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Exxon Production Research Company

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WELLFILE

ANALYSIS OF OIL FROM 34/10-1 WELL, NORWAY

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SUMMARY AND CONCLUSIONS

A separator oil sample (EPR No. 69423) from DST-3 in 34/10-1 (perf. 1788-1792 meters) is interpreted to be a biodegraded immature oil belonging to the main family of North Sea oils. Isotopically (C^{13}/C^{12}) it is close in composition to oils from nearby reservoirs in the Statfjord formation. It does not appear to have had major degradation by water washing.

The oil sample analyzed had the following gross properties:

API gravity at 60°F	28.7°
Sulfur by weight	0.61%
Heavy (C_{15+}) compounds	77.2% of oil by weight
Light gasolines (C_4-C_7)	4.8% of oil by weight

The oil was analyzed by routine geochemical techniques. (See Procedures section.) Details of the analytical results are given in Tables 1 and 2 and in Figures 1 thru 3.

PROCEDURES

A sample of the oil was "topped" by heating it at 45°C for 19 hours. The remaining portion, referred to in Table 1 as the "C_{15+} fraction", comprised 77.2% of the total original oil. Most of those lighter compounds that contain fewer than about 15 carbon atoms per molecule were evaporated off during the "topping", and some of the compounds with from 15 to about 20 or 21 carbon atoms per molecule were also lost or diminished in amounts by evaporation.

The heavy (C_{15+}) fraction was treated with pentane to precipitate asphaltenes, and the pentane-soluble portion was then analyzed by liquid column chromatography (Table 1). The heavy saturate and heavy aromatic hydrocarbons were separated during this procedure.

A gas chromatogram was obtained of the whole oil, with a separate trace for the sulfur compounds in the oil (Fig. 1). Another gas chromatographic instrument was used to obtain a chromatogram of the heavy saturate hydrocarbon compounds (Fig. 2).

The heavy saturate hydrocarbons and the heavy aromatics were analyzed by mass spectrometry to measure the different molecular types of compounds present (Table 1). The saturates and the aromatics were also analyzed by another type of mass spectrometer to obtain their C^{13}/C^{12} carbon isotope values (Table 1). The mass spectrometric data are summarized in Fig. 3

Gravity in °API and pour point in °F were measured routinely, and the sulfur content in percent by weight was measured by use of a Leco sulfur analyzer (Page 1).

Light gasolines (C_4-C_7) were analyzed by still another gas chromatograph (Table 2).

DISCUSSION

The 34/10-1 oil sample appears to have undergone bacterial degradation. The normal paraffin peaks in the gas chromatogram of the saturate compounds are rather subdued (numbered peaks in Fig. 2) and the iso-paraffin peaks, especially pristane and phytane, are relatively prominent. The percent of paraffins in the heavy saturates (Table 1 and Fig. 1) appears to be reduced; 21.5 percent is lower than normal for North Sea oils. These features are typical of bacterial action.

Water-washing does not appear to be significant because the relatively soluble toluene still comprises 12.3% of the gasolines (Table 2).

The pristane and phytane peaks mentioned above are so prominent that bacterial degradation alone does not seem to provide an adequate explanation for them. We believe that relative immaturity of the oil is also involved. With increasing maturation the pristane and phytane would be diminished. The idea that immaturity is involved is supported by the unusual amount of steranes present (Fig. 3 and Table 1). The large "hump" in the 4-ring naphthene curve at the top of Fig. 3 is unusual for a North Sea oil; the pattern of FIT-6 from 25/10-1 is the usual one. Increased maturity will reduce this concentration of sterane compounds in the C-27 to C-29 range, as represented by this large hump in the 34/10-1 oil pattern.

In Fig. 3 an oil sample and an oil stain from the Grandad area are compared to the 34/10-1 oil sample. The carbon isotope values are similar and so are the patterns of aromatic molecular types. The saturate molecular types differ among the three samples, and we attribute the differences to degradation and to varying maturation levels.

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TABLE 1 ANALYSIS OF HEAVY (C_{15+}) FRACTION OF OIL
DST-3, 34/10-1

EPR No.	69423
Residue (C_{15+}) in Total Oil (%)	77.2
Gross Composition of C_{15+} Fraction (%)	
Saturates	47.4
Aromatics	30.3
Eluted NSO's	9.7) NSO 19,6
Noneluted NSO's	9.9)
Asphaltenes	2.7
Carbon Isotope Values ($^{o}/oo$ from PDB)	
Saturates (δSAT)	-29.4
Aromatics (δARO)	-28.6
Saturate Molecular Types (%)	
Paraffins	21.5
1-Ring Naphthenes	23.9
2- " "	19.3
3- " "	14.7
4- " "	14.4
5- " "	4.1
6- " "	2.2
Four-Ring Naphthenes (%)	
20 Carbon atoms per molecule	8.3
21 " " " "	7.2
22 " " " "	6.1
23 " " " "	5.3
24 " " " "	5.0
25 " " " "	4.8
26 " " " "	5.5
27 " " " "	10.2
28 " " " "	12.3
29 " " " "	14.8
30 " " " "	11.7
31 " " " "	5.3
32 " " " "	3.4
Aromatic Molecular Types	
Benzenes (B)	17.8
Indanes (I)	12.4
Indenes (IN)	11.4
Naphthalenes (N)	3.7
Tetrahydrophenanthrenes (T)	11.2
Dihydrophenanthrenes (D)	19.4
Phenanthrenes (P)	12.3
Pyrenes (PY)	2.4
Chrysenes (C)	1.1
Benzothiophenes (BT)	3.8
Dibenzothiophenes (DT)	4.5
Thiophenophenanthrenes (TP)	0.0

C4-C7 OIL

TABLE 2 LIGHT GASOLINES, DST-3, 34/10-1

69423

	TOTAL PERCENT	NORM PERCENT		TOTAL PERCENT	NORM PERCENT
METHANE	0. 000		CHEX	0. 499	10. 32
ETHANE	0. 000		33-DMP	0. 000	0. 00
PROPANE	0. 032		11-DMCP	0. 134	2. 76
IBUTANE	0. 068	1. 40	2-MHEX	0. 000	0. 00
NBUTANE	0. 087	1. 80	23-DMP	0. 183	3. 79
IPENTANE	0. 224	4. 63	3-MHEX	0. 221	4. 56
NPENTANE	0. 116	2. 39	1C3-DMCP	0. 131	2. 70
22-DMB	0. 022	0. 46	1T3-DMCP	0. 111	2. 29
CPENTANE	0. 071	1. 47	1T2-DMCP	0. 215	4. 44
23-DMB	0. 050	1. 03	3-EPENT	0. 000	0. 00
2-MP	0. 199	4. 12	224-TMP	0. 000	0. 00
3-MP	0. 125	2. 59	NHEPTANE	0. 162	3. 35
NHEXANE	0. 134	2. 77	1C2-DMCP	0. 031	0. 63
MCP	0. 358	7. 40	MCH	0. 994	20. 54
22-DMP	0. 000	0. 00	ECP	0. 024	0. 49
24-DMP	0. 047	0. 96	BENZENE	0. 039	0. 80
223-TMB	0. 000	0. 00	TOLUENE	0. 596	12. 31

TOTALS

ALL COMP	4. 870
GASOLINE	4. 839

SIG COMP RATIOS

C1/C2	1. 93
A /D2	1. 34
D1/D2	2. 87
C1/D2	7. 37
PENT/IPENT	0. 52
CH/MCP	1. 39

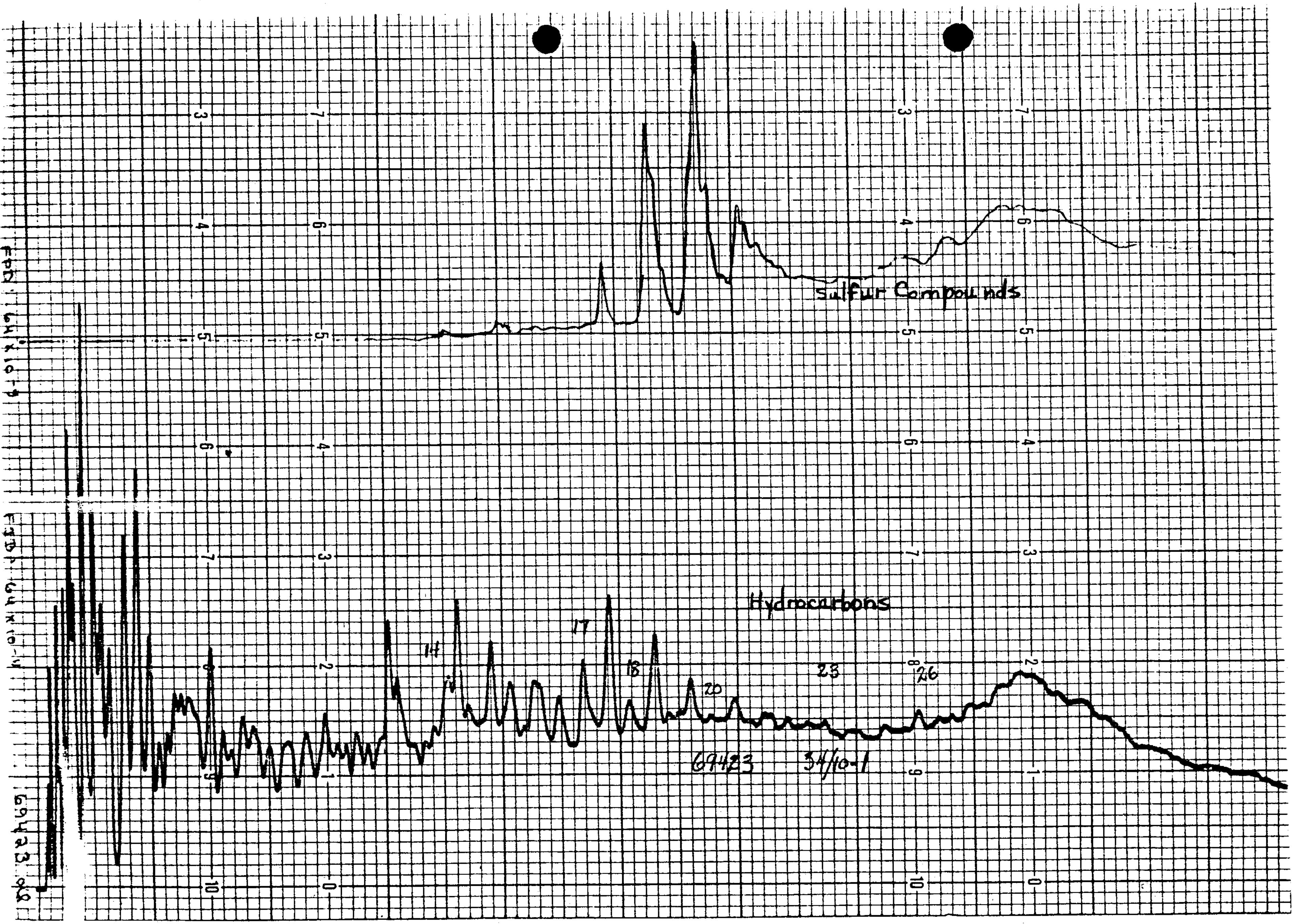

FIG. 1 GAS CHROMATOGRAMS OF "WHOLE OIL" AND OF SULFUR COMPOUNDS, 34/10-1, DST-3.

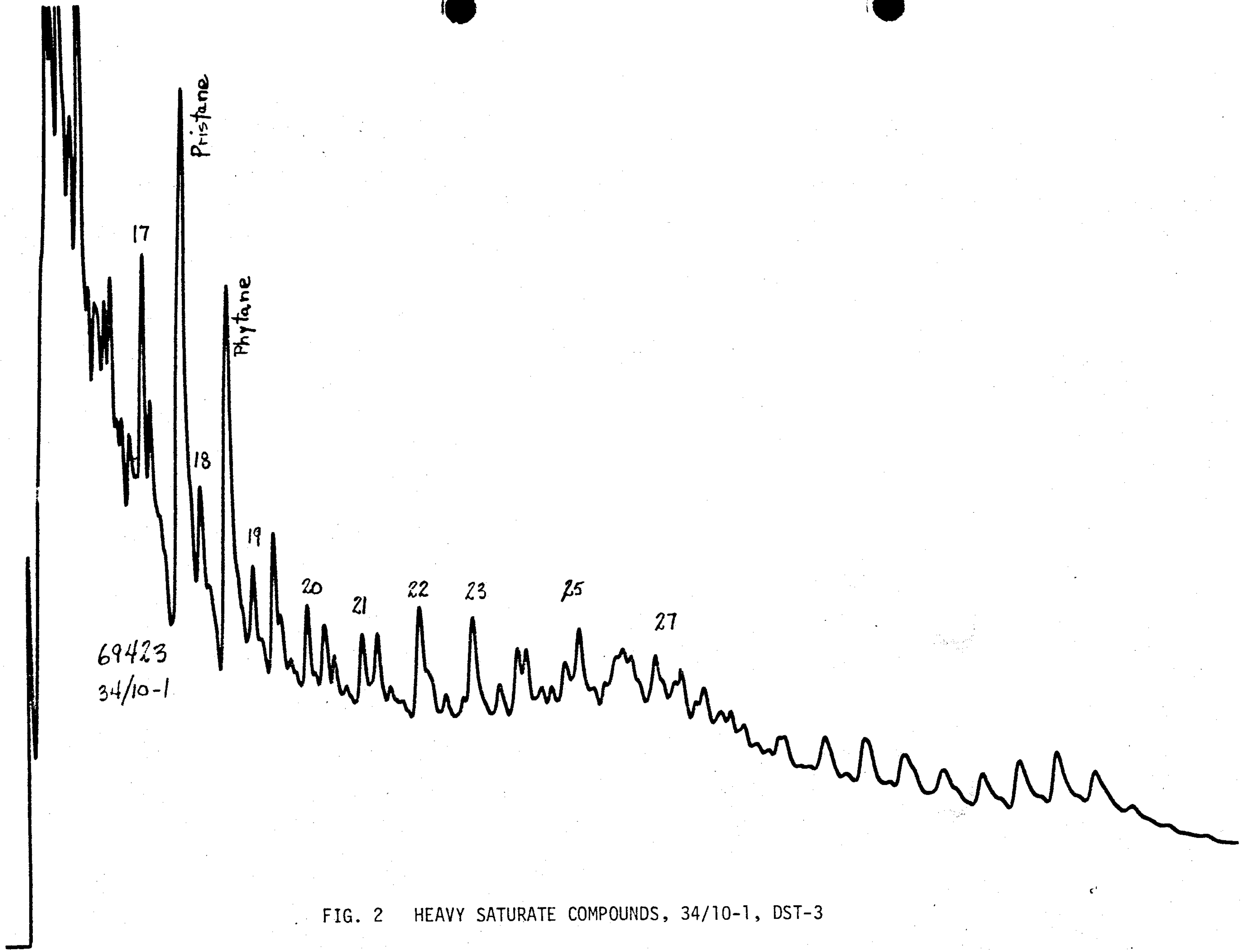

FIG. 2 HEAVY SATURATE COMPOUNDS, 34/10-1, DST-3

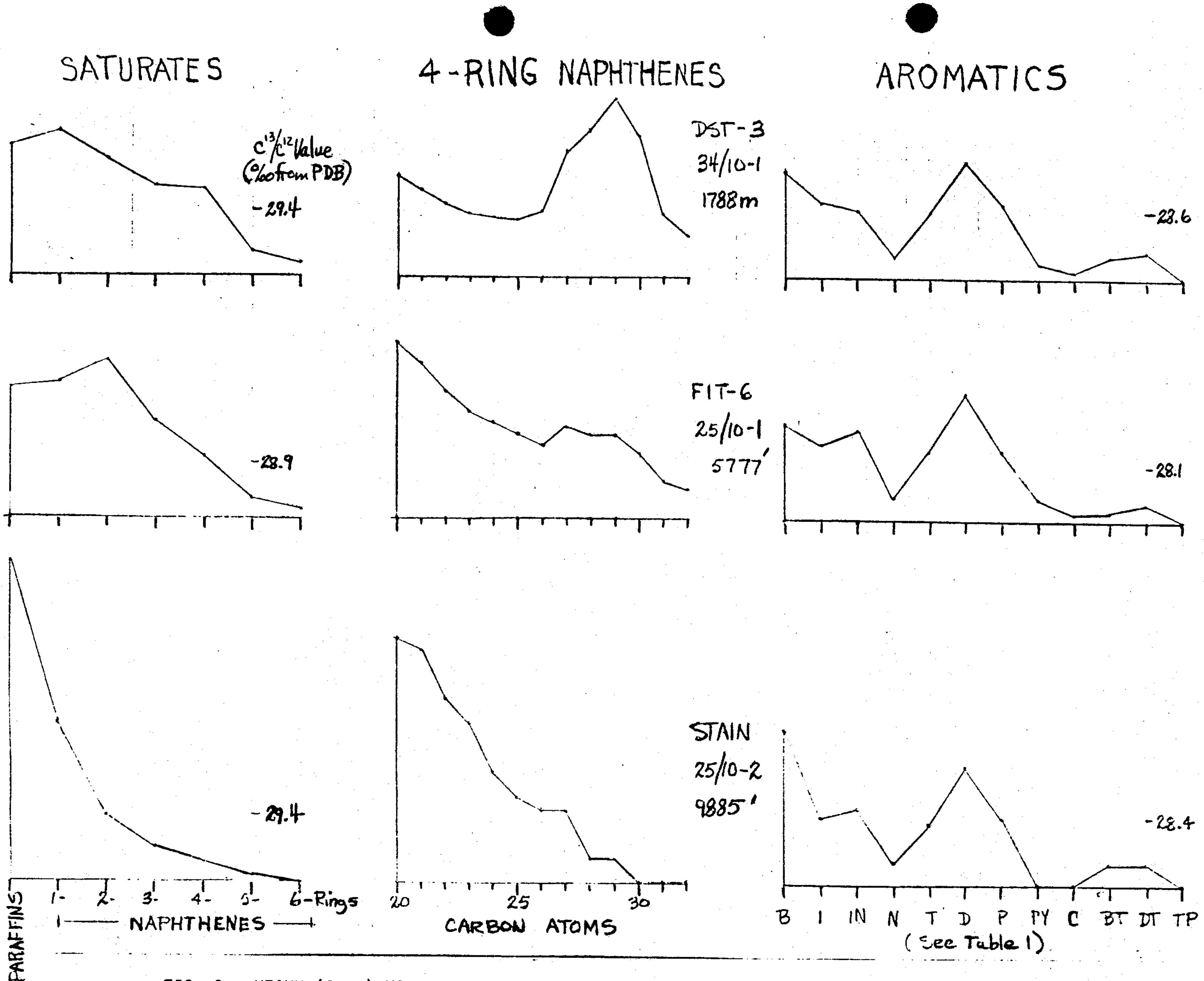

FIG. 3 HEAVY (C_{15+}) MOLECULAR TYPES AND CARBON ISOTOPE VALUES (Data by Mass Spectrometry).