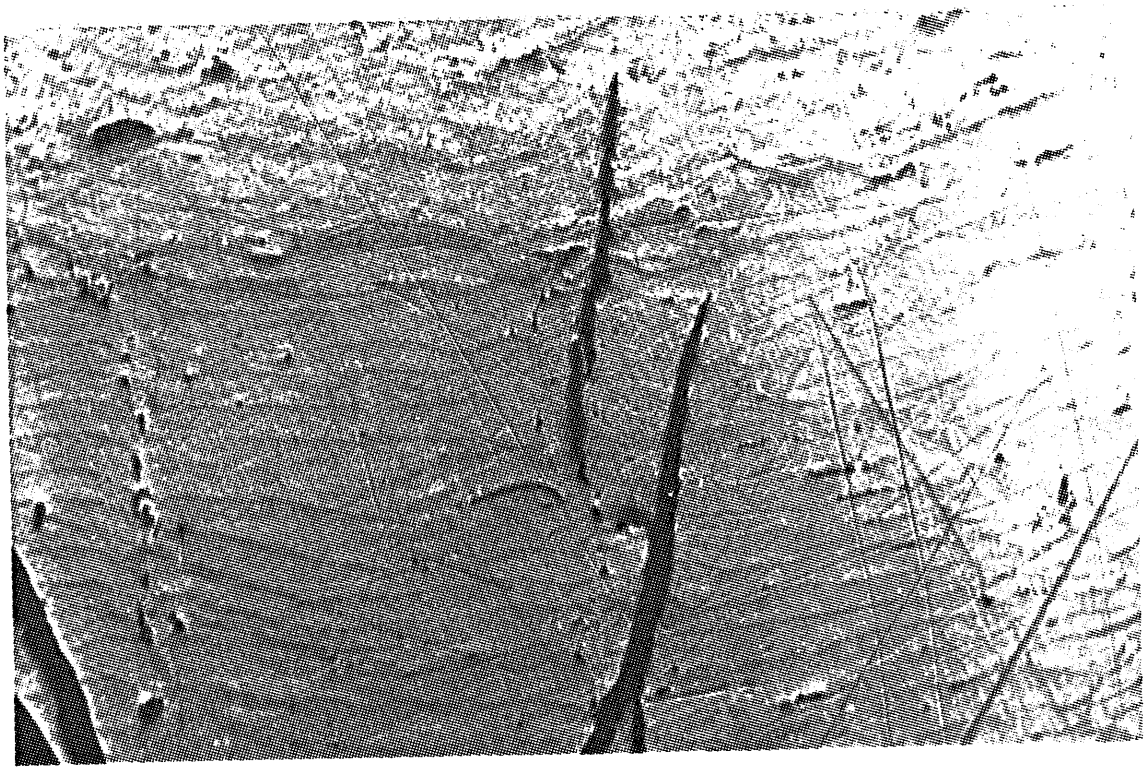


Plate 1: 3060 - 3065 m **Reflected Light**
Exsudatinite (primary oil; black veins) occurs with suberinite (moderate grey) in this vitrinite (light grey) rich shale.
Field Dimension: 0.26 x 0.18 mm

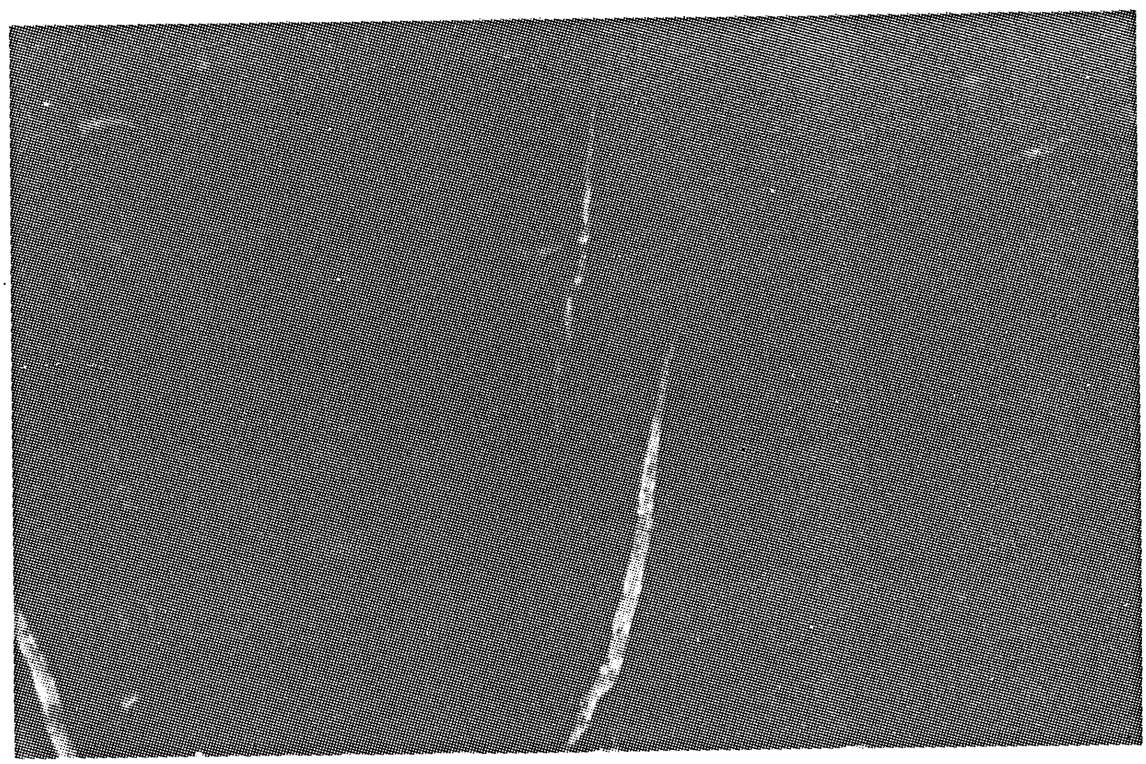


Plate 2: Same field as above **Fluorescence Mode**
Exsudatinite and liptodetrinite have a moderate orange fluorescence whilst suberinite fluorescence is notably "dull".

PE907893

This is an enclosure indicator page.
The enclosure PE907893 is enclosed within the container PE902151 at this location in this document.

The enclosure PE907893 has the following characteristics:

```
     ITEM_BARCODE = PE907893
CONTAINER_BARCODE = PE902151
             NAME =  SEM Core Photograph
            BASIN = OTWAY
           PERMIT = PEP 111
             TYPE = WELL
          SUBTYPE = CORE_PHOTO
      DESCRIPTION = SEM Core Photographs Plate 3 & 4
                    (Enclosure from Appendix
                    G--Petrological Report--of Well
                    Completion Report vol.2) for
                    Windermere-2
          REMARKS =
     DATE_CREATED =
    DATE_RECEIVED = 9/11/89
             W_NO = W992
        WELL_NAME = Windermere-2
       CONTRACTOR = Amdel
     CLIENT_OP_CO = Minora Resources NL
```

(Inserted by DNRE - Vic Govt Mines Dept)

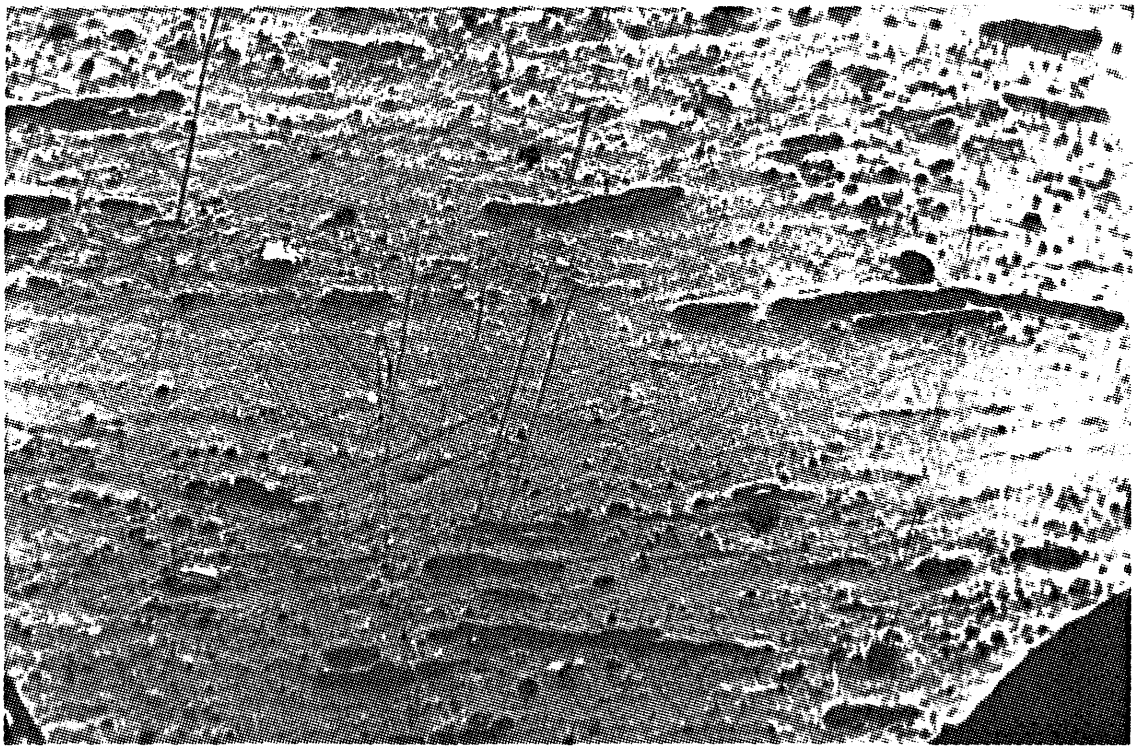


Plate 3: 3060 - 3065 m **Reflected Light**
This is a more typical field of view of this vitrinite rich coal.
Field Dimension: 0.26 x 0.18 mm

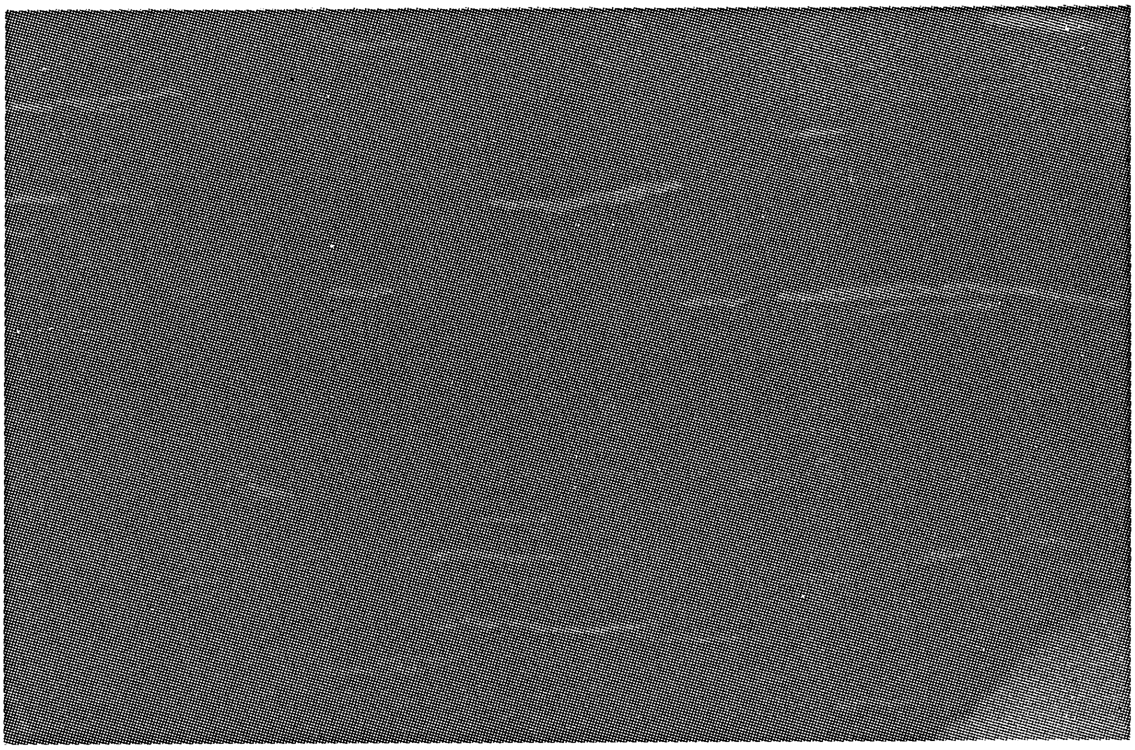


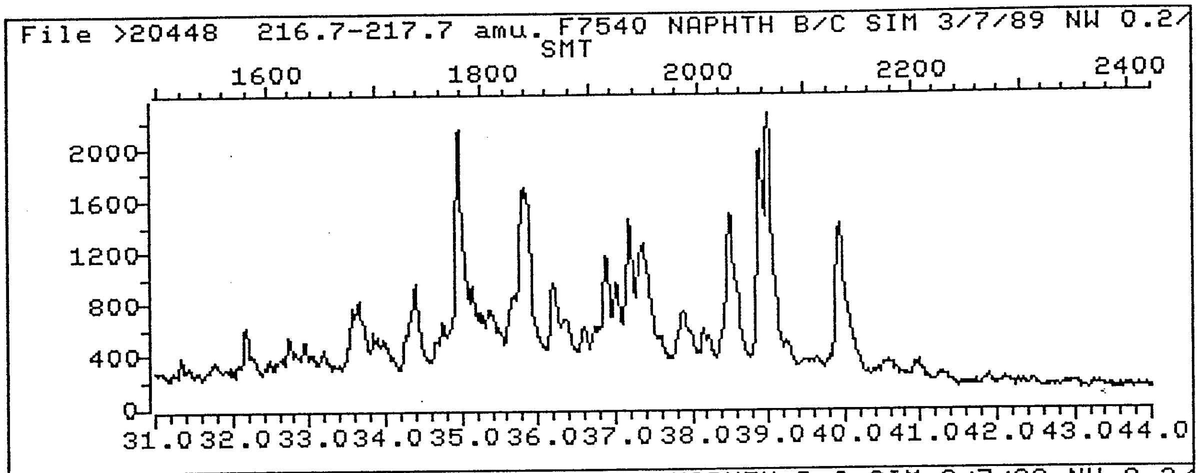
Plate 4: Same field as above **Fluorescence Mode**
The majority of the exinite in this coal consists of sporinite and liptodetrinite.

amdel

APPENDIX 4

OTHER MASS FRAGMENTOGRAMS OF NAPHTHENES IN OIL

FROM WINDERMERE -2, DST 2A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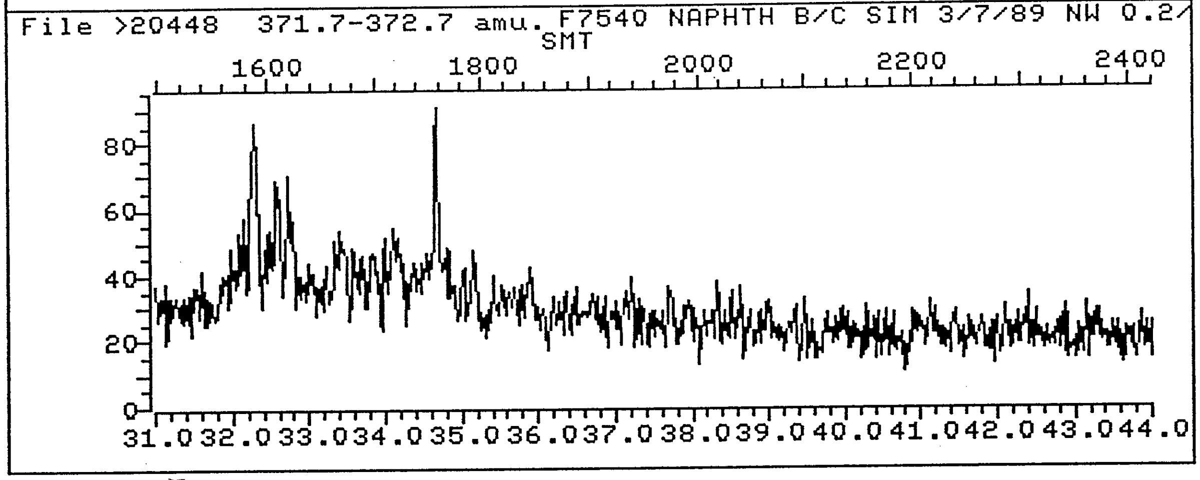
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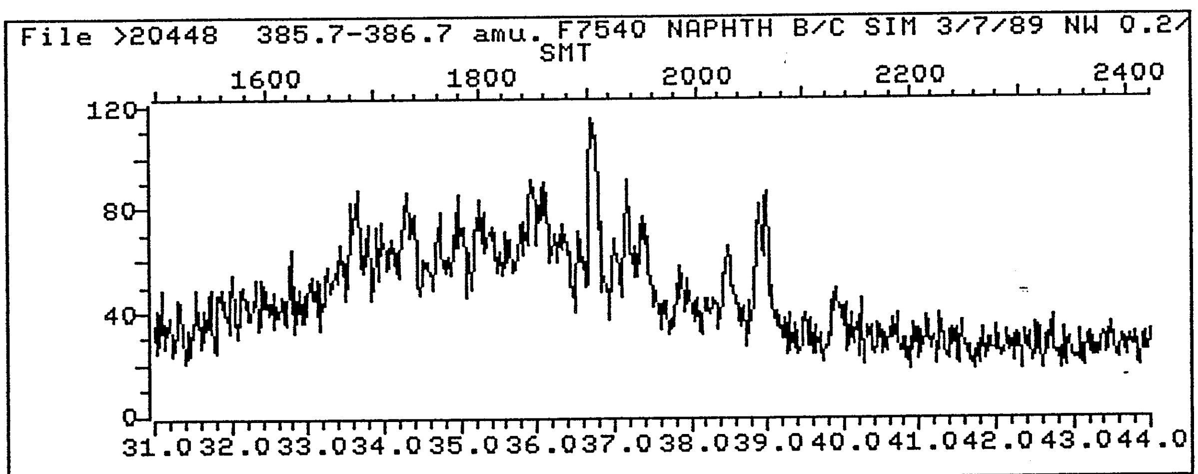
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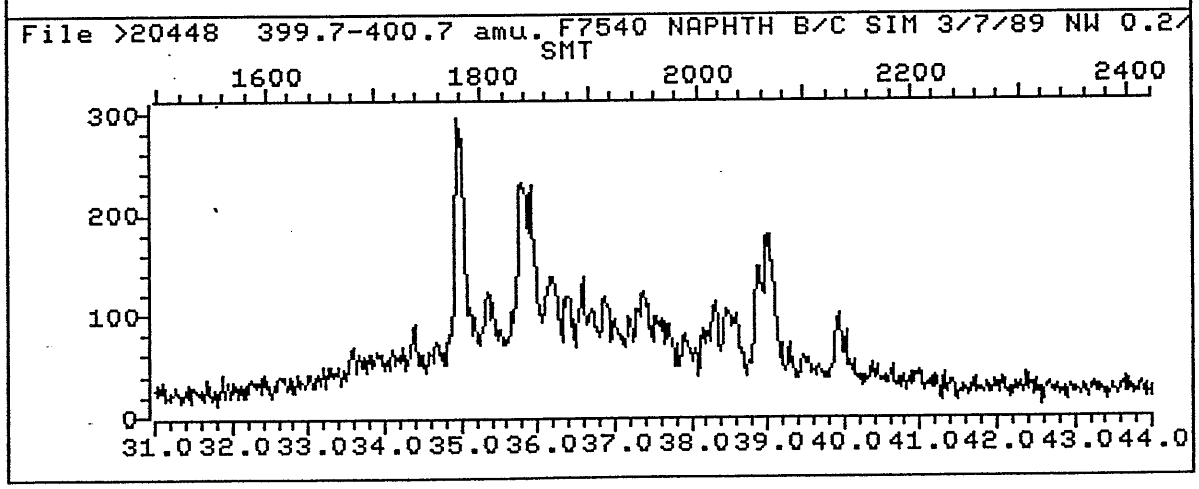
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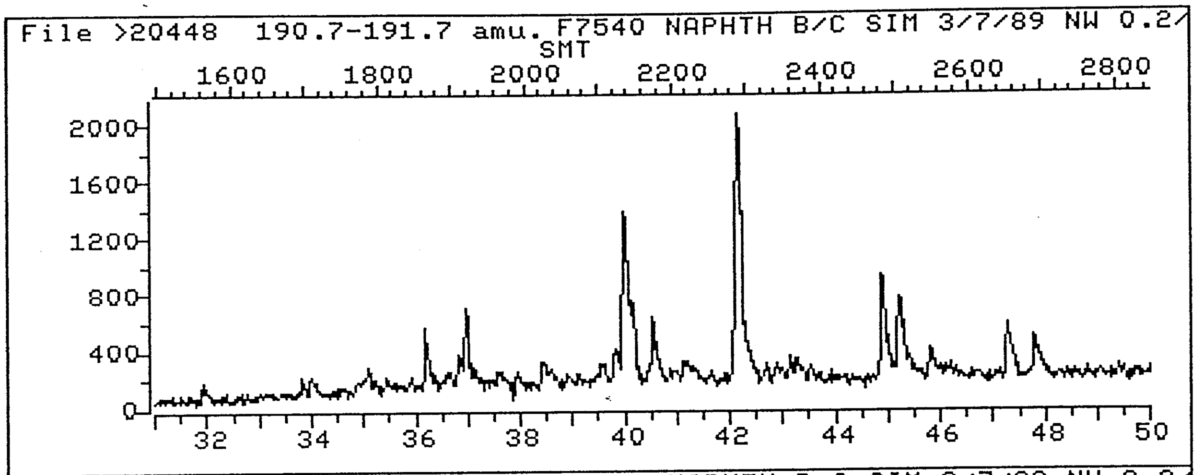
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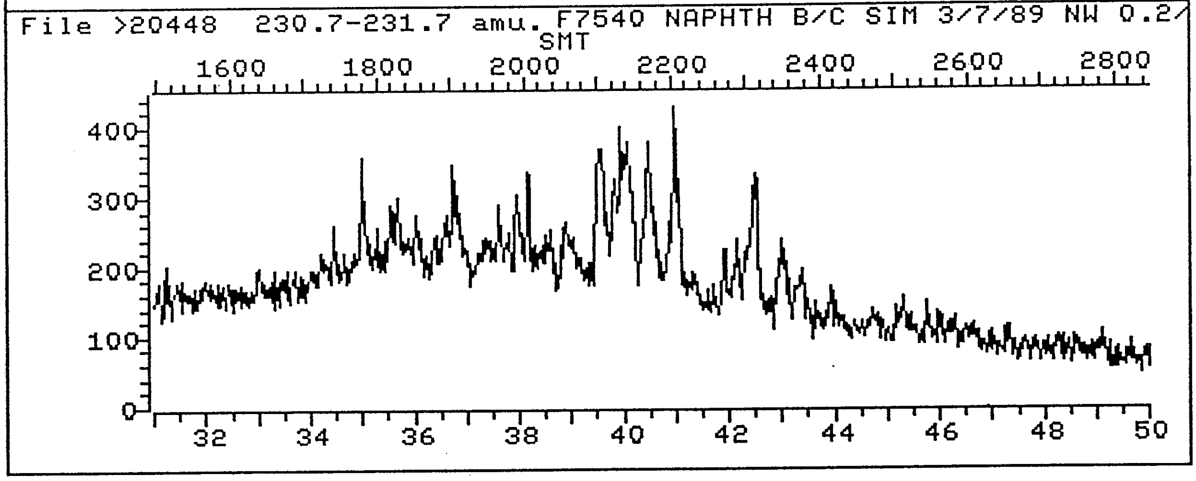
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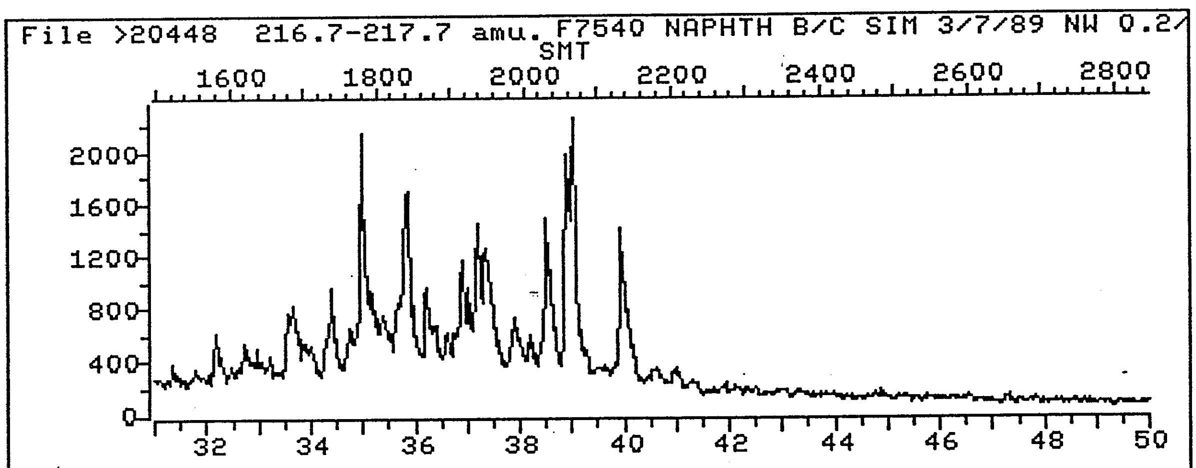
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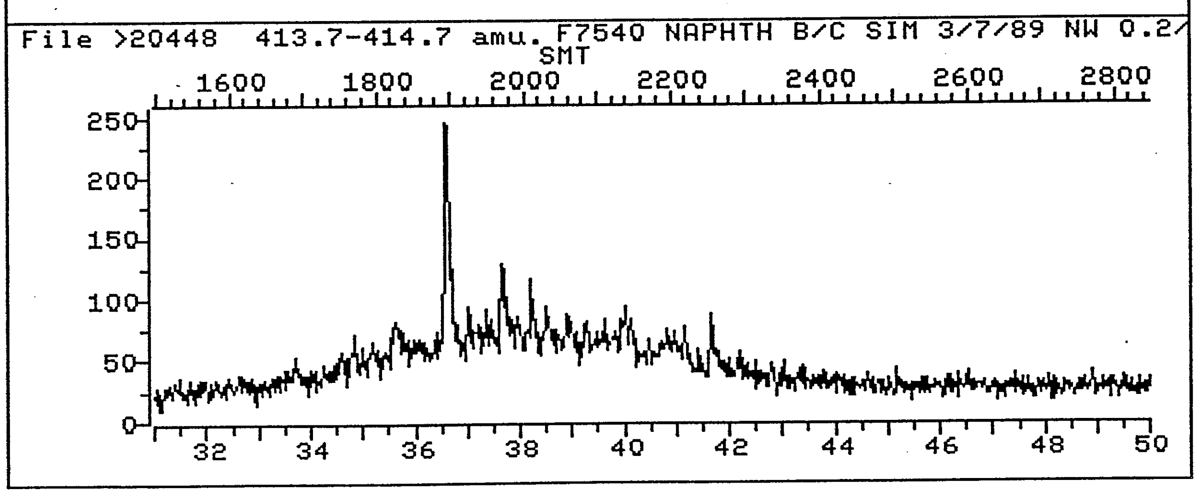
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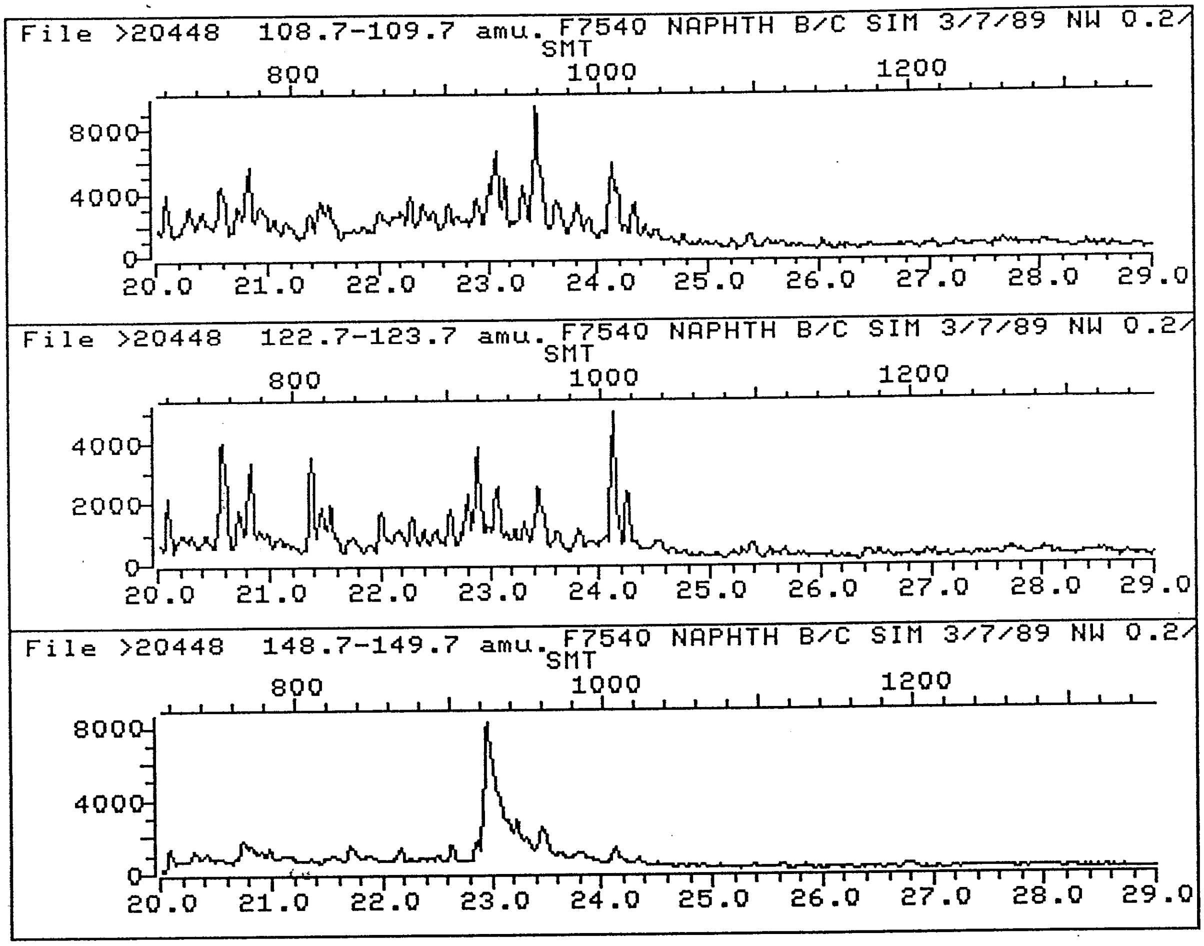
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4000 2000 0
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8000 4000 0
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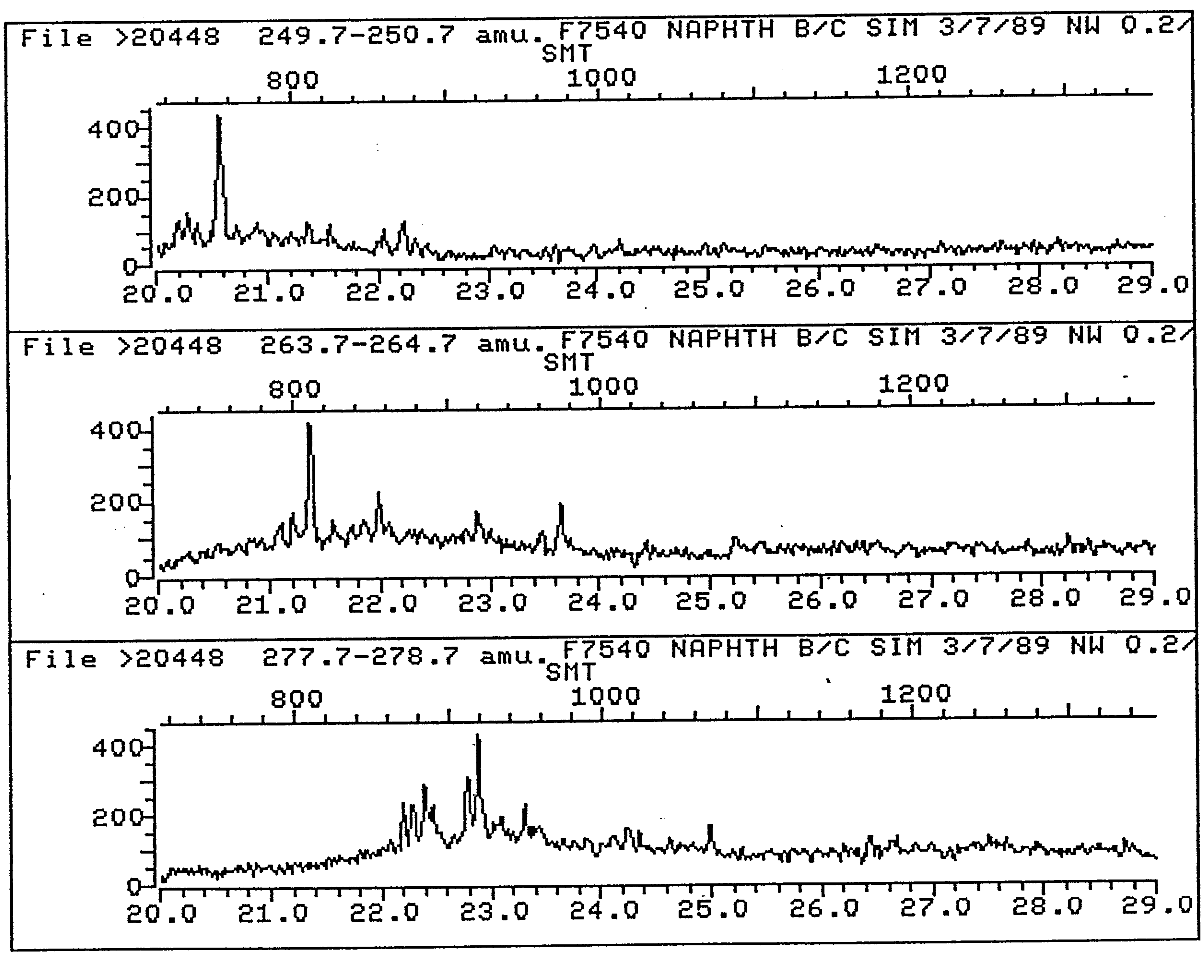
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400 200 0
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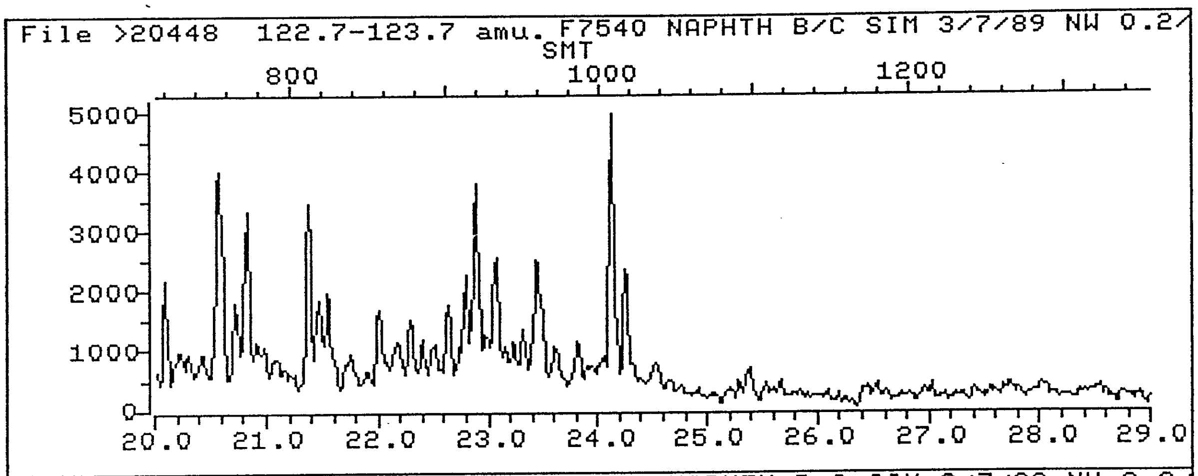
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1200
5000
4000
3000
2000
1000
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25.0
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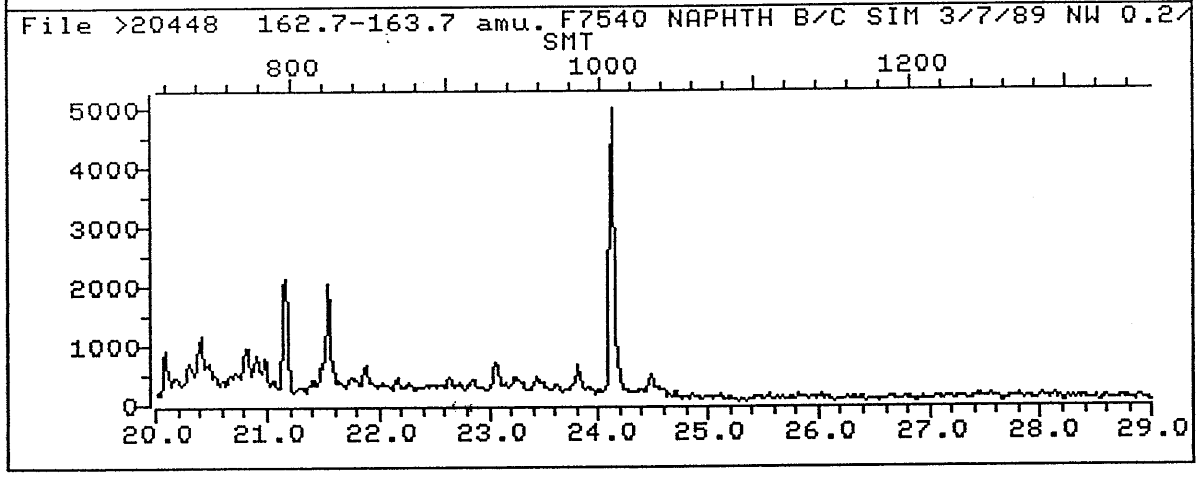
29.0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1200
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4000
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1000
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23.0
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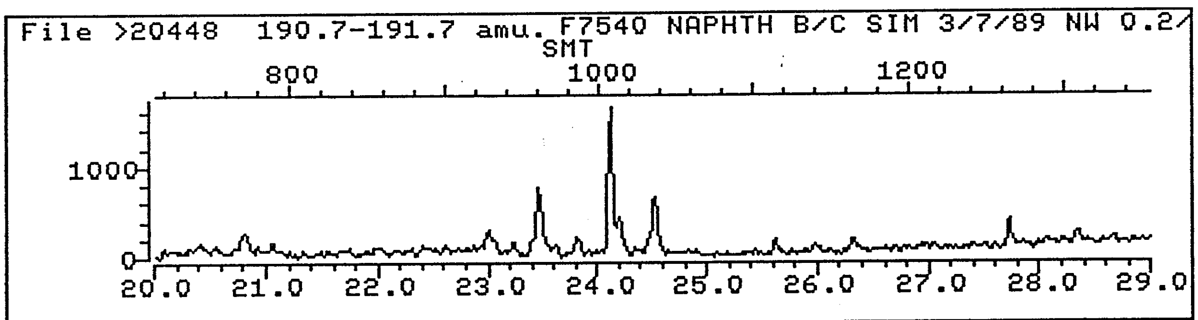
29.0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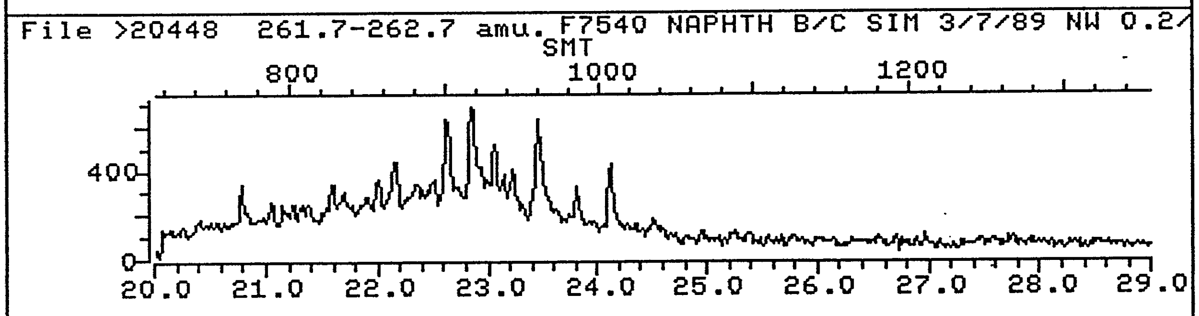
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1200
400
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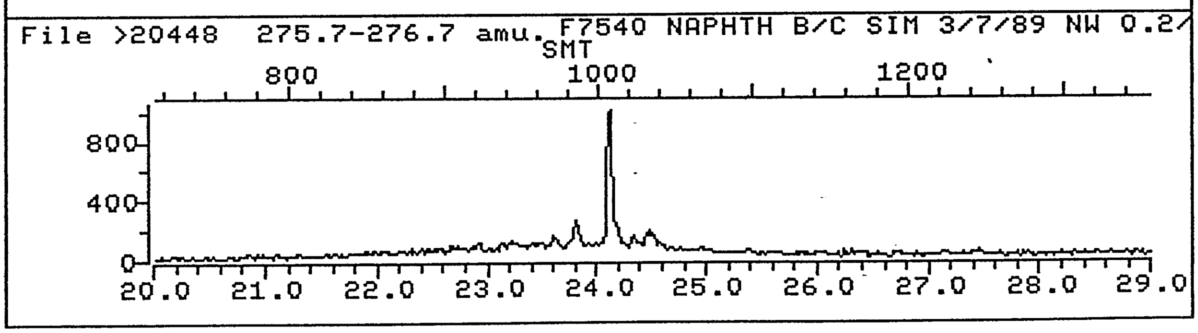
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1000
1200
800
400
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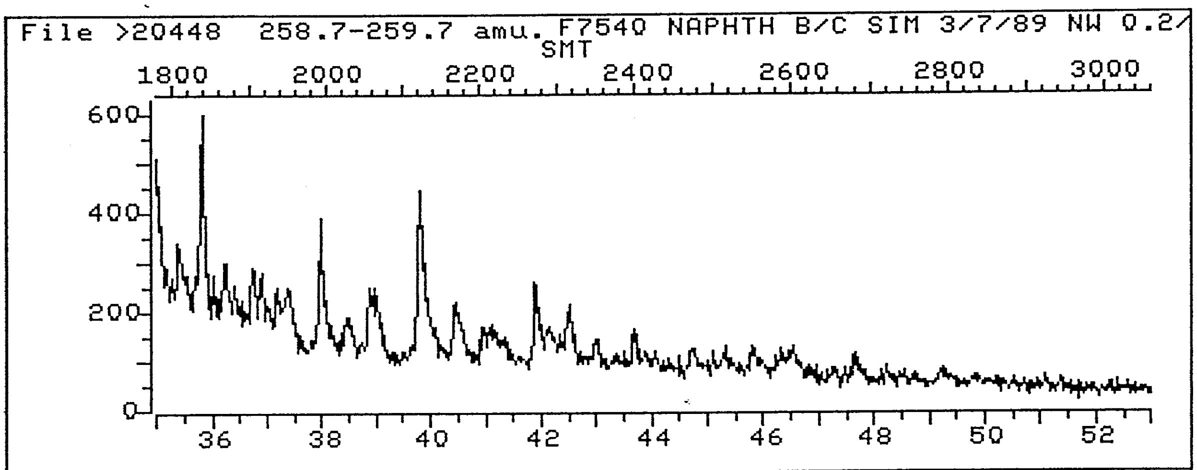
29.0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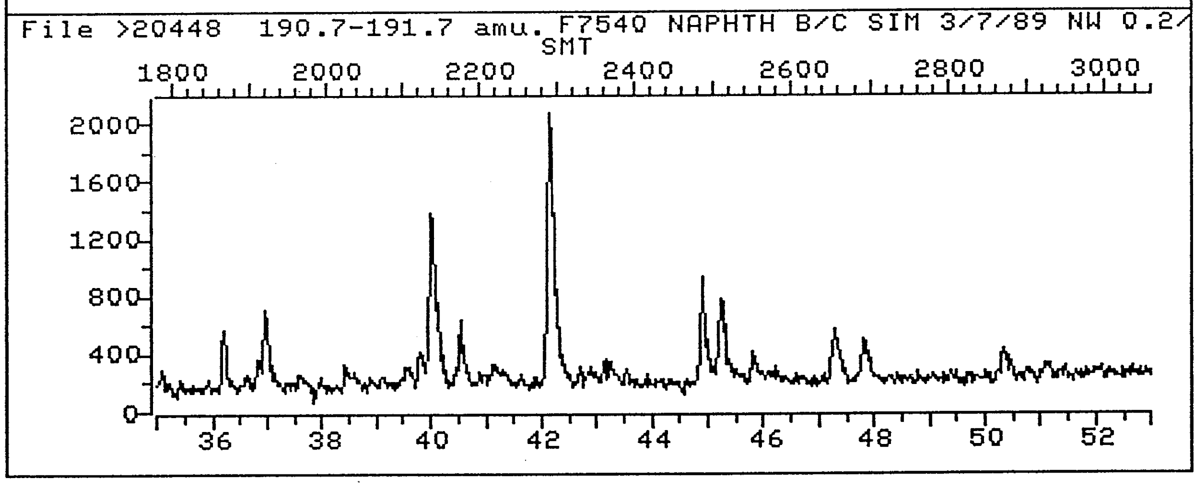
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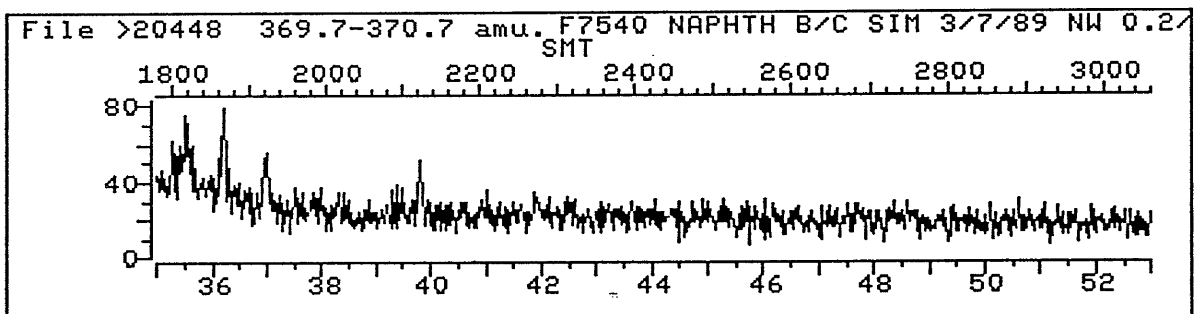
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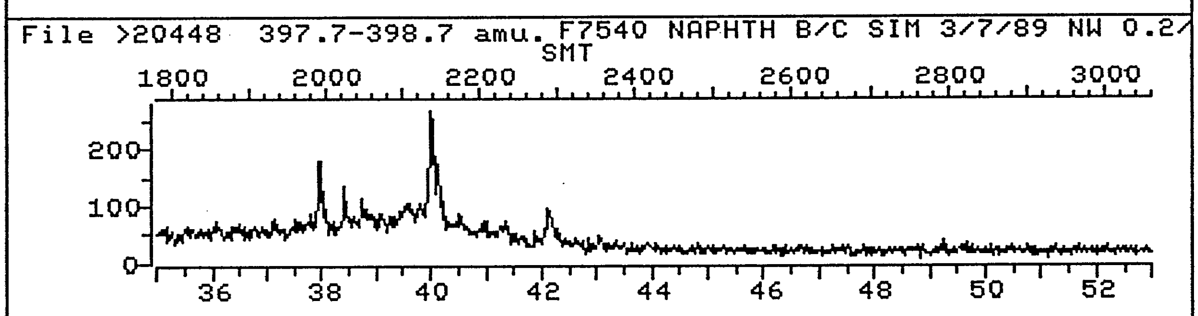
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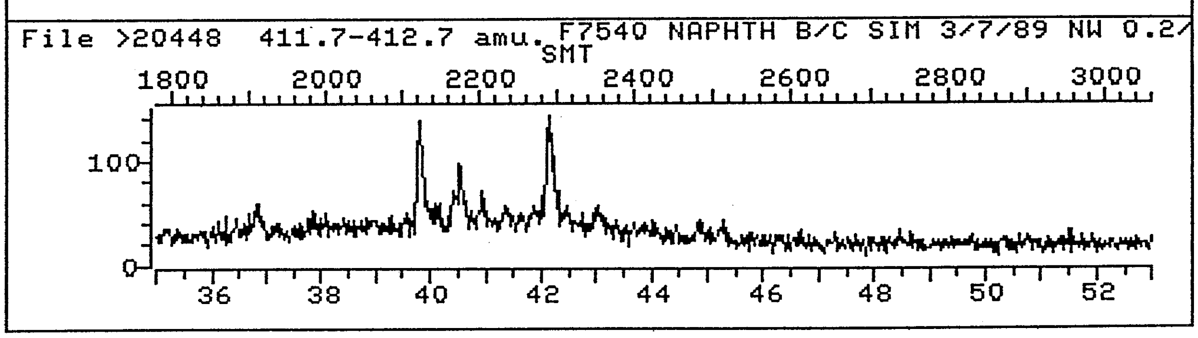
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