

E & D Files

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North Sea, Norwegian Sector,  
Eldfisk 2/7-92, Oil, Water,  
and Sidewall Core Characterization  
DMS-114-75

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Geochemical characterization has been completed on oil, water and sidewall cores recovered from the Eldfisk 2/7-92, Norwegian Sector, North Sea. Samples include oil and water collected from the 3878-3109 m. (12,165-10,200 ft.) and 3400-3426 m. (11,155-11,240 ft.) intervals in the Danian-Cretaceous section, a companion gas-liquid recovered from DMS-1, in Jurassic sandstone at depths from 4340-4380 m. (14,190-14,390), and sidewall cores taken from the 2759-3070 m. (9,053-10,100 ft.) interval from the Paleocene through the Upper Cretaceous section, and at 4114, 4130, and 4270 m. (13,496, 13,590, and 14,010 ft.), in Jurassic sandstone.

Conclusions and interpretations resulting from this study are as follows:

1. The oils are mature light crudes characteristic of those produced from fields in the Ekofisk complex. Despite separate reservoir horizons, the oil recovered from the Danian-Cretaceous limestone is similar to that from Jurassic sandstone. Those from the shallower zone have densities of about 0.827 kg/l @ 15°C (39.5 API gravity), that from the deeper zone a density of 0.824 kg/l @ 15°C (41.2 API gravity). All have a low content of sulfur, nitrogen and heavy metals.
2. All three oil samples originated from organic matter which accumulated in an open marine environment.
3. The rock sample recovered from a depth of 2943 m. (9,654 ft.) in Paleocene strata and one taken from 4270 m. (14,010 ft.) in the Jurassic both qualify as source rocks since petroleum has been generated and migrated out. Although most of the other sidewall samples are rich in organic content, and approach conditions favorable for petroleum genesis, they have high ratios of oil to kerbitumen. This indicates that all of the oil is not indigenous to the section, but has migrated from other sources. Therefore, these samples must be classified as capillary reservoirs rather than source rocks.
4. Both waters recovered with oil from the two intervals in the Danian-Cretaceous are badly contaminated with drilling mud filtrate and spent acid, and are probably not representative of true formation waters.

Petroleum genesis and the similarity between Danian-Cretaceous and Jurassic oil has been treated in several reports - most recently DMS-128-75. The above conclusions and interpretations are based on data provided in Tables I through V and Figures 1 through 9.

David A. Morris

DMS-114-75  
Attachment 3

TABLE I

CHARACTERIZATION OF THREE OILS  
 PHYSICAL, CHEMICAL, AND INSTABILITY PROPERTIES  
 ASSOCIATED WITH MIDDLE-CRETACEOUS LIMESTONE AND TERTIARY SANDSTONE IN THE  
 ALBERTA 27-92 N. 001/W001

Location Branch Code	Density kg./l. at 15°C	API Gravity	Pour Point °C	Viscosity		Miscellaneous			
				70 mm cP	100 mm cP	Sulfur wt. %	Nitrogen wt. %	Vanadium ppm	Nickel ppm
001	0.8280	39.3 <sup>#</sup>	15.0	4.2	3.0	0.07	0.07	ND	1.02
002	0.8256	39.0 <sup>#</sup>	15.0	4.5	4.0	0.17	0.05	ND	0.75
003	0.8237	41.2 <sup>#</sup>	25.0	4.9	2.9	0.07	0.02	ND	0.56

Location Branch Code	Total Crude		Calc.		Calc.		Calc.		Calc./Sum Production GPI
	Calc.	Wt. %	Calc.	Wt. %	Calc.	Wt. %	Calc.		
001	-26.7	75.4	-26.7	21.0	-26.0	3.6	-25.7	1.05	
002	-26.7	86.0	-26.7	49.0	-25.9	4.2	-27.7	1.05	
003	-26.7	86.0	-26.0	17.6	-25.0	2.4	-25.7	1.04	

#Middle-Cretaceous Limestone  
 #Tertiary Sandstone  
 ND = none detected

STONY	
THOMPSON	
SHANNON	
GREEN	
LARSEN	
LOONEY	
PRESTON	
RAV	
SHAW	
CFD	

TABLE II

SOURCE ROCK EVALUATION DATA FROM  
ELDFISK 2/7-9X NORWEGIAN SECTOR, NORTH SEA, NORWAY

GEOCHEM- ISTRY BRANCH CODE	DEPTH		CARB- ONATE CARBON WT.%	OR- GANIC CARBON WT.%	RATIO SOLUBLE / TOTAL CARBON	SOLUBLE ORGANIC MATTER						ODD-EVEN PREDD- INANCE OEP		
	METERS	FEET				TOTAL		SATURATES		AROMATICS			ASPHALTICS	
						WT.%	C-13	WT.%	C-13	WT.%	C-13		WT.%	C-13
NCR	2759----	9053----	.54	1.30	.356	.578	-28.1	68.0	IN	24.0	-26.7	8.0	-27.1	.91
NCS	2782----	9126----	.06	.45	.132	.074	IN	50.4	IN	27.3	-26.5	22.3	-26.3	1.31
NCT	2804----	9200----	.10	.56	.123	.085	IN	67.3	IN	18.7	-26.4	14.0	-26.4	IN
NCU	2862----	9390----	.14	.66	.294	.243	IN	71.6	-28.0	18.9	-27.0	9.5	-26.4	1.16
NCV	2894----	9496----	.11	.66	.183	.150	-27.2	64.2	-28.2	31.3	-25.9	4.5	-24.8	1.24
NCW	2943----	9654----	.12	1.77	.010	.022	-28.3	43.1	IN	16.5	IN	40.4	-28.4	1.10
NCX	2922----	9585----	.04	1.36	.066	.111	-27.0	38.1	-28.1	41.4	-26.9	20.5	-26.4	1.28
NCY	2964----	9725----	.37	2.42	.349	1.055	-27.6	67.2	-28.3	24.9	-26.7	7.8	-26.9	1.03
NCZ	3010----	9875----	.10	1.49	.061	.113	-27.3	57.7	-28.3	40.2	-26.5	2.1	IN	1.45
NDA	3032----	9948----	2.22	.75	.141	.133	-27.6	65.0	-28.4	22.6	-27.0	12.4	-26.6	IN
NDB	3078----	10100----	2.78	.40	.108	.053	IN	69.7	IN	11.9	IN	18.4	IN	1.16
NEU	4114----	13496----	3.98	.60	.237	.177	-27.2	75.4	-27.6	20.8	-26.5	3.8	-26.2	1.06
NEV	4130----	13550----	ND	.97	.257	.322	-27.1	74.8	-27.3	20.0	-26.3	5.2	IN	1.15
NFA	4270----	14010----	ND	1.00	.032	.040	IN	50.4	IN	15.5	IN	34.1	IN	.96

IN = Insufficient sample for this determination

ND = Not determined

TABLE III

FORMATION WATER CHARACTERIZATION

TOP 2/7-9 ELDFISK N. SEA NORWAY DST.3

O&W.WEL.HED.REVERSE OUT AFTER POST ACID FLOW PERIOD 4/5/74

CHEMISTRY BRANCH CODE, NSX  
 TOTAL DISSOLVED CHROMIUM = 0.44 PPM  
 RESISTIVITY, 25 DEG. C, 0.082 OHM METERS  
 = 6.42

TOTAL DISSOLVED SOLIDS = 9.34

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION	EQUIVALENTS	ANIONS	CONCENTRATION	EQUIVALENTS
	WT/WT PER CENT	PER 100 GRAMS		WT/WT PER CENT	PER 100 GRAMS
SODIUM	1.6200	0.0705	CHLORIDE	5.7600	0.1625
POTASSIUM	0.0380	0.0010	BROMIDE	0.0201	0.0003
CALCIUM	1.7200	0.0858	IODIDE	0.0023	0.0000
MAGNESIUM	0.0637	0.0052	SULFATE	0.0790	0.0016
AMMONIUM	0.0073	0.0004	PHOSPHATE	<0.0005	0.0000
MONIA	0.0000	0.0000	BICARBONATE	0.0025	0.0000
STRONTIUM	<0.00095	0.0000	CARBONATE	0.0000	0.0000
BARONIUM	0.0340	0.0008			
<b>TOTAL =</b>	<b>3.4766</b>	<b>0.1632</b>	<b>TOTAL =</b>	<b>5.8643</b>	<b>0.1644</b>

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	0.00
TOLUENE	0.00

trace-of-oil

Attachment to DAM-146-75

TABLE IV

FORMATION WATER CHARACTERIZATION

2/7-9 ELDFISK N. SEA NORWAY DST.2

O&W CHOKE MAN.ON RIG FLR.REV.OUT AFTER P.A.FLOW 4/1/74

CHEMISTRY BRANCH CODE, NSY  
 TOTAL DISSOLVED CHROMIUM = 0.71 PPM  
 RESISTIVITY, 25 DEG. C, 0.053 OHM METERS  
 = 3.34

TOTAL DISSOLVED SOLIDS = 20.31

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION		ANIONS	CONCENTRATION	
	WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS		WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	0.8200	0.0357	CHLORIDE	12.5000	0.3526
POTASSIUM	0.0410	0.0010	BROMIDE	0.0059	0.0001
CALCIUM	6.7800	0.3383	IODIDE	0.0076	0.0001
MAGNESIUM	0.0891	0.0073	SULFATE	0.0280	0.0006
AMMONIUM	0.0035	0.0001	* PHOSPHATE	0.0000	0.0000
IRON	0.0000	0.0000	BICARBONATE	0.0000	0.0000
ZINC	0.00305	0.0000	CARBONATE	0.0000	0.0000
COPPER	0.0417	0.0010			
TOTAL =	7.7748	TOTAL = 0.3833	TOTAL =	12.5415	TOTAL = 0.3532

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	0.00
TOLUENE	0.00

trace of oil

\* insufficient sample

Attachment to DAM-146-75

## TABLE V

LITHOLOGICAL DESCRIPTIONS OF MIDDLE Eocene, 2/7-92 Well,  
KAWAULAI MOUNTAIN/WAIALEALE

- ANCS 9033:  
SL QTY SLTY CL  
This sample is very badly fractured and distorted, and heavily contaminated by drilling mud. It appears to consist of dark yellowish brown (MOR 3/2), soft, compact, microbedded, non-calcareous, very slightly quartzose silty clay, interbedded with a 1/4 in. thick lens of olive gray (SI 4/1) to olive black (SI 3/1), very hard, brittle, nonporous, dolomite. The clay unit contains a trace of silt size pyrite; trace of tan to light brown carbonaceous matter; 2% fine quartzose silt; and 98% clay size fraction. Dolomite unit appears to contain recrystallized filaments of calcareous algae. No megafossils, foraminifera, or calcareous nanoplankton noted.
- ANCS 9126:  
V SL CALC SH  
Olive gray (SI 3/2), medium hard, compact, thinly and irregularly bedded, jointed, very slightly calcareous shale. This sample contains a trace of very fine silt size brassy pyrite; trace of fine silt size black carbonaceous debris; 1 to 2% quartzose silt; and 98 to 99% clay size fraction. Sample contains traces of dark reddish brown (?) hydrocarbons along fracture surfaces and bedding planes. No fossils observed.
- ANCS 9200:  
SLQTY SLTY CL  
Medium dark gray (M2), medium hard, compact, massive, nonbedded, very slightly calcareous, slightly quartzose silty clay. Sample consists of a trace of silt size, brassy pyrite; trace of silt size fresh muscovite mica; trace of dark reddish brown to black, silt size carbonaceous debris; 5% quartzose silt; and about 95% clay size fraction. This sample is somewhat "greasy" or "waxy" on freshly fractured surfaces. No fossils noted.
- ANCS 9350:  
SL QTY SLTY SH  
Olive gray (SI 4/1), medium hard, thinly bedded, somewhat irregularly fissile, very slightly calcareous, very slightly quartzose silty shale. Sample contains a trace of dark reddish brown, silt size carbonaceous debris; trace of fresh, silt size muscovite mica; 2% quartzose silt; and about 98% clay size fraction. No fossils were noted.
- ANCS 9406:  
SL QTY SLTY SH  
Dark gray (M1) to grayish black (M2), moderately hard, compact, uniform, irregularly thin bedded, very slightly calcareous, very slightly quartzose silty shale. Sample consists of a trace of silt size muscovite mica; trace of fine silt size brassy pyrite; trace of dark reddish brown carbonaceous matter; 2% quartzose silt; and about 98% clay size fraction. This sample is somewhat indurated and although exhibiting poorly developed fissility, is transitional between a claystone and shale. No fossils noted.

TABLE I (Cont.)

LITHOLOGICAL DESCRIPTIONS OF SIBERIA CORE, 2/7-28 WELL  
PERMIAN SECTION/NORTH SEA

ANEX 9585 <sup>*</sup> SAND CL	Greenish gray (SEF 6/1), moderately hard, massive, compact, noncalcareous clay interbedded in sharp contact with an 11 cm. thick lens of dark gray (N3) to grayish black (N2), moderately hard, noncalcareous, pyritic, very carbonaceous clay. Greenish gray bed contains a trace of widely disseminated, brassy pyrite; trace of silt size muscovite mica; trace of quartzose silt; and essentially 100% clay size fraction. Dark gray lens consists of perhaps 5% very fine silt size pyrite; perhaps 30 to 40% very finely divided, dark brown to dark reddish brown carbonaceous matter; and about 55 to 65% clay mineral fraction. The sharp contact between these two lithologies dips at about 30° to the long axis of this core. No fossils noted.
ANEX 9654 <sup>*</sup> SAND CL	Grayish red (10R 4/2) to very dusky red (10R 2/2), moderately hard, compact, uniform, irregularly thin bedded, very slightly calcareous shale. Sample contains a trace of very fine grained quartzose silt; trace of silt size muscovite mica; and essentially 100% clay size fraction. No megafossils, foraminifera, or calcareous nanoplankton were noted.
ANEX 9725 <sup>*</sup> F SL CALD CL	This sample consists of a vertebra-size piece of what largely appears to be drilling mud. Results based on this sample should be evaluated with the knowledge of possible contamination. Sample appears to consist of dark gray (N3), very soft, fine, uniform, nonbedded, very slightly calcareous clay. Sample contains a trace of fine quartzose silt; trace of black, lustrous, silt size carbonaceous debris; 1% very fine sand to silt size muscovite mica; and about 99% clay size fraction. No fossils noted.
ANEX 9875 <sup>*</sup> QTL SLTY SL	Dark gray (N3), moderately hard, compact, uniform, irregularly thin bedded, very slightly calcareous, quartzose silty shale. Sample contains a trace of silt size muscovite mica; trace of black, silt size carbonaceous debris; trace of silt size brassy pyrite; 30% very fine quartzose silt; and about 80% clay size fraction. Fractured surface of this sample appears "greasy" or "waxy". No megafossils, foraminifera, or calcareous nanoplankton noted.
ANEX 9940 <sup>*</sup> SL QTL SLTY SL	This sample is very badly fractured and disturbed and drilling mud is present throughout the core and along bedding planes and fracture surfaces. Matrix dark gray (N4), moderately hard, compact, uniform, very highly fractured and irregularly thin bedded, moderately calcareous, very slightly quartzose silty shale. Sample contains a trace of silt size muscovite mica; 3 to 4% black, silt size carbonaceous fragments; 10% fine quartzose silt; and about 84% clay size fraction. No fossils noted.

## TABLE V (Cont.)

LITHOLOGICAL DESCRIPTIONS OF MIDWALL CORES, 2/7-92 HILL  
MEMPHIS BASIN, NORTH MISS.

AND 10,100'      Medium dark gray (R<sub>1</sub>), very hard, uniform, nonbedded, very fine  
 grained clayey limestone or extremely calcareous claystone.  
 SE CALC CLIST      Sample contains a trace of very fine silt size brassy pyrite;  
 trace of black, silt size carbonaceous matter; trace of silt  
 size muscovite mica; 15% fine grained quartzose silt; 30%  
 insoluble clay size fraction, and about 70% soluble carbonate  
 fraction. No microfossils or foraminifera noted. Sample contains  
 very abundant, although somewhat recrystallized and overgrown  
 calcareous microfossils.



**FIGURE 1**  
**ELDPISK 2/7-91/N. SEA/NORWAY**  
**COMPONENT COMPOSITION OF CRUDE OIL**  
**THROUGH N-DECANE, BP = 345,4F (= 174,1C)**

Attachment to DAM-146-75

COMPONENT	NTR	WT PERCENT OF SAMPLE
HELIUM	0,000	
HYDROGEN SULFIDE	0,000	
OXYGEN + ARGON	0,000	
NITROGEN	0,370	
CARBON DIOXIDE	2,924	
METHANE	12,351	
ETHANE	4,115	
PROPANE	3,770	
ISOBUTANE	1,116	
N-BUTANE	2,791	
ISOPENTANE	1,268	
N-PENTANE	1,852	
NEOHXANE	0,023	
CYCLOPENTANE	0,104	
2,3-DIMETHYLBUTANE	0,093	
2-METHYLPENTANE	0,788	
3-METHYLPENTANE	0,437	
N-HEXANE	1,551	
METHYLCYCLOPENTANE + 2,2-DIMETHYLPENTANE	0,295	
2,4-DIMETHYLPENTANE	0,068	
BENZENE + 2,2,3-TRIMETHYLBUTANE	0,536	
CYCLOHEXANE + 3,3-DIMETHYLPENTANE	0,595	
2-METHYLHEXANE	0,420	
2,3-DIMETHYLPENTANE + 1,1-DIMECYCLOPENT.	0,204	
3-METHYLHEXANE	0,253	
1-CIS-3-DIMETHYLCYCLOPENTANE	0,111	
1-TRANS-3-DIMECPENTANE + 3-ETHYLPENTANE	0,133	
1-TRANS-2-DIMETHYLCYCLOPENTANE	0,180	
N-HEPTANE	1,430	
1,2-DIMETHYLCYCLOPENTANE	0,013	
METHYLHEX + 2,2-DIMEHEX + 1,1,3-TRIMECPENT	1,251	
2,3-DIMETHYLHEXANE	0,049	
2,4-DIMETHYLHEXANE + ETHYLCYCLOPENTANE	0,118	
2,2,3-TRIMETHYLPENTANE	0,008	
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	0,062	
3,3-DIMETHYLHEXANE	0,011	
TOLUENE	0,523	
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	0,066	
2,3,4-TRIMETHYLPENTANE	0,000	
2,5-DIMEHEX + 2,3,3-TRIMEPENT + 2-ME3-ETPENT.	0,191	
2-METHYLHEPTANE + 4-METHYLHEPTANE	0,515	
3,4-DIMEHEX + 1-CIS-2-TRAN-4-TRIMECPENT	0,137	
3-ETHYLHEXANE	0,026	
3-METHYLHEPTANE + 3-ME-3-ETHYLPENTANE	0,342	
2,2,5-TRIMEHEX + 1,1,3-TR-4-TETRAMECYPENT.	0,014	
1-CIS-2-CIS-4-TRIMETHYLCYCLOPENTANE	0,015	
1-TRANS-4 + 1-CIS-3 + 1,1-DIMECYHEXANE	0,416	
1-ME-3-ETHCYPENT + 2,2,4-TRIMETHYLHEXANE	0,058	
1-ME-TRANS-2 + 1-ME-CIS-2-ETHYLCYPENTANE	0,052	
CYCLOHEPTANE	0,013	
N-OCTANE + 1-TRANS-2-DIMETHYLCYCLOHEXANE	1,259	
1-CIS-4-DIMETHYLCYCLOHEXANE	3,138	
1-TRANS-3-DIMETHYLCYCLOHEXANE	0,090	
2,2,4-TRIMEHEXANE + ISOPROPYLCYCLOPENT.	0,018	
2,3,5-TRIMEHEXANE + 2,2-DIMETHYLHEPTANE	0,023	
1-METHYL-CIS-2-ETHYLCYCLOPENTANE	0,068	
2,4-DIMEHEPTANE + 2,2,3-TRIMETHYLHEXANE	0,180	
2,6-DIMEHEPTANE + 1-CIS-2-DIMECYHEXANE	0,054	
N-PROPYLCYPENT + 2,5- + 3,5-DIMEHEPTANE	0,101	
ETHYLCYCLOHEXANE	0,340	
ETHYLBENZENE	0,088	
2,3,4-TRIMETHYLHEPTANE + 1,1,3-TRIMECYHEXANE	0,171	
2,3,4-TRIMETHYLHEXANE	0,035	
2-METHYL-3-ETHYLHEXANE	0,015	
P-XYLENE	0,265	
M-XYLENE + 2,3,4-TRIMETHYLHEXANE	0,448	
2,3- + 3,4-DIMETHYLHEPTANE	0,011	
4-METHYLOCTANE	0,252	
2-METHYLOCTANE	0,196	
3-ETHYLHEPTANE	0,032	
2-METHYLOCTANE	0,214	
O-XYLENE (+ A C-10 ALKANE)	0,223	
2,2,4-TRIMETHYLHEPTANE	0,022	
2,2,5-TRIMETHYLHEPTANE	0,052	
2,2,6-TRIMETHYLHEPTANE	0,010	
***UNKNOWN***	0,042	
2,5,5-TRIMETHYLHEPTANE	0,019	
2,4,4-TRIMETHYLHEPTANE	0,031	
***A C-9 NAPHTHENE***	0,138	
ISOPROPYLBENZENE	0,073	
N-NONANE	1,133	
C-9 NAPHTHENES + C-10 ALKANES	1,867	
N-PROPYLBENZENE	0,021	
1-METHYL-3-ETHYLBENZENE	0,169	
1-METHYL-4-ETHYLBENZENE	0,065	
1-METHYL-2-ETHYLBENZENE	0,196	
1,3,5-TRIMETHYLBENZENE	0,270	
1,2,4-TRIMETHYLBENZENE	0,302	
1,2,3-TRIMETHYLBENZENE	0,095	
N-DECANE	1,040	
UNDECANES AND HEAVIER	48,194	

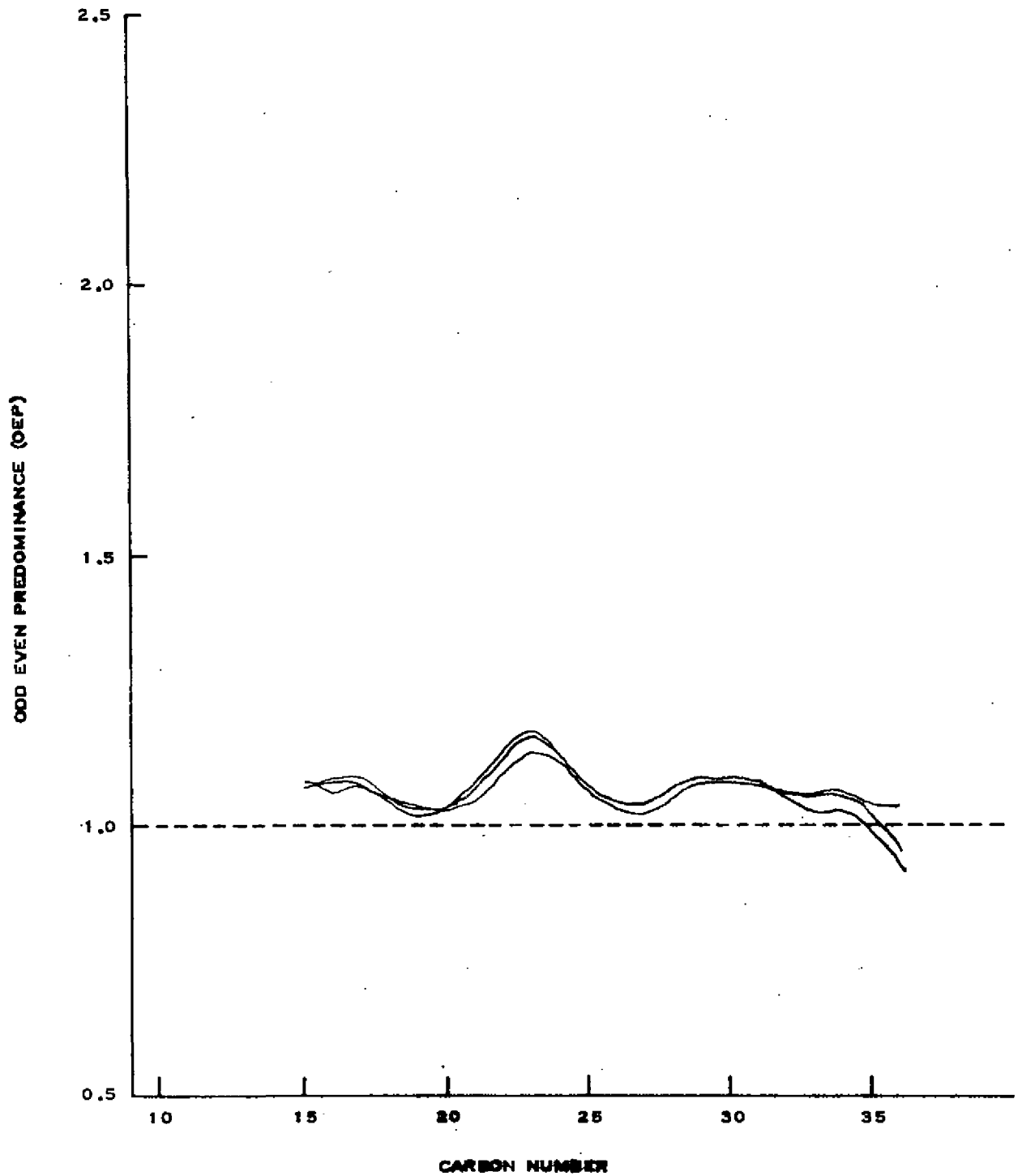


FIGURE 2. OEP CURVES FOR OIL SAMPLES NSX, NSY, AND NTR FROM 2/7-9X, NORWEGIAN SECTOR, NORTH SEA

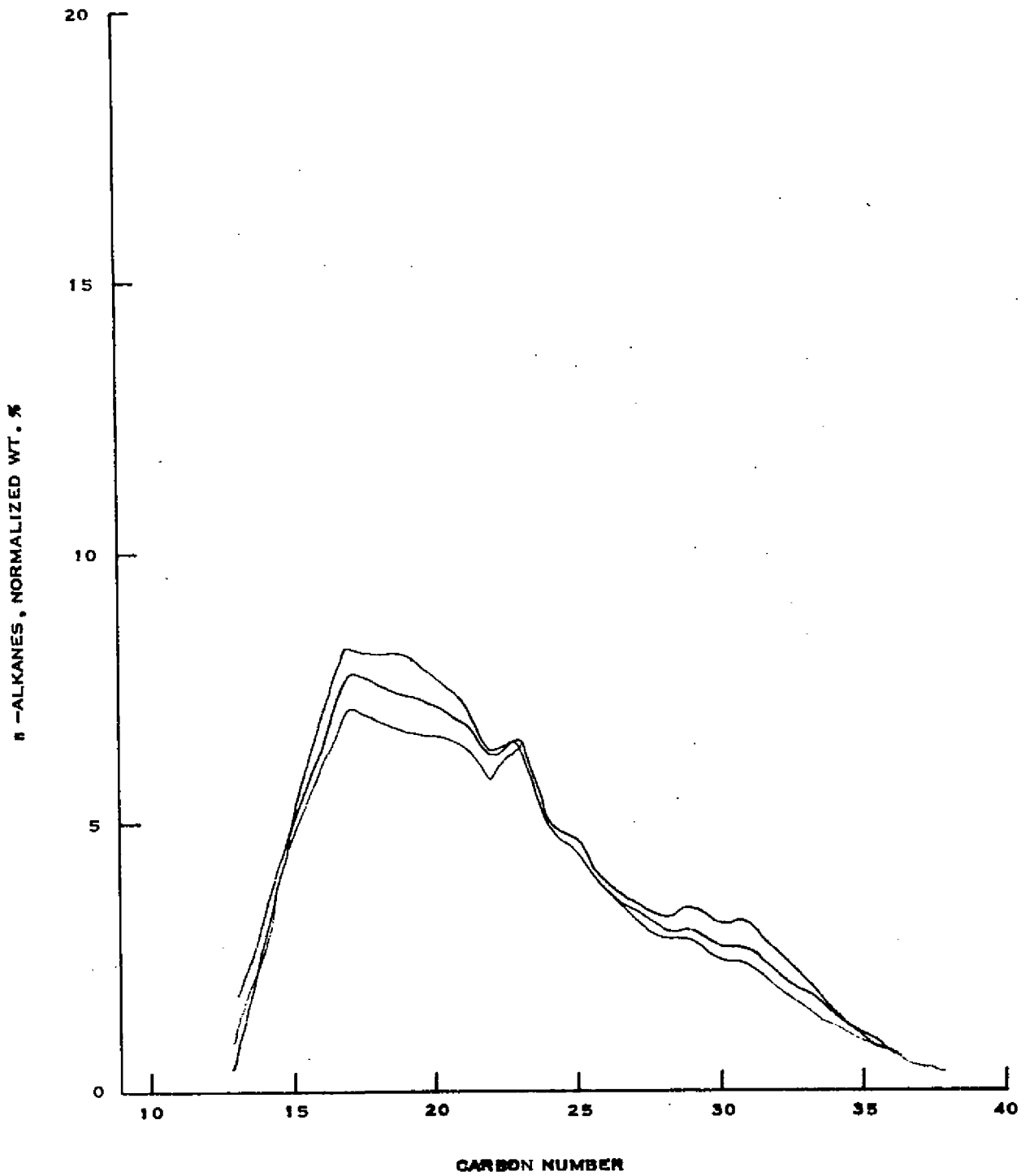


FIGURE 3. n-ALKANE DISTRIBUTION CURVES FOR OIL SAMPLES NSX, NSY, AND NTR FROM 2/7-9X, NORWEGIAN SECTOR, NORTH SEA

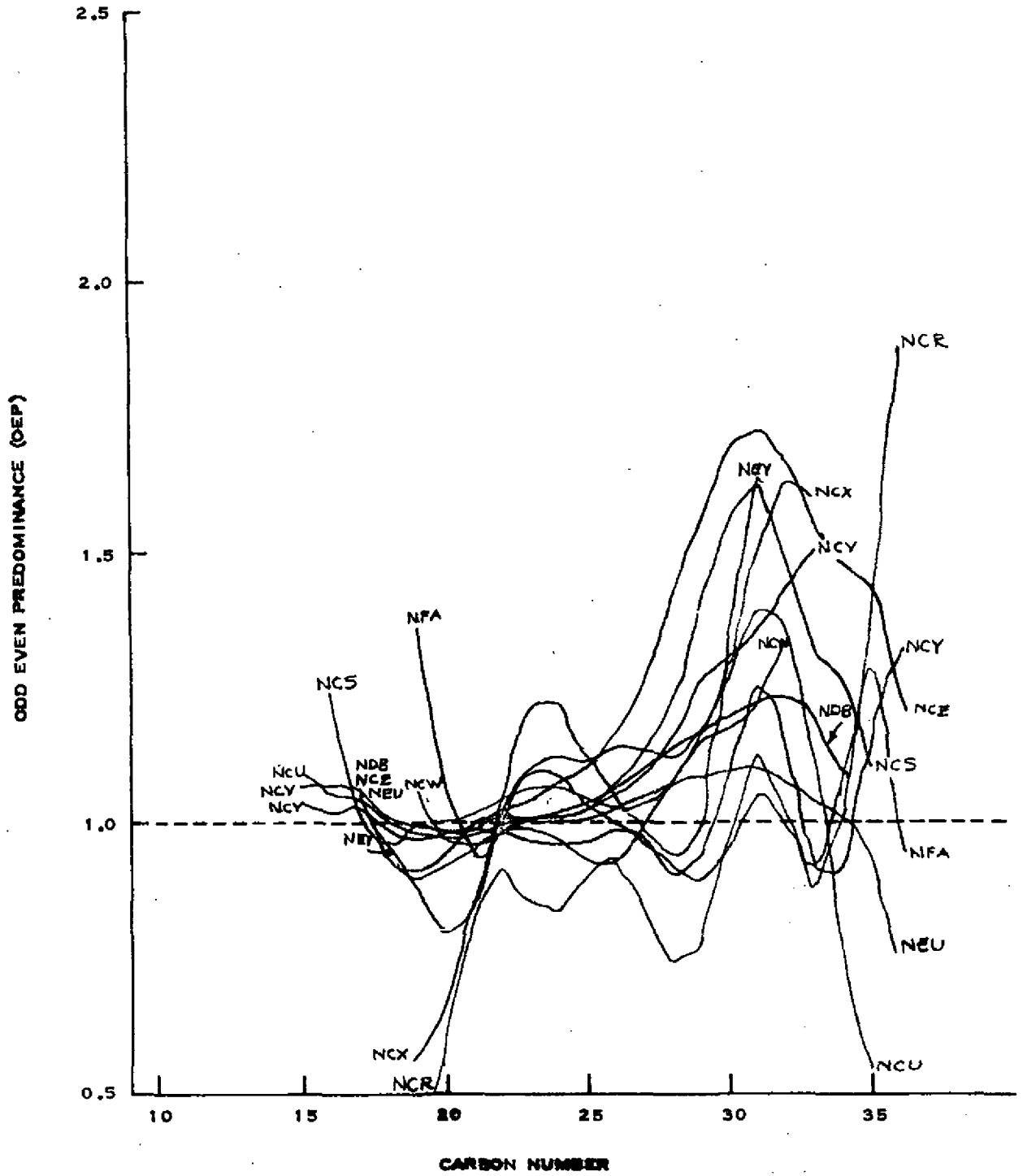


FIGURE 4. OEP CURVES FOR SIDEWALL CORE SAMPLES FROM 2/7-9X, NORWEGIAN SECTOR, NORTH SEA

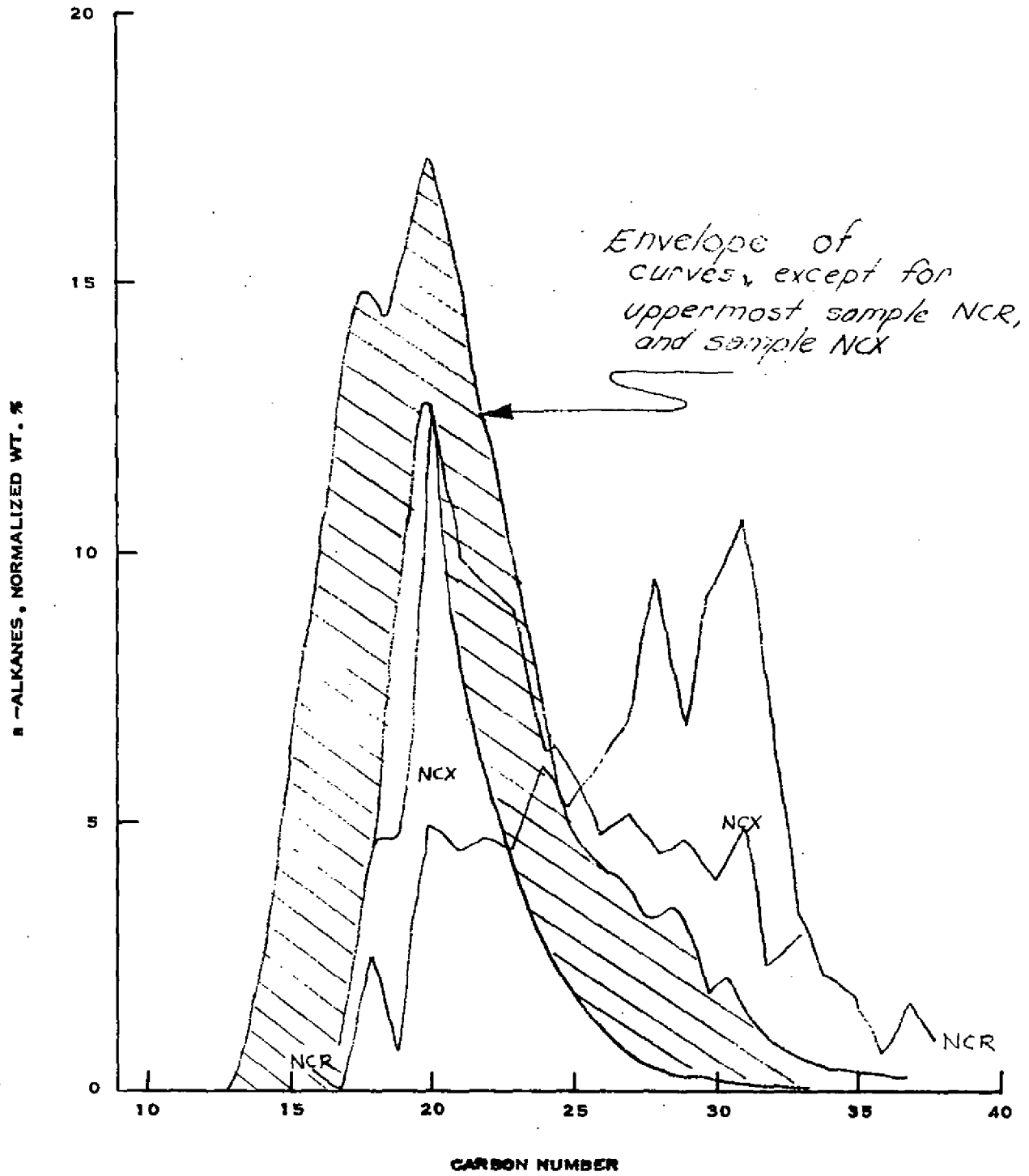


FIGURE 5. n-ALKANE DISTRIBUTION CURVES FOR SIDEWALL CORE SAMPLES FROM 2/7-9X, NORWEGIAN SECTOR, NORTH SEA

Carbon Isotopic Composition,  $\delta^{13}\text{C}_{\text{PDB}}$

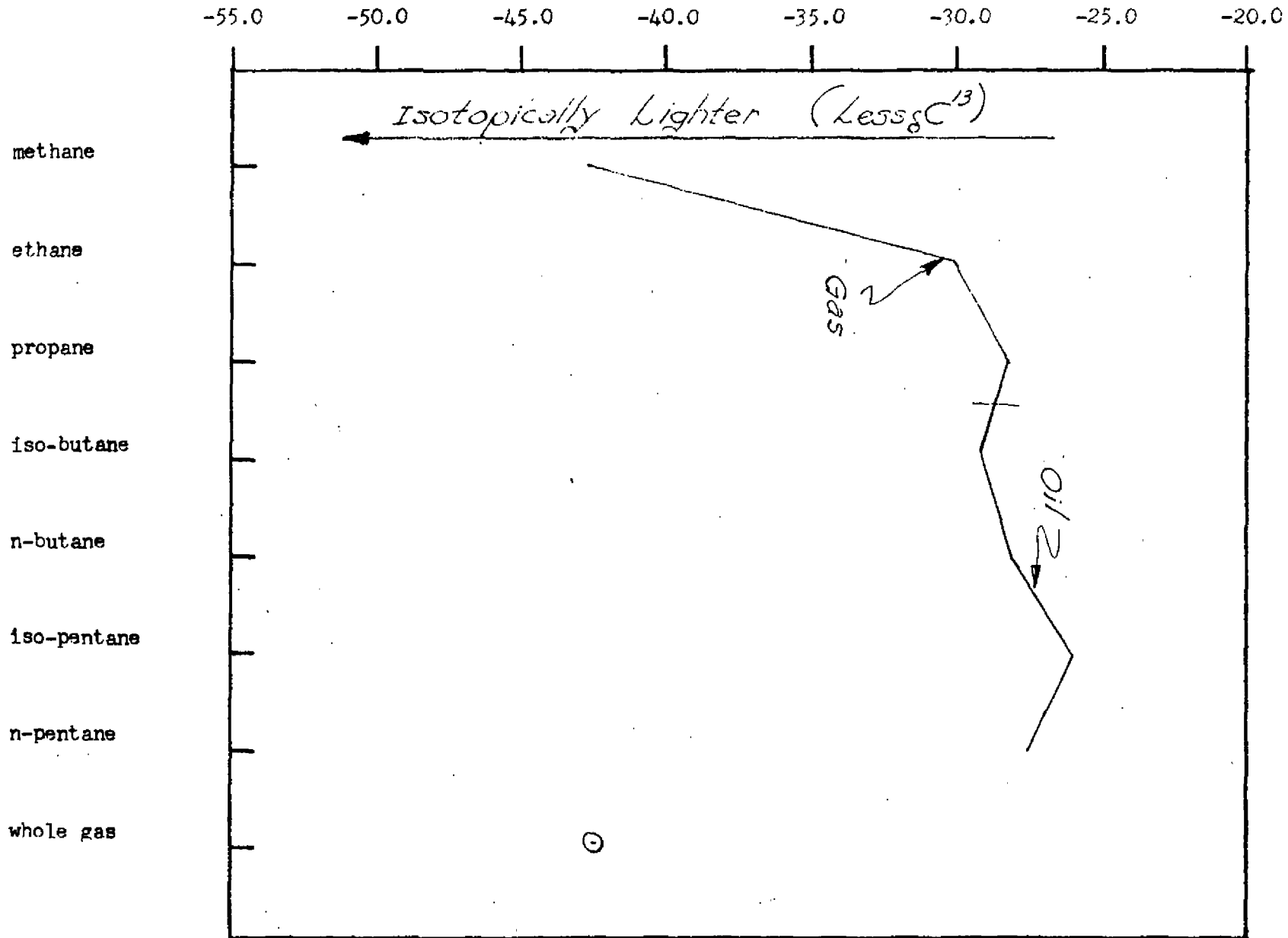
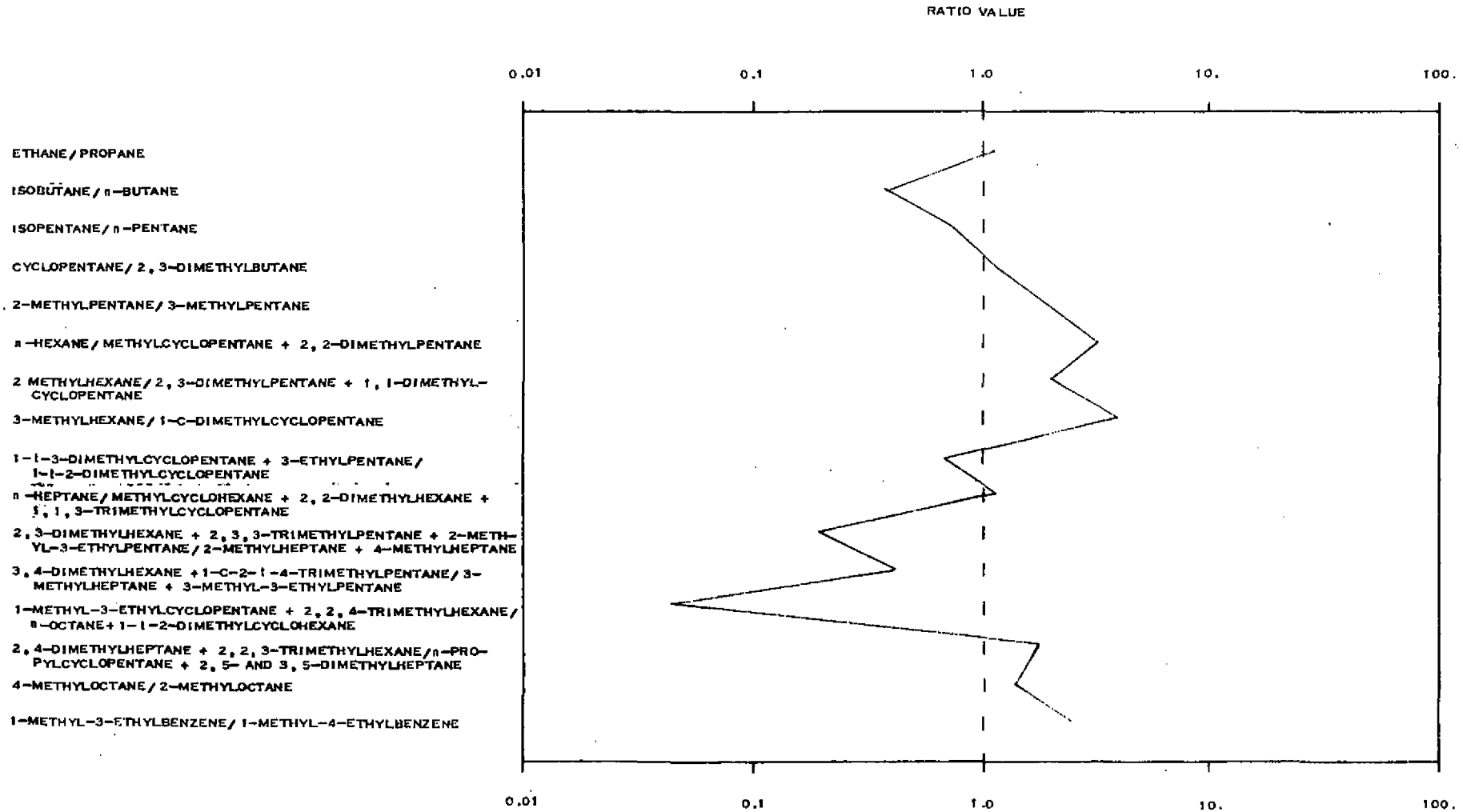


FIGURE 6. CARBON ISOTOPIC COMPOSITION OF NTQ-NTR COMPARISON GAS-LIQUID PAIR FROM THE JURASSIC IN 2/7-9X, NORWEGIAN SECTOR, NORTH SEA

FIGURE 7. OIL SAMPLE NTR FROM THE JURASSIC IN 2/7-9X, NORWEGIAN SECTOR, NORTH SEA  
RATIOS OF COMPONENTS



Attachment to DAM-116-75

FIGURE 8

STIFF DIAGRAM FOR WATER SAMPLE NSX

TOP 2/7-9 ELDFISK N. SEA NORWAY DST.3  
 O&W.WEL.HED.REVERSE OUT AFTER POST-ACID FLOW PERIOD 4/5/74

MILLIEQUIVALENTS / LITER

10000 1000 100 10 1 10 100 1000 10000

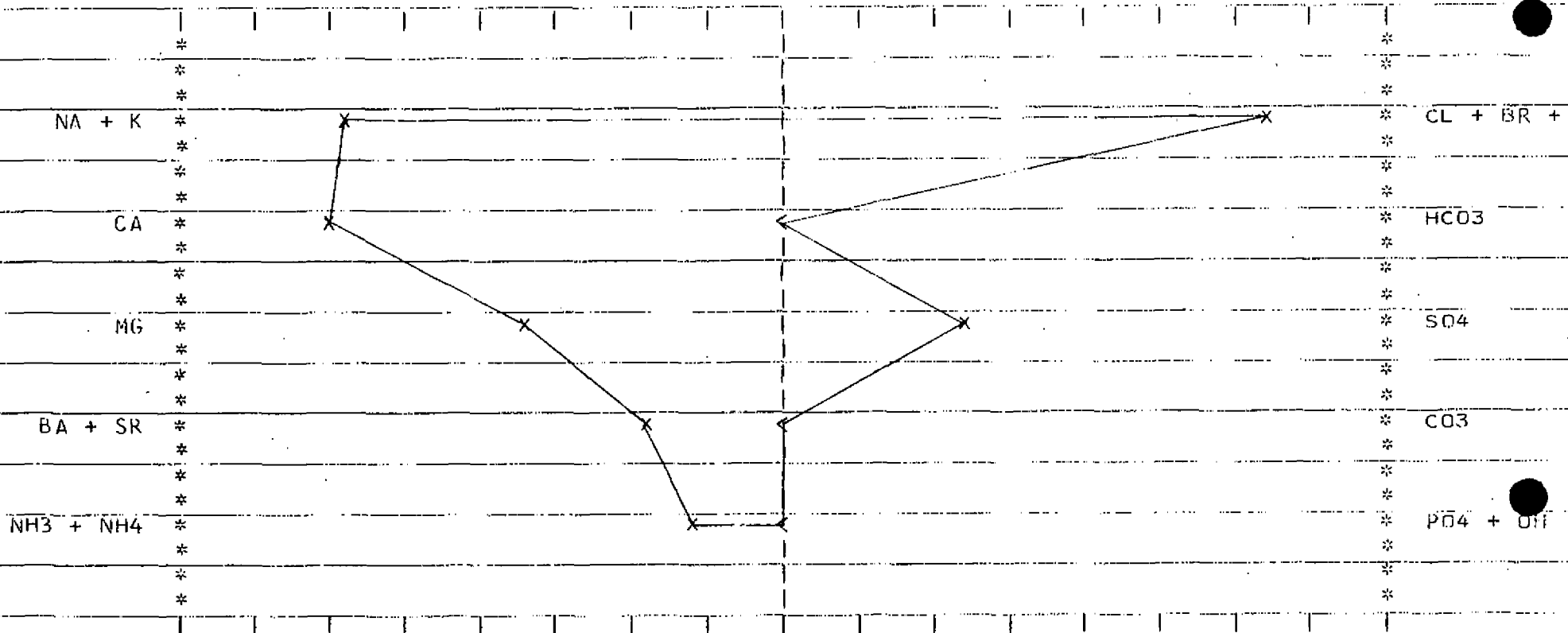




FIGURE 9

STIFF DIAGRAM FOR WATER SAMPLE NSY

2/7-9 ELDFISK N. SEA NORWAY DST.2  
 O&N CHUKE MAN. ON RIG FLR. REV. OUT AFTER P.A. FLOW 4/1/74

MILLIEQUIVALENTS / LITER

