Rec. 23-4-74

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PHILLIPS 66

April 18, 1974

INTER-OFFICE CORRESPONDENCE / SUBJECT:
BARTLESVILLE, OKLAHOMA

Thermal Alteration and Source Rock Potential study of sidewall cores from PPCo 2/4-11 Espen and PPCo 2/7-9 Eldfisk, Norway

file

J. Schriber
Attention: W. Byrd
Stavanger Office

A total of 14 sidewall core samples were examined from the 2/4-11 well for relative abundance of amorphous kerogen; of these samples eight contained enough organic material to permit Reflectance studies. Results of these studies are illustrated on the accompanying attachment for the Espen well.

A summary of the attached Espen well data indicates: A secondary source rock at 9700' with a fairly low thermal history; direct measurements were not possible but samples at 9400' and 9900' with .55 and .54 R_o (Reflectivity) respectively.

At 12,470' the R_o value is .59 compared to .86 R_o at 12,618'. Subsequently studied samples stratigraphically lower indicate this increase at 12,618' is not an isolated increase. R_o values of .88 at 13,075'; .92 at 13,320'; and .89 at 13,510' were measured. These data are interpreted as indicating a much higher thermal history for rocks from 12,618' through 13,510' and may be related to salt tectonics with subject interval of higher R_o values absorbing temperature increase and not allowing elevated temperatures to penetrate sediments at 12,470'.

An alternate interpretation may be that sediments from 12,470' and younger were not present when the elevated temperatures occurred and would thus effectively date this period of elevated thermal alteration.

Also, it should be noted that potential primary and secondary source rocks are indicated at 13,075' and 13,320' respectively.

A total of 15 sidewall core samples were studied from the 2/7-9 Eldfisk well for relative abundance of amorphous kerogen. Unfortunately only four of these samples contained sufficient organics to evaluate them for reflectivity. See 2/7-9 Eldfisk well attachment.

A summary of these data indicate: a rapid increase in reflectivity from 9053' through 9948' with R_o values increasing from .37 to .83 respectively. As mentioned above, sufficient organics were not recovered below 9948' to make reflectance readings. However, in transmitted light the meager amount of organics observed appeared black, indicating a high thermal history, and in ultraviolet light would not fluoresce.

Relative abundance of amorphous kerogen indicates potential primary source rocks at 9585', and potential secondary source rocks at 9800' and 13,830'.

In conclusion, from presently available data there does not appear to be an abundance of liquid hydrocarbon generating organics at optimum reflective values, i.e., .70 R_o through 1.0 R_o to suggest major source beds in the sedimentary sequences studied.

Logan Urban

LU:mm
Attach.

cc: W. E. Ryker (r) J. R. Davis - London
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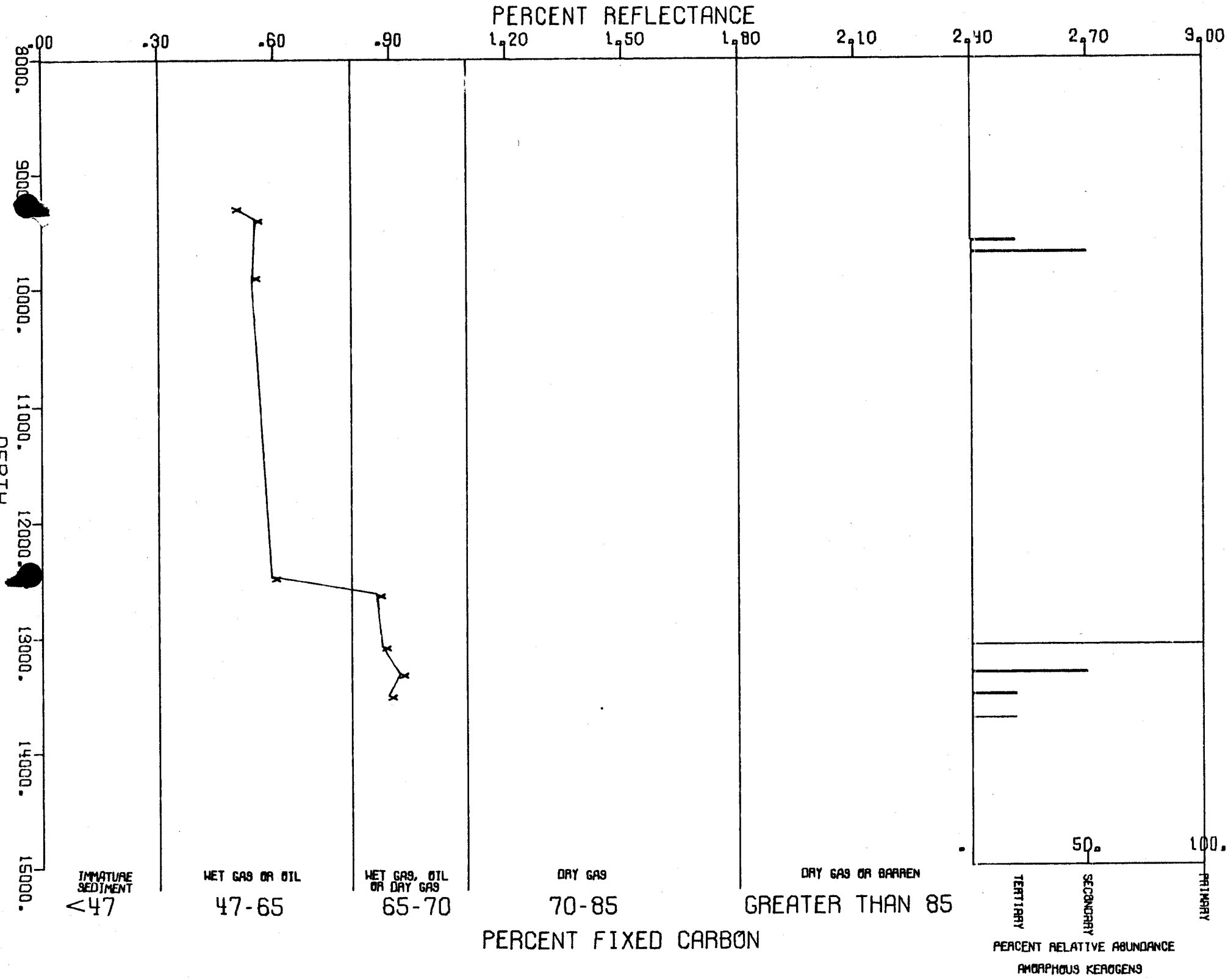
H. A. Kuehnert (r) R&EPS file

THERMAL ALTERATION AND SOURCE ROCK POTENTIAL OF PHILLIPS PETROLEUM 2/4-11 ESPEN NORWAY

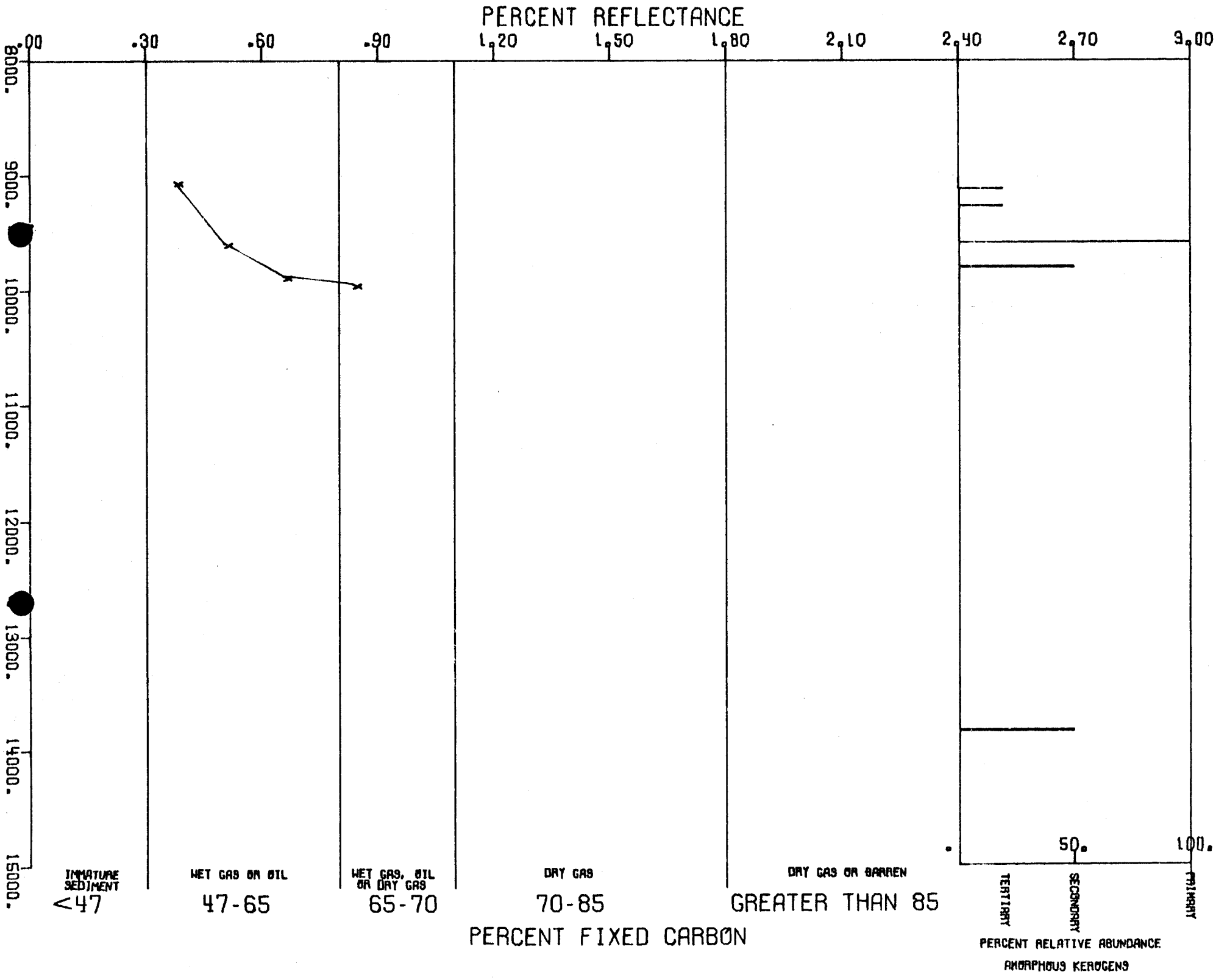


JOB F000 W.O. RXS68

DEPTH	MEAN	STD DEV
9300.	0.498	0.025
9400.	0.551	0.029
9900.	0.545	0.038
12479.	0.596	0.040
12618.	0.365	0.047
13075.	0.881	0.052
13320.	0.925	0.038
13510.	0.894	0.055

TOP	BASE	PERCENT RELATIVE ABUNDANCE AMORPHOUS KEROGENS
9200.	9201.	0.
9300.	9301.	0.
9400.	9401.	0.
9500.	9501.	0.
9600.	9601.	20.
9700.	9701.	50.
9900.	9901.	0.
12470.	12471.	0.
12618.	12619.	0.
12885.	12886.	0.
13075.	13075.	100.
13320.	13321.	50.
13510.	13511.	20.
13712.	13713.	20.

THERMAL ALTERATION AND SOURCE ROCK POTENTIAL OF PHILLIPS PETROLEUM 2/7-9 ELDFISK NORWAY



JOB F000 W.O. RXS68

DEPTH	MEAN	STD DEV
9053.	0.377	0.025
9585.	0.506	0.019
9875.	0.660	0.040
9948.	0.839	0.042

TOP	BASE	PERCENT RELATIVE ABUNDANCE AMORPHOUS KEROGENS
9053.	9054.	0.
9126.	9127.	20.
9200.	9201.	0.
9275.	9276.	20.
9425.	9426.	0.
9496.	9497.	0.
9585.	9586.	100.
9654.	9655.	0.
9800.	9801.	50.
9875.	9876.	0.
9948.	9949.	0.
10026.	10027.	0.
13400.	13401.	0.
13496.	13497.	0.
13830.	13831.	50.

TOP	BASE	PERCENT RELATIVE ABUNDANCE AMORPHOUS KEROGENS
9053.	9054.	0.
9126.	9127.	20.
9200.	9201.	0.
9275.	9276.	20.
9425.	9426.	0.
9496.	9497.	0.
9585.	9586.	100.
9654.	9655.	0.
9800.	9801.	50.
9875.	9876.	0.
9948.	9949.	0.
10026.	10027.	0.
13400.	13401.	0.
13496.	13497.	0.
13830.	13831.	50.

Mr. Schriber - Tananger
CJD

cc: R & D Files
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INTER-OFFICE CORRESPONDENCE / SUBJECT:
BARTLESVILLE, OKLAHOMA

July 23, 1975

File

North Sea, Norwegian Sector,
Espen 2/4-11X, Oil, Water,
SWC Characterization
DAM-128-75

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Geochemical characterization has been completed on oil, water and sidewall cores recovered from the Espen 2/4-11X, Norwegian Sector, North Sea. Samples include a companion pair collected from DST-5 of the 3146-3161 m (10,320-10,370 ft) interval, and water from reversed circulation of DST's-4 and 3 conducted between 3188 and 3200 m (10,460-10,500 ft), and 3639-3667 m (11,940-12,030 ft), respectively, and sidewall cores taken at about 30 meter (100 ft) intervals beginning at 2803 m (9197 ft) and extending down to a depth of 4197 m (13,770 ft). The DST's were run in Danian-Cretaceous strata and the sidewall cores represent an inclusive range that extends through the Lower Cretaceous and into the Jurassic.

Conclusions and interpretations resulting from this study are as follows:

1. The oil is characteristic of that produced from fields in the Ekofisk complex. It is a mature light crude, high in saturates, i.e., paraffins and naphthenes, with a density of 0.8388 kg/l at 15°C (37.1 API gravity), and a sulfur and nitrogen content of only 0.14 and 0.10 weight percent, respectively.

2. The oil originated from organic matter which accumulated in an open marine environment.

3. The claystone recovered from a depth of 2803 m (9197 ft) NCG qualifies as a source rock since petroleum has been generated and migrated out.

4. The suite of sidewall samples are rich in organic content, especially those representing the Lower Cretaceous-Jurassic rocks over the 3812-4197 m (12,505-13,770 ft) intervals. Petroleum genesis is well advanced throughout the section. However, with the exception of sample NCG the remaining samples have high ratios of oil to kerobitumen. This indicates that not all the oil is indigenous to the section but is migrating probably over short distances through porous laminae. These samples are classified as capillary reservoirs rather than source rocks. This suggests that hydrodynamic as well as lithological factors crucial for petroleum migration have not been met and that most of the oil which has been generated in the vicinity of this well still is retained in the section.

5. As emphasized in several earlier reports, e.g., Eldfisk 2/7-1X report Er-116-71, it is apparent that conditions for petroleum genesis in the North Sea Basin were essentially identical during the Jurassic and again during the Paleocene. This study supports this finding and indicates the Danian Cretaceous crude oil

produced from this wall is virtually identical to the oil extracted from the sidewall cores taken over the 2803-4197 m (9197-13770 ft) interval. This recurrence of similar conditions of source rock formation over geological time also has been observed in the Persian Gulf Basin.

6. Final or bottom waters recovered from the 3188-3200 m (10,460-10,500 ft) and 3639-3667 m (11,940-12,030 ft) intervals are not representative of the formation. Water recovered from the deeper interval consists mainly of spent acid, and the final recovery from the shallower zone is badly contaminated with drilling mud. The middle sample recovered from the 3188-3200 m (10,460-10,300 ft) interval is most representative of the formation. It has a resistivity of 0.406 ohm-meters, a pH of 8.29, and a total dissolved solids content of 1.69 wt. percent. Direct geochemical evidence indicates the waters recovered from both intervals have been in contact with liquid petroleum.

These conclusions and interpretations are based on data provided in Tables I through IX and Figures 1 through 10.

David A. Morris

DAM/JBF/pam

Attachments: Tables I-IX
Figure 1-10

TABLE I

CHARACTERIZATION OF CRUDE OILS
PHYSICAL, CHEMICAL, AND ISOTOPIC PROPERTIES
RECOVERED FROM DANIAN-CRETACEOUS IN THE
ESPEN 2/4-11X WELL, NORWEGIAN SECTOR, NORTH SEA

Geochem. Branch Code	Density	API Gravity	Pour Point Deg-C	Viscosity		Heteroelements				Total Crude C-13	Major Petroleum Fractions						Odd-Even Predominance OEP
				21 Deg C CS	38 Deg C CS	Sulfur Wt. %	Nitrogen Wt. %	Vanadium Wt. %	Nickel Wt. %		Saturates		Aromatics		Asphaltics		
											Wt. %	C-13	Wt. %	C-13	Wt. %	C-13	
NTP*	0.8388	37.1	-4.0	8.9	4.5	0.14	0.10	0.16	2.11	-27.2	74.0	-26.3	20.5	-25.9	5.5	-25.6	1.02

*For detailed compositional data see Figure 1.

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TABLE II

SOURCE ROCK EVALUATION DATA

PALEOCENE, LOWER CRETACEOUS AND JURASSIC SIDEWALL CORES FROM THE ESPEN 2/4-11X WELL, NORWEGIAN SECTOR, NORTH SEA

GEOCHEMISTRY BRANCH CODE	DEPTH METERS	DEPTH FEET	CARBONATE CARBON, WT %	ORGANIC CARBON, WT %	RATIO SOLUBLE / TOTAL CARBON	SOLUBLE ORGANIC MATTER: TOTAL WT %	TOTAL C-13	SATURATES WT %	SATURATES C-13	AROMATICS WT %	AROMATICS C-13	ASPHALTICS WT %	ASPHALTICS C-13	ODD-EVEN PREDOMINANCE OEP
NCG	2803	9197	0.43	0.84	0.051	0.053	-26.5	46.5	-28.6	36.8	-27.8	16.7	-26.0	1.11
NCH	2834	9297	0.09	0.60	0.274	0.206	-28.3	73.6	-27.7	20.0	-27.3	6.5	-26.8	1.11
NCI	2864	9397	0.05	0.66	0.081	0.067	-26.1	64.4	-27.6	24.2	-26.6	11.5	-25.8	1.13
NCJ	2895	9497	0.06	0.86	0.219	0.236	-27.7	69.3	-28.1	23.4	-26.7	7.3	-26.6	1.04
NCK	2925	9597	0.16	0.46	0.291	0.166	--	--	-27.8	13.8	-26.6	6.2	-25.6	1.03
NCL	2956	9697	0.12	0.94	0.179	0.209	--	--	-29.6	37.3	-27.5	15.4	-27.5	0.92
NCM	2987	9800	0.04	0.84	0.115	0.120	-27.6	41.8	-28.3	36.6	-26.5	21.6	-26.1	1.08
NCN	3032	9947	0.23	0.64	0.329	0.263	-27.9	76.0	--	19.4	26.6	4.6	-26.3	1.02
NCO	3812	12505	3.41	1.64	0.481	0.982	-27.7	76.2	-28.0	19.9	-26.7	3.9	-26.2	1.05
NGD	4033	13232	1.25	2.65	0.180	0.593	-27.5	66.8	-27.6	26.4	-26.7	6.8	-26.2	1.06
NGC	4086	13405	0.89	2.80	0.185	0.646	-27.6	66.0	-27.7	28.2	-26.7	5.8	-26.6	1.05
NGB	4118	13510	0.71	2.85	0.170	0.605	-27.2	66.8	-26.8	27.0	-25.9	6.2	-25.8	1.04
NFZ	4197	13770	1.72	0.61	0.239	0.182	-27.4	63.4	-28.3	19.5	-26.8	17.2	-27.1	1.06

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TABLE III

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY
O&W DST 3

GEOCHEMISTRY BRANCH CODE, NTC
TOTAL DISSOLVED CHROMIUM = 0.92 PPM
RESISTIVITY, 25 DEG. C, 0.073 OHM METERS
PH = 4.38 TOTAL DISSOLVED SOLIDS = 13.78

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS	ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	1.3300	0.0579	CHLORIDE	8.3000	0.2341
POTASSIUM	0.0300	0.0008	BROMIDE	0.0140	0.0002
CALCIUM	3.9000	0.1946	IODIDE	0.0000 *	0.0000
MAGNESIUM	0.1200	0.0099	SULFATE	0.0580	0.0012
AMMONIUM	0.0046	0.0002	PHOSPHATE	0.0016	0.0001
AMMONIA	0.0000	0.0000	BICARBONATE	0.0000	0.0000
BARIUM	< 0.00485	0.0001	CARBONATE	0.0000	0.0000
STRONTIUM	0.0265	0.0006			
TOTAL =	5.4113	TOTAL = 0.2637	TOTAL =	8.3735	TOTAL = 0.2355

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM	
BENZENE	0.00	- oil present
TOLUENE	0.00	

* insufficient sample

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TABLE IV

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY
O&W DST 3

GEOCHEMISTRY BRANCH CODE, NTD
TOTAL DISSOLVED CHROMIUM = 0.50 PPM
RESISTIVITY, 25 DEG. C, 0.071 OHM METERS
PH = 4.52

TOTAL DISSOLVED SOLIDS = 13.68

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	1.9400	0.0844
POTASSIUM	0.0300	0.0008
CALCIUM	3.2000	0.1597
MAGNESIUM	0.1100	0.0090
AMMONIUM	0.0067	0.0003
AMMONIA	0.0000	0.0000
BARIUM	< 0.00485	0.0001
STRONTIUM	0.0435	0.0010
TOTAL =	5.3283	TOTAL = 0.2549

ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
CHLORIDE	8.2800	0.2335
BROMIDE	0.0210	0.0003
IODIDE	0.0014	0.0000
SULFATE	0.0520	0.0011
PHOSPHATE	0.0008	0.0000
BICARBONATE	0.0000	0.0000
CARBONATE	0.0000	0.0000
TOTAL =	8.3551	TOTAL = 0.2349

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM	
BENZENE	0.00-	= oil present
TOLUENE	0.00-	

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TABLE V

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY
O&W DST 3

GEOCHEMISTRY BRANCH CODE, NTE
TOTAL DISSOLVED CHROMIUM = 1.03 PPM
RESISTIVITY, 25 DEG. C, 0.071 OHM METERS
PH = 4.55 TOTAL DISSOLVED SOLIDS = 13.76

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS	ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	1.9600	0.0853	CHLORIDE	8.4500	0.2383
POTASSIUM	0.0300	0.0008	BROMIDE	0.0215	0.0003
CALCIUM	3.0900	0.1542	IODIDE	0.0013	0.0000
MAGNESIUM	0.1100	0.0090	SULFATE	0.0540	0.0011
AMMONIUM	0.0067	0.0003	PHOSPHATE	0.0006	0.0000
AMMONIA	0.0000	0.0000	BICARBONATE	0.0000	0.0000
BARIUM	< 0.00485	0.0001	CARBONATE	0.0000	0.0000
STRONTIUM	0.0450	0.0010			
TOTAL =	5.2399	TOTAL = 0.2503	TOTAL =	8.5273	TOTAL = 0.2397

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM	
BENZENE	0.00 -	- oil present
TOLUENE	0.00 -	

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TABLE VI

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY
WATER DST 3

GEOCHEMISTRY BRANCH CODE, NTF
TOTAL DISSOLVED CHROMIUM = 1.01 PPM
RESISTIVITY, 25 DEG. C, 0.071 OHM METERS
PH = 4.58

TOTAL DISSOLVED SOLIDS = 13.58

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS	ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	2.4500	0.1066	CHLORIDE	7.9600	0.2245
POTASSIUM	0.0300	0.0008	BROMIDE	0.0225	0.0003
CALCIUM	2.9100	0.1452	IODIDE	0.0015	0.0000
MAGNESIUM	0.1100	0.0090	SULFATE	0.0500	0.0010
AMMONIUM	0.0070	0.0003	PHOSPHATE	0.0007	0.0000
AMMONIA	0.0000	0.0000	BICARBONATE	0.0000	0.0000
BARIUM	< 0.00485	0.0001	CARBONATE	0.0000	0.0000
STRONTIUM	0.0470	0.0011			
TOTAL =	5.5519	TOTAL = 0.2627	TOTAL =	8.0346	TOTAL = 0.2258

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	68.20
TOLUENE	41.80

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TABLE VII

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY

WATER DST 4

GEOCHEMISTRY BRANCH CODE, NSZ
TOTAL DISSOLVED CHROMIUM = <0.51 PPM
RESISTIVITY, 25 DEG. C, 0.219 OHM METERS
PH = 8.19

TOTAL DISSOLVED SOLIDS = 3.13

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	1.0200	0.0444
POTASSIUM	0.0400	0.0010
CALCIUM	0.0469	0.0023
MAGNESIUM	0.1000	0.0082
AMMONIUM	0.0001	0.0000
AMMONIA	0.0000	0.0000
BARIUM	<0.00015	0.0000
STRONTIUM	0.0009	0.0000
TOTAL =	1.2079	TOTAL = 0.0559

ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
CHLORIDE	1.8500	0.0522
BROMIDE	0.0057	0.0001
IODIDE	0.0003	0.0000
SULFATE	0.0650	0.0014
PHOSPHATE	0.0000 *	0.0000
BICARBONATE	0.0110	0.0002
CARBONATE	0.0000	0.0000
TOTAL =	1.9319	TOTAL = 0.0537

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	0.00
TOLUENE	0.00

* insufficient sample

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TABLE VIII

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N. SEA NORWAY
WATER DST 4

GEOCHEMISTRY BRANCH CODE, NTA
TOTAL DISSOLVED CHROMIUM = < 0.50 PPM
RESISTIVITY, 25 DEG. C. 0.406 OHM METERS
PH = 8.29

TOTAL DISSOLVED SOLIDS = 1.69

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS	ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	0.5300	0.0231	CHLORIDE	0.9200	0.0259
POTASSIUM	0.0200	0.0005	BROMIDE	0.0029	0.0000
CALCIUM	0.0211	0.0011	IODIDE	0.0003	0.0000
MAGNESIUM	0.0408	0.0034	SULFATE	0.1190	0.0025
AMMONIUM	< 0.0001	0.0000	PHOSPHATE	0.0008	0.0000
AMMONIA	0.0000	0.0000	BICARBONATE	0.0380	0.0006
BARIUM	< 0.00055	0.0000	CARBONATE	0.0000	0.0000
STRONTIUM	0.0005	0.0000			
TOTAL =	0.6129	TOTAL = 0.0279	TOTAL =	1.0809	TOTAL = 0.0291

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	0.40
TOLUENE	0.40

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TABLE IX

FORMATION WATER CHARACTERIZATION
ESPEN 2/4-11 N.SEA NORWAY
MUD DST 4

GEOCHEMISTRY BRANCH CODE, NTB
TOTAL DISSOLVED CHROMIUM = 10.70 PPM
RESISTIVITY, 25 DEG. C, 0.238 OHM METERS
PH = 7.90 TOTAL DISSOLVED SOLIDS = 3.

INORGANIC CONSTITUENTS

CATIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS	ANIONS	CONCENTRATION WT/WT PER CENT	EQUIVALENTS PER 100 GRAMS
SODIUM	1.1500	0.0500	CHLORIDE	1.3100	0.0370
POTASSIUM	0.0220	0.0006	BROMIDE	0.0024	0.0000
CALCIUM	0.0161	0.0008	IODIDE	< 0.0003	0.0000
MAGNESIUM	< 0.0011	0.0001	SULFATE	1.2100	0.0252
AMMONIUM	0.0000-*	0.0000	PHOSPHATE	0.0013	0.0000
AMMONIA	0.0000	0.0000	BICARBONATE	0.2120	0.0035
BARIUM	< 0.00025	0.0000	CARBONATE	0.0000	0.0000
STRONTIUM	0.0002	0.0000			
TOTAL =	1.1906	TOTAL = 0.0515	TOTAL =	2.7359	TOTAL = 0.0656

DISSOLVED AROMATIC HYDROCARBONS

COMPOUND	CONCENTRATION PPM
BENZENE	3.40
TOLUENE	17.00

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* insufficient sample

FIGURE 1

COMPONENT COMPOSITION OF COMBINED STREAM
THROUGH N-DECANE, BP = 345.4F (= 174.1C)
ESPEN 2/4-11X, NORWEGIAN SECTOR, NORTH SEA

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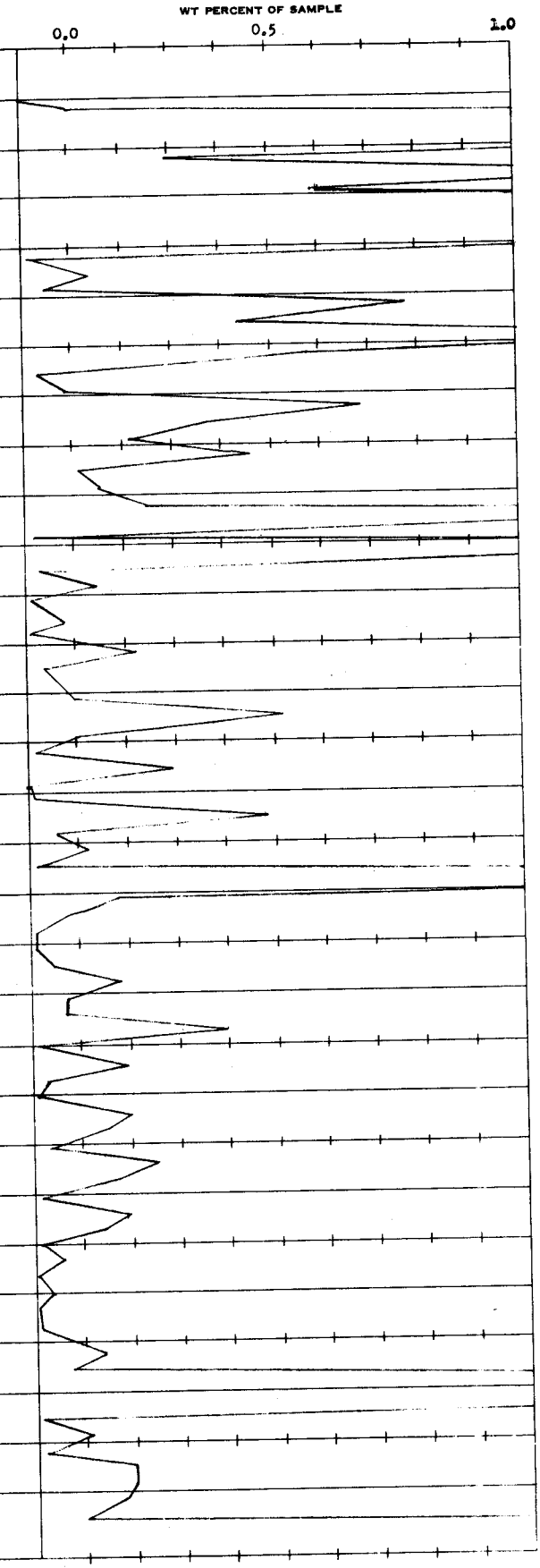
COMPONENT	ANTP-ANTO
HELIUM	0.000
HYDROGEN SULFIDE	0.000
OXYGEN + ARGON	0.000
NITROGEN	0.104
CARBON DIOXIDE	2.133
METHANE	1.106
ETHANE	0.300
PROPANE	1.367
ISOBUTANE	0.619
N-BUTANE	1.862
ISOPENTANE	1.101
N-PENTANE	1.797
NEOHEXANE	0.011
CYCLOPENTANE	0.146
2,3-DIMETHYLBUTANE	0.064
2-METHYLPENTANE	0.783
3-METHYLPENTANE	0.449
N-HEXANE	1.552
METHYLCYCLOPENTANE + 2,2-DIMETHYLPENTANE	0.590
2,4-DIMETHYLPENTANE	0.059
BENZENE + 2,2,3-TRIMETHYLBUTANE	0.117
CYCLOHEXANE + 3,3-DIMETHYLPENTANE	0.682
2-METHYLHEXANE	0.396
2,3-DIMETHYLPENTANE + 1,1-DIMECYCLOPENT.	0.221
3-METHYLHEXANE	0.463
1-CIS-3-DIMETHYLCYCLOPENTANE	0.139
1-TRANS-3-DIMECYPENTANE + 3-ETHYLPENTANE	0.163
1-TRANS-2-DIMETHYLCYCLOPENTANE	0.270
N-HEPTANE	1.426
1-CIS-2-DIMETHYLCYCLOPENTANE	0.049
ECYHEX + 2,2-DIMEHEX + 1,1,3-TRIMECYPENT	1.474
,5-DIMETHYLHEXANE	0.048
2,4-DIMETHYLHEXANE + ETHYLCYCLOPENTANE	0.163
2,2,3-TRIMETHYLPENTANE	0.005
1-TRANS-2-CIS-4-TRIMETHYLCYCLOPENTANE	0.080
3,3-DIMETHYLHEXANE	0.011
TOLUENE	0.234
1-TRANS-2-CIS-3-TRIMETHYLCYCLOPENTANE	0.048
2,3,4-TRIMETHYLPENTANE	0.000
2,3-DIMEHEX + 2,3,3-TRIMEPENT + 2-ME3-ETPENT	0.106
2-METHYLHEPTANE + 4-METHYLHEPTANE	0.536
3,4-DIMEHEX + 1-CIS-2-TRAN-4-TRIMECYPENT	0.132
3-ETHYLHEXANE	0.027
3-METHYLHEPTANE + 3-ME-3-ETHYLPENTANE	0.316
2,2,5-TRIMEHEX + 1,1,3-TR-4-TETRAMECYPENT.	0.013
1-CIS-2-CIS-4-TRIMETHYLCYCLOPENTANE	0.023
1-TRANS-4 + 1-CIS-3 + 1,1-DIMECYHEXANE	0.492
1-ME-3-ETHCYPENT + 2,2,4-TRIMETHYLHEXANE	0.076
1-ME-TRANS-2 + 1-ME-CIS-3-ETHYLCYPENTANE	0.124
CYCLOHEPTANE	0.029
N-OCTANE + 1-TRANS-2-DIMETHYLCYCLOHEXANE	1.240
1-CIS-4-DIMETHYLCYCLOHEXANE	0.194
1-TRANS-3-DIMETHYLCYCLOHEXANE	0.088
2,2,4-TRIMEHEXANE + ISOPROPYLCYCLOPENT.	0.023
2,3,5-TRIMEHEXANE + 2,2-DIMETHYLHEPTANE	0.021
1-METHYL-CIS-2-ETHYLCYCLOPENTANE	0.074
2,4-DIMEHEPTANE + 2,2,3-TRIMETHYLHEXANE	0.195
2,6-DIMEHEPTANE + 1-CIS-2-DIMECYHEXANE	0.091
N-PROPYLCYPENT + 2,5- + 3,5-DIMEHEPTANE	0.087
ETHYLCYCLOHEXANE	0.412
ETHYLBENZENE	0.033
3,3-DIMETHYLHEPTANE + 1,1,3-TRIMECYHEXANE	0.210
2,3,3-TRIMETHYLHEXANE	0.048
2-METHYL-3-ETHYLHEXANE	0.034
P-XYLENE	0.210
M-XYLENE + 2,3,4-TRIMETHYLHEXANE	0.162
2,3- + 3,4-DIMETHYLHEPTANE	0.043
4-METHYLOCTANE	0.271
2-METHYLOCTANE	0.183
3-ETHYLHEPTANE	0.034
3-METHYLOCTANE	0.215
O-XYLENE (+ A C-10 ALKANE)	0.164
2,2,4-TRIMETHYLHEPTANE	0.024
2,2,5-TRIMETHYLHEPTANE	0.069
2,2,6-TRIMETHYLHEPTANE	0.017
UNKNOWN	0.049
2,5,5-TRIMETHYLHEPTANE	0.019
2,4,4-TRIMETHYLHEPTANE	0.022
A C-9 NAPHTHENE	0.157
ISOPROPYLBENZENE	0.086
N-NONANE	1.134
C-9 NAPHTHENES + C-10 ALKANES	2.112
N-PROPYLBENZENE	0.022
1-METHYL-3-ETHYLBENZENE	0.127
1-METHYL-4-ETHYLBENZENE	0.030
1-METHYL-2-ETHYLBENZENE	0.200
1,3,5-TRIMETHYLBENZENE	0.216
1,2,4-TRIMETHYLBENZENE	0.197
1,2,3-TRIMETHYLBENZENE	0.105
N-DECANE	1.057
UNDECANES AND HEAVIER	68.374



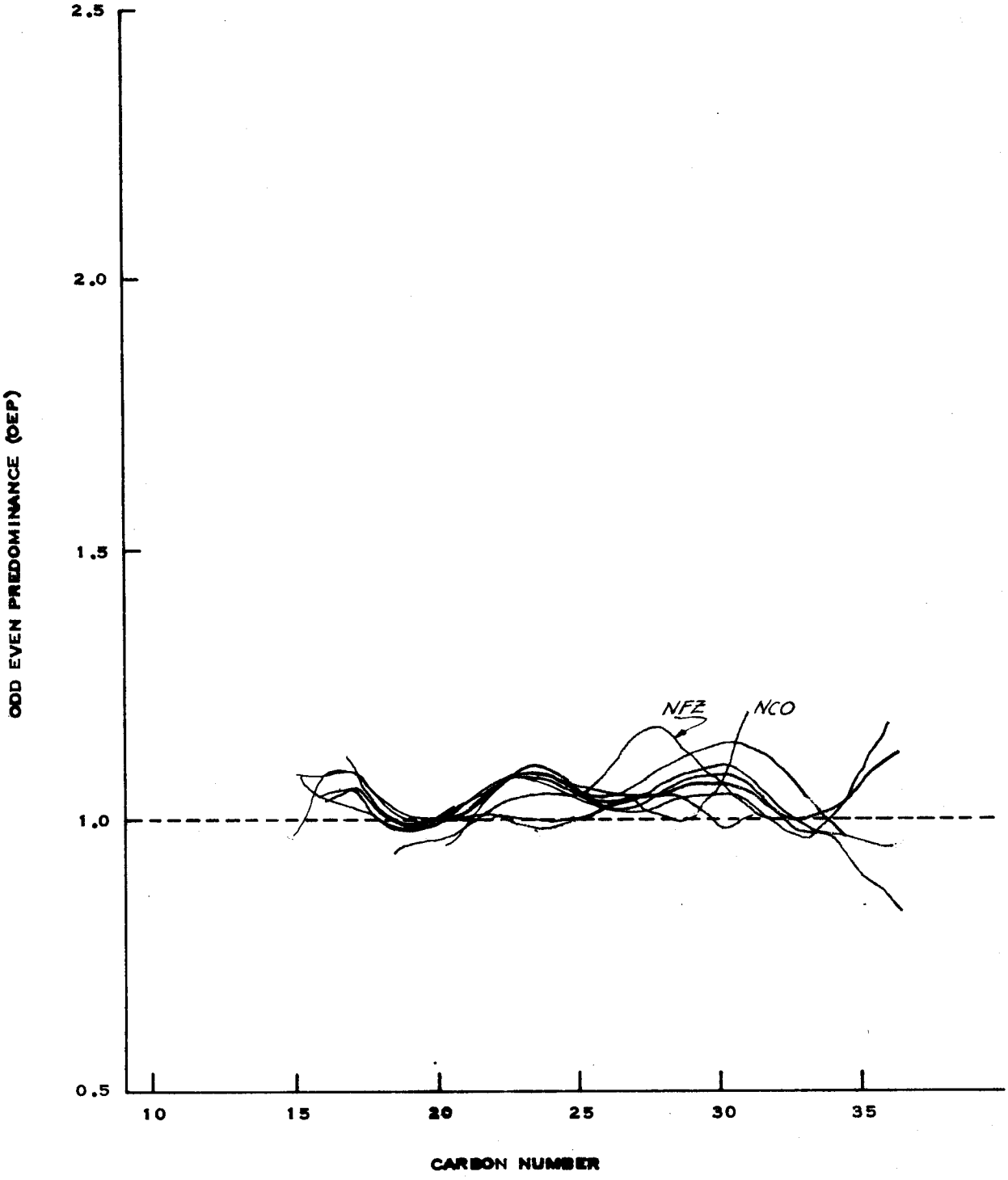


Figure 2. Odd-Even Predominance (OEP) curves as a function of carbon number for an oil recovered from Danian-Cretaceous Limestone, and oil extracted from sidewall cores over this section and from underlying beds of Lower Cretaceous-Jurassic age, in the Espen 2/4-11X, Norwegian Sector, North Sea. Except for peak positions on two of the five soluble organic extracts from the Lower Cretaceous-Jurassic interval, the curves are similar and nearly identical for like plots for oil recovered from Danian-Cretaceous reservoirs in the region.

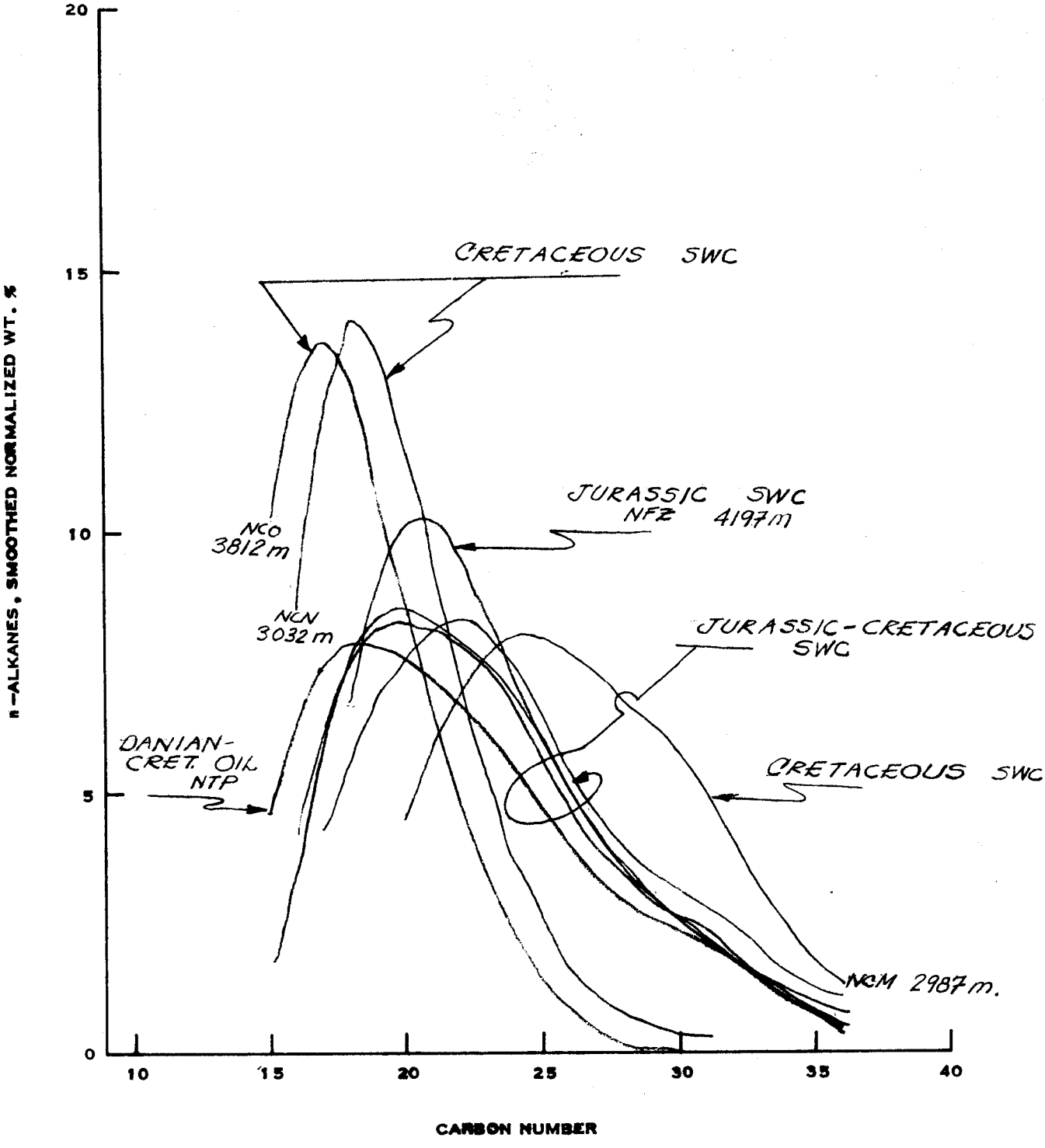


Figure 3. Concentration of n-alkanes by carbon number for the oil recovered from the Danian-Cretaceous Limestone, and various oils extracted from sidewall cores over this section and from underlying beds of Lower Cretaceous and Jurassic age, in the Espen 2/4-11X, Norwegian Sector, North Sea.

FIGURE 4

STIFF DIAGRAM FOR WATER SAMPLE NTC

ESPEN 2/4-11 N. SEA NORWAY

O&W DST 3

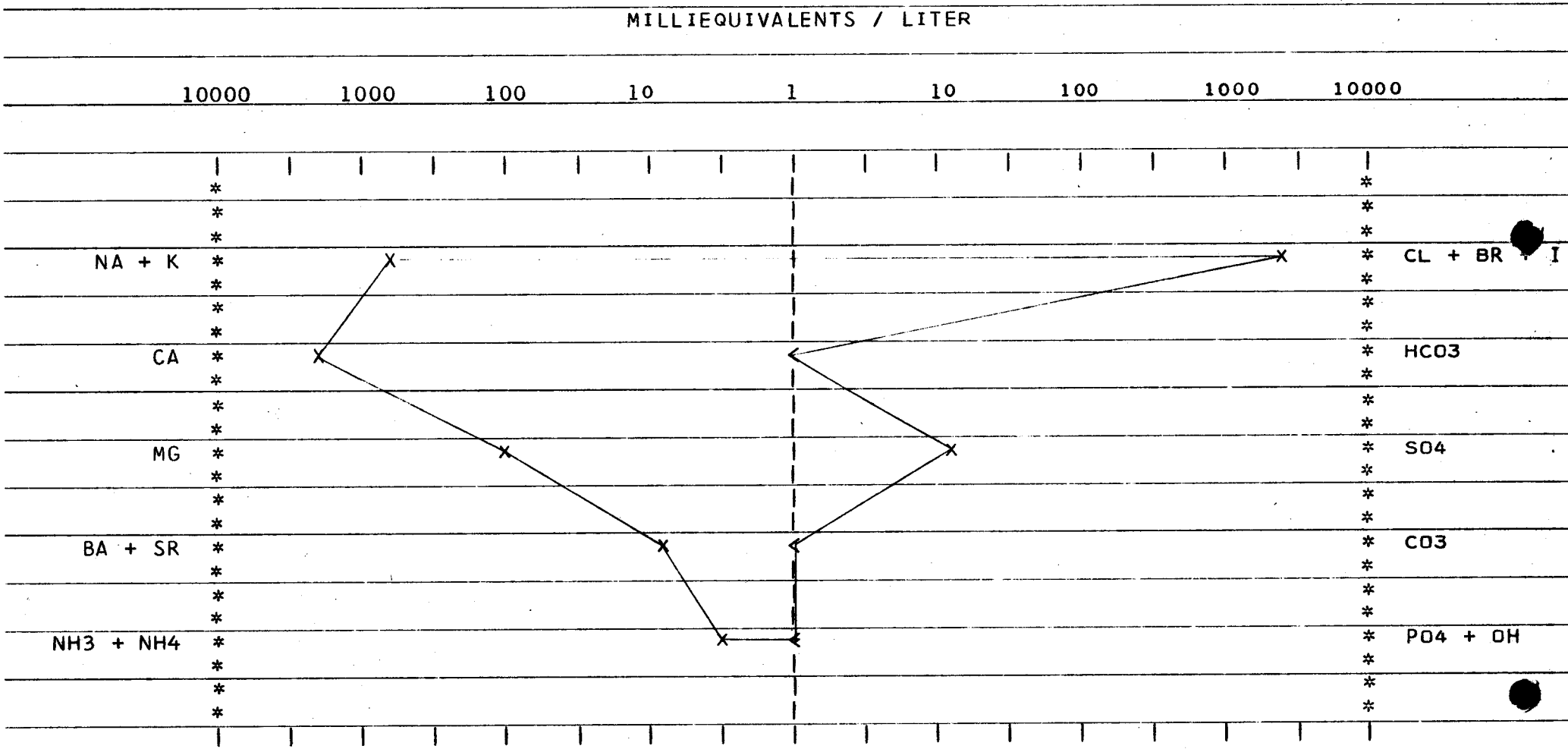


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FIGURE 5

STIFF DIAGRAM FOR WATER SAMPLE NTD

ESPEN 2/4-11 N. SEA NORWAY

O&W DST 3

MILLIEQUIVALENTS / LITER

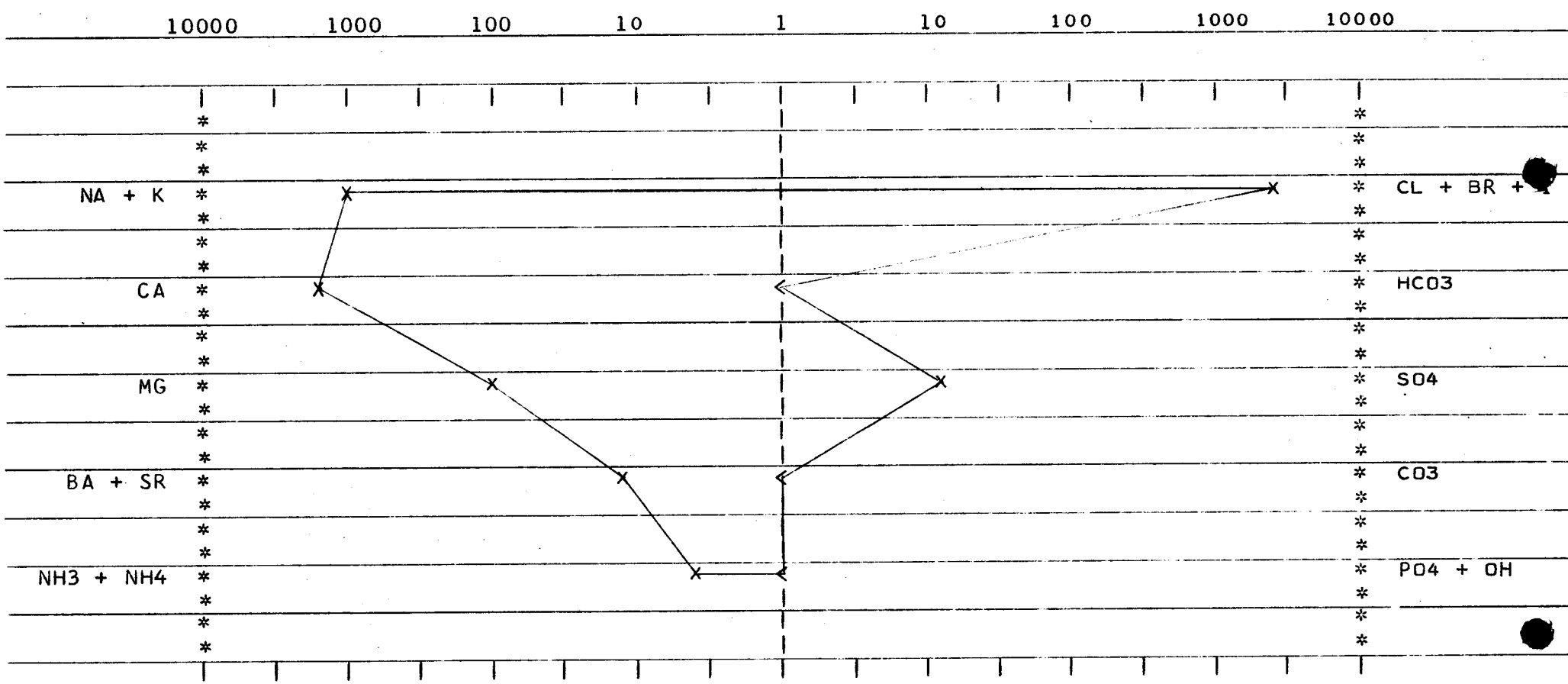

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FIGURE 6

STIFF DIAGRAM FOR WATER SAMPLE NTE

ESPEN 2/4-11 N. SEA NORWAY

O&W DST 3

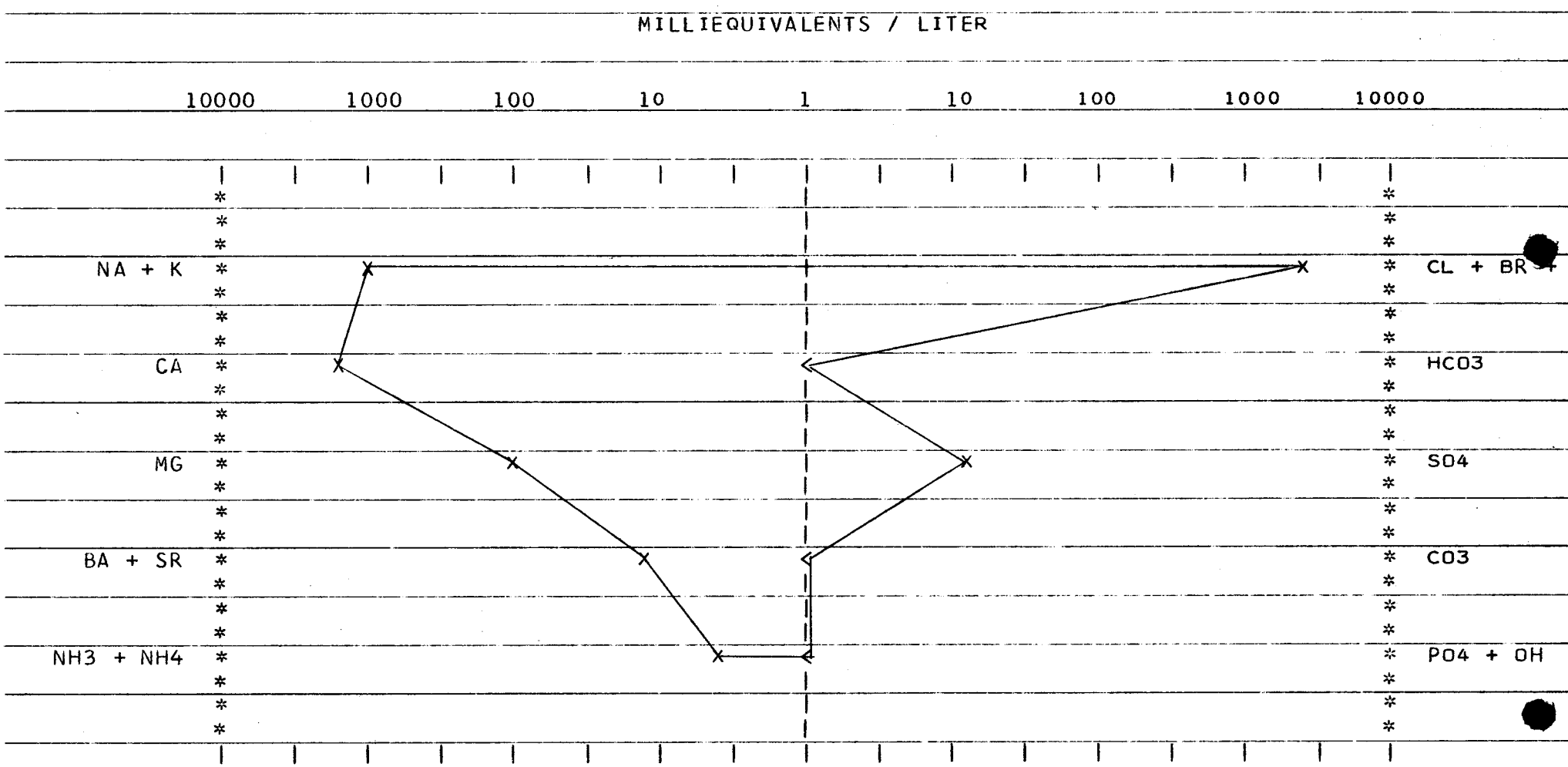

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FIGURE 7

STIFF DIAGRAM FOR WATER SAMPLE NTF

ESPEN 2/4-11 N. SEA NORWAY

WATER DST 3

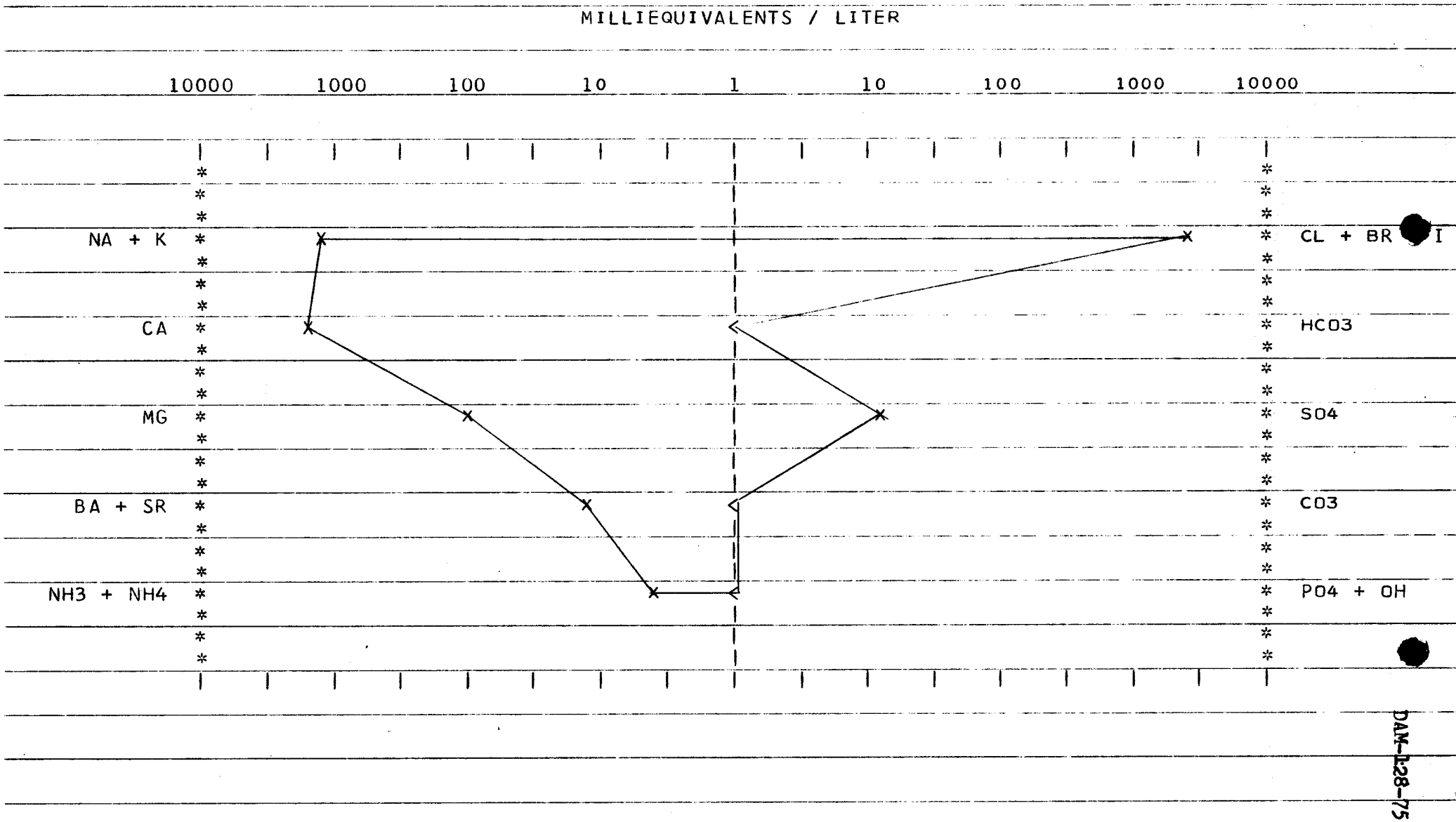

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FIGURE 8

STIFF DIAGRAM FOR WATER SAMPLE NSZ

ESPEN 2/4-11 N. SEA NORWAY

WATER DST 4

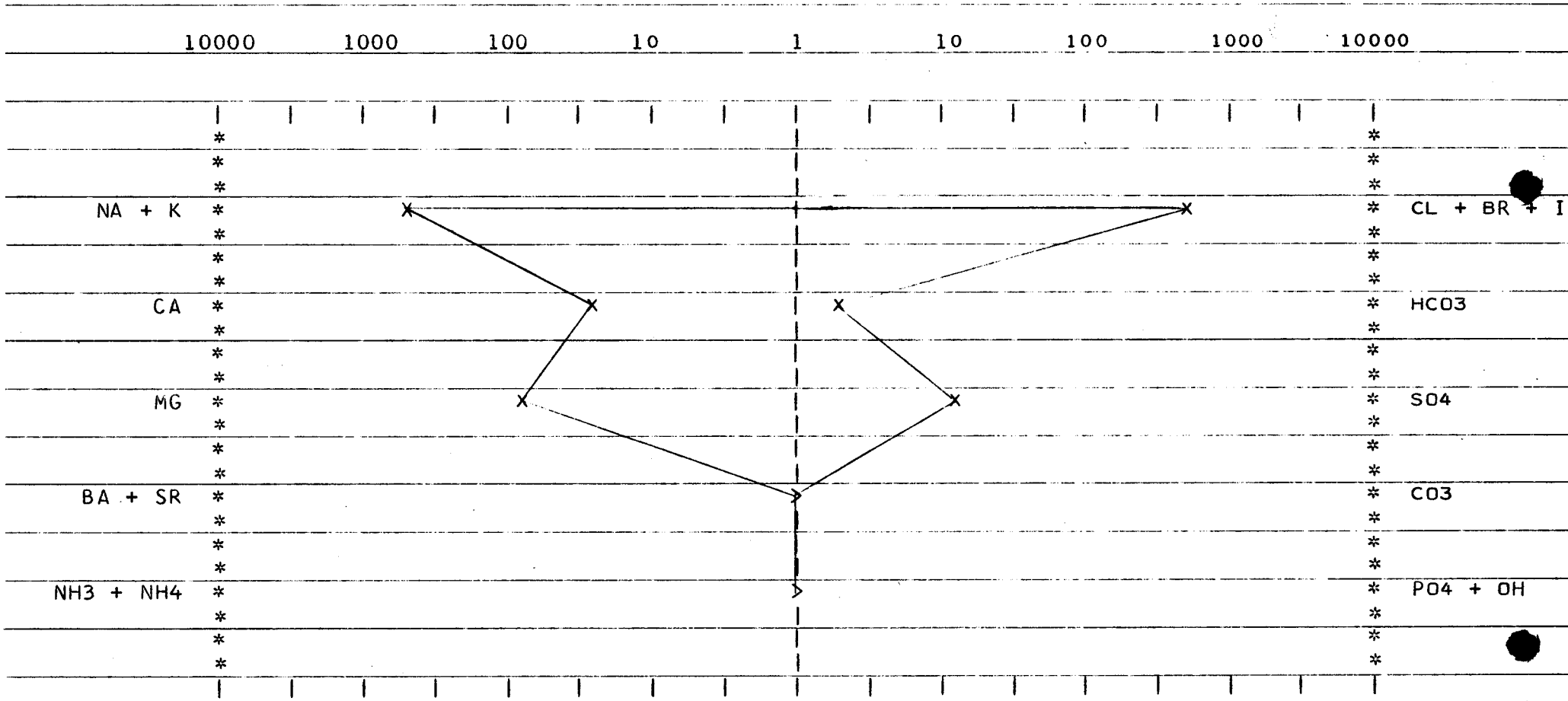

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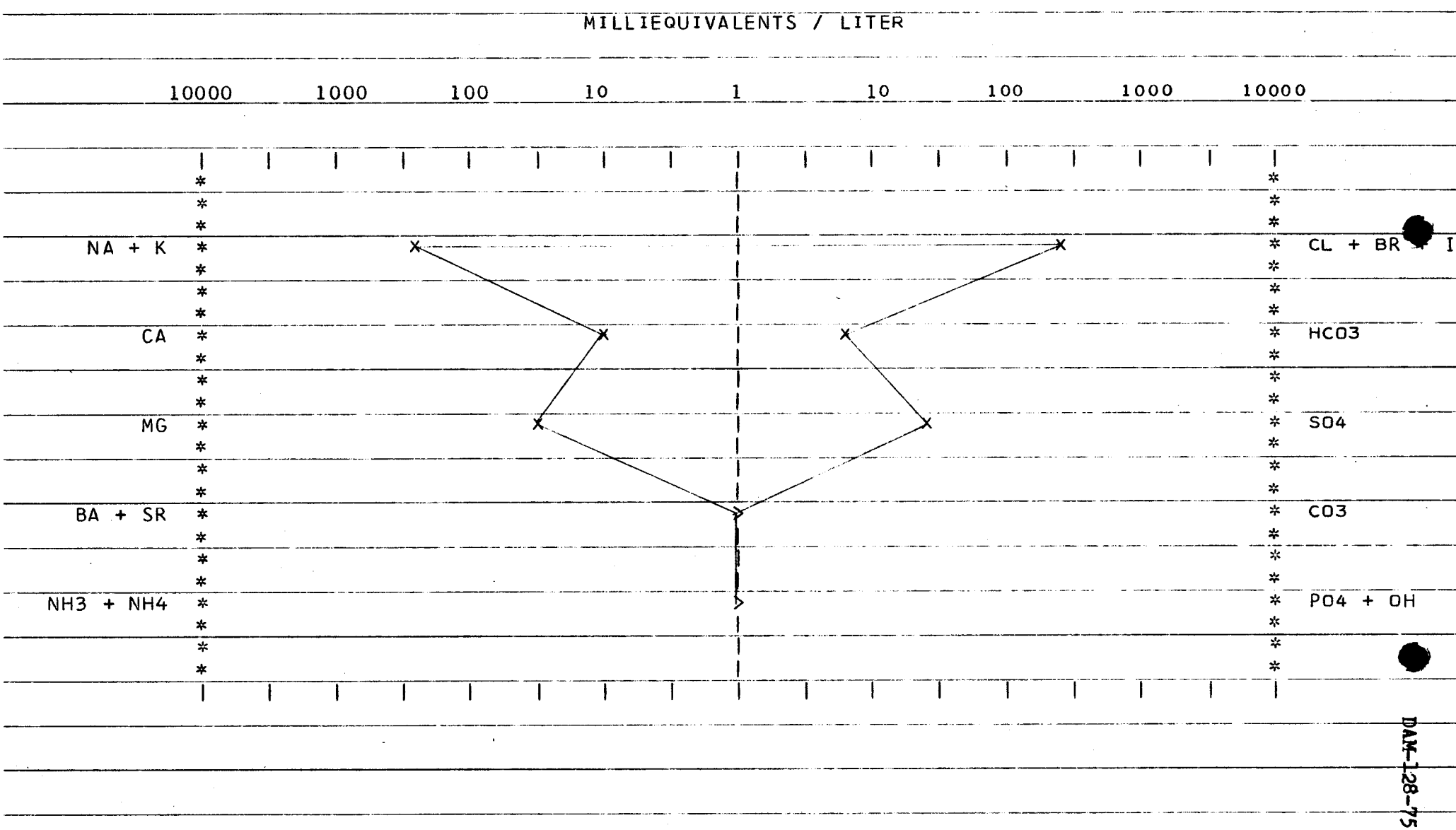
FIGURE 9

STIFF DIAGRAM FOR WATER SAMPLE NTA

ESPEN 2/4-11 N. SEA NORWAY

WATER DST 4



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