U-106

HYDROCARBON SOURCE CHARACTERISTICS OF CUTTINGS FROM WELL 25/11-5, NORWAY

by

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SUMMARY AND CONCLUSIONS

Canned cuttings from the interval 1610-7100 ft (T.D.) were analyzed routinely for hydrocarbon source characteristics. Charges for the work were billed to our Job No. 7585.

The samples were in very poor condition. The cans had been in storage for more than a year and many had completely rusted through, allowing their contents to dry and the free gases to escape. As a result, the data are much less reliable than we prefer.

The geochemical profiles for 25/11-5 are similar to those obtained earlier for 25/11-1.

The analytical data from 25/11-5 are interpreted grossly as follows:

Interval (ft)	Maturity	Average Richness of Shales	Indigenous Hydrocarbons Expected if Reservoired
1610-5500	Immature	Fair to Good	Minor Gas
5500-6400	Transitional	Fair	Gas, Minor Liquids
6400-7000	Mature	Fair to Good	Oil, Gas

Analytical results are listed in detail in Tables I-III, and interpretations based on kerogen and total organic matter are given in Table II. Graphical summaries of the data and interpretations are given in Fig. 1.

PROCEDURES

Compositions and concentrations of hydrocarbon gases in the air spaces above the cuttings in the sample cans were determined by gas chromatography. Similar data were obtained on gases released from a standard mixture of cuttings and tap water after two minutes of agitation in a Waring blender. Combined results on the air space gas plus the cuttings gas were calculated for each sample. The data were plotted graphically to show vertical variations in total gas (C_1-C_4) and wet gas (C_2-C_4), and a graphical plot was also made of the percent wet gas in total gas (Fig. 1). Detailed results of the analyses are listed in Table I.

Several of the cans had rusted severely so that large holes had formed in the cans. Gas analyses on these samples were not attempted, but the other analyses which are cited below were run on them as well as on the samples that were analyzed for gases.

Chips of uniform lithologies were picked by hand from the heterogeneous mixtures of chips in the original samples. These are described in Table II. Our routine analytical procedures were used for determining the light gasoline (C_4-C_7) content and the total organic content of the "picked" chips. These results are given in Table III, and they are plotted graphically in Fig. 1. Visual Kerogen characteristics were also determined on 14 of the samples (Fig. 1 and Table II).

DISCUSSION

The geochemical profiles for 25/11-5 are generally similar to those determined previously for well 25/11-1. (See Fig. 2 vs Fig. 1.) From both wells there were high gas yields within the interval 5000-6000 ft. This interval contains the reservoir sands and the cuttings gas may be leakage from the reservoir. The % C_2-C_4 profiles for both wells also show a peaking within the 5000-6000 ft interval. In addition, notably higher gasoline (C_4-C_7) yields began in both wells within the 5000-6000 ft interval.

Between 6000 ft and 7000 ft in both wells, there is another peaking in the profiles for total gas yields and for % C_2-C_4 in total gas (Fig. 1).

The kerogen alteration and kerogen type profiles for both wells are similar. Both show a reversal to "1+" herbaceous kerogen at about 6000 ft, contrasting with higher alteration indices at shallower depths. Both had predominantly amorphous or algal kerogen with alterations of "2", starting at about 6500 ft.

The source of the oils in the Grandad wells is not resolved by the data given here. The shales adjacent to the reservoir sands appear to be a bit too immature and too gas-prone to have generated significant oil. The beds with predominantly amorphous kerogen, starting at about 6500 ft, appear to be the more likely oil sources. The samples from 5600 and 5850 ft which have higher gasoline yields and higher % C_2-C_4 in their gases possibly have been "contaminated" by hydrocarbons from the reservoir sands. Their geochemical properties are not compatible with their visual kerogen.

RELATED SERVICE REPORTS

EPR 69-ES10 "Kerogen and Source Analyses of Canned Cuttings from the Esso 9/8-1 and Esso 16/9-1 Wells, Norway" by R. E. Metter et al, March 1969.

EPR 69-ES14 "Geochemical Analysis of Canned Cuttings Samples from the Esso 16/1-1 Well, Norway" by R. E. Metter and P. H. Monaghan, April, 1969.

EPR 69-ES17 "Geochemical Analyses of Canned Cuttings Samples from the Esso 16/7-1 Well, Norway" by R. E. Metter and P. H. Monaghan, April 1969.

EPR 69-ES18 "Geochemical Analysis of Canned Cuttings Samples from the Esso 16/2-1 Well, Norway" by R. E. Metter and P. H. Monaghan, May 1969.

EPR 69-ES19 "Geochemical Analyses of Canned Cuttings Samples from the Esso 25/11-1 Well, Norway" by R. E. Metter and P. H. Monaghan, May 1969.

EPR-64ES-70 "Geochemical Comparisons Between Oils and Core Extracts from the 25/8-1, 25/10-1 and 25/11-1 Wells, Offshore Norway" by R. E. Metter, Sept. 1970.

EPR.9ES.71 "Geochemical Analyses of Oil Samples from Concession 25, Offshore Norway" by R. E. Metter, January 1971.

EPR.34ES.71 "Geochemical Analyses of Core Extracts from the 25/10-2 Well, Norway" by R. E. Metter, April 1971.

TABLE IA

C_1-C_4 HYDROCARBON ANALYSES - AIR SPACE AT TOP OF CANS

SAMPLE NUMBER	R	DEPTH	GAS CONCENTRATION (VOLUME GAS PER MILLION VOLUMES CUTTINGS)							GAS COMPOSITION (PERCENT)									
			METHANE (C_1)	ETHANE (C_2)	PROPANE (C_3)	ISO-BUTANE (iC_4)	NORMAL BUTANE (nC_4)	WET (C_2-C_4)	TOTAL (C_1-C_4)	TOTAL GAS						WET GAS			
										C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
66036A	4	1610	10.44	0.85	0.54	0.03	0.04	1.46	11.90	12.2689	88.	7.	5.	0.	0.	58.	37.	2.	3.
66036B	4	1850	9904.64	10.71	2.87	2.32	2.23	18.12	9922.75	0.1826	100.	0.	0.	0.	0.	59.	16.	13.	12.
66036D	4	2360	2619.11	14.70	4.67	0.79	1.52	21.68	2640.79	0.8209	99.	1.	0.	0.	0.	67.	22.	4.	7.
66036G	4	3170	8.52	0.85	0.45	0.07	0.04	1.41	9.93	14.1994	85.	9.	5.	1.	0.	60.	32.	5.	3.
66036H	4	3410	4913.61	21.39	1.99	0.13	0.67	24.17	4937.78	0.4895	100.	0.	0.	0.	0.	88.	8.	1.	3.
66036I	4	3580	15.07	0.86	0.52	0.12	0.30	1.80	16.87	10.6697	89.	5.	3.	1.	2.	47.	29.	7.	17.
66036K	4	4090	2096.07	23.77	3.68	0.50	1.60	29.55	2125.62	1.3902	99.	1.	0.	0.	0.	81.	12.	2.	5.
66036M	4	4370	3618.82	47.42	9.67	3.12	5.49	65.70	3684.52	1.7831	99.	1.	0.	0.	0.	72.	15.	5.	8.
66036N	4	4500	11.94	2.45	1.26	0.63	0.93	5.27	17.21	30.6216	70.	14.	7.	4.	5.	46.	24.	12.	18.
66036O	4	4600	2.87	0.09	0.06	0.01	0.04	0.20	3.07	6.5146	94.	3.	2.	0.	1.	45.	30.	5.	20.
66036R	4	5500	4964.92	1067.91	384.96	225.32	144.07	1822.25	6787.16	26.8484	73.	16.	6.	3.	2.	59.	21.	12.	8.
66036S	4	5600	783.35	562.18	270.66	208.86	94.73	1136.43	1919.78	59.1958	41.	29.	14.	11.	5.	50.	24.	18.	8.
66037A	4	5850	29822.68	3092.34	1223.46	1155.25	323.14	5794.18	35616.86	16.2681	84.	9.	3.	3.	1.	53.	21.	20.	6.
66037D	4	6300	207.64	53.52	65.17	101.16	59.11	278.96	486.60	57.3283	43.	11.	13.	21.	12.	19.	23.	37.	21.
66037E	4	6400	15.70	2.41	7.38	20.40	15.59	45.78	61.48	74.4632	26.	4.	12.	33.	25.	5.	16.	45.	34.
66037F	4	6500	620.63	900.16	914.31	195.81	214.00	2224.28	2844.91	78.1845	22.	32.	31.	7.	8.	40.	41.	9.	10.
66037H	4	6700	2378.53	1340.60	1191.72	290.81	322.20	3145.33	5523.86	56.9408	43.	24.	22.	5.	6.	43.	38.	9.	10.
66037K	4	7000	8.08	5.06	9.92	17.63	30.44	63.05	71.13	88.6405	11.	7.	14.	25.	43.	8.	16.	28.	48.

TABLE IB

C_1-C_4 HYDROCARBON ANALYSES - CUTTINGS ONLY

SAMPLE NUMBER	R	DEPTH	GAS CONCENTRATION (VOLUME GAS PER MILLION VOLUMES CUTTINGS)							GAS COMPOSITION (PERCENT)									
			METHANE (C_1)	ETHANE (C_2)	PROPANE (C_3)	ISO-BUTANE (iC_4)	NORMAL BUTANE (nC_4)	WET (C_2-C_4)	TOTAL (C_1-C_4)	TOTAL GAS						WET GAS			
										C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
66036A	4	1610	834.65	4.92	0.62	0.58	0.02	6.14	840.79	0.7302	99.	1.	0.	0.	0.	81.	10.	9.	0.
66036B	4	1850	1051.20	4.60	0.87	0.91	2.54	8.92	1060.12	0.8414	100.	0.	0.	0.	0.	52.	10.	10.	28.
66036D	4	2360	864.09	5.31	1.88	0.60	1.66	9.45	873.54	1.0817	99.	1.	0.	0.	0.	56.	20.	6.	18.
66036G	4	3170	1033.33	7.74	3.56	0.56	1.66	13.52	1046.85	1.2914	99.	1.	0.	0.	0.	58.	26.	4.	12.
66036H	4	3410	1013.36	6.87	3.38	0.47	1.13	11.85	1025.21	1.1558	99.	1.	0.	0.	0.	57.	29.	4.	10.
66036I	4	3580	406.81	2.28	1.10	0.39	1.11	4.88	411.69	1.1852	99.	1.	0.	0.	0.	46.	23.	8.	23.
66036K	4	4090	1286.67	6.84	2.05	0.19	0.51	9.59	1296.26	0.7398	99.	1.	0.	0.	0.	72.	21.	2.	5.
66036M	4	4370	1033.33	10.20	2.75	0.80	2.28	16.03	1049.36	1.5276	99.	1.	0.	0.	0.	64.	17.	5.	14.
66036N	4	4500	1526.34	9.61	4.04	3.88	6.55	24.08	1550.42	1.5531	99.	1.	0.	0.	0.	40.	17.	16.	27.
66036O	4	4600	2072.96	7.35	3.40	1.77	3.10	15.62	2088.58	0.7478	100.	0.	0.	0.	0.	47.	22.	11.	20.
66036R	4	5500	2682.66	660.48	675.65	769.54	663.40	2769.07	5451.73	50.7925	50.	12.	12.	14.	12.	24.	24.	28.	24.
66036S	4	5600	1118.48	202.56	377.07	777.00	460.20	1816.83	2935.31	61.8957	38.	7.	13.	26.	16.	11.	21.	43.	25.
66037A	4	5850	3338.61	489.60	471.96	895.10	709.42	2566.07	5904.68	43.4583	57.	8.	8.	15.	12.	19.	18.	35.	28.
66037D	4	6300	1242.52	10.18	9.69	30.23	21.82	71.92	1314.44	5.4715	94.	1.	1.	2.	2.	14.	13.	43.	30.
66037E	4	6400	947.13	4.83	8.06	65.50	57.17	135.56	1082.69	12.5206	88.	0.	1.	6.	5.	4.	6.	48.	42.
66037F	4	6500	1320.31	979.20	2615.15	918.72	1139.88	5652.94	6973.25	81.0660	19.	14.	38.	13.	16.	17.	47.	16.	20.
66037H	4	6700	1282.46	554.88	1794.44	855.32	1423.08	4627.71	5910.18	78.3008	22.	9.	31.	14.	24.	12.	39.	18.	31.
66037K	4	7000	1002.84	8.40	156.74	154.78	255.23	575.15	1577.99	36.4482	63.	1.	10.	10.	16.	1.	27.	27.	45.

TABLE IC

C_1-C_4 HYDROCARBON ANALYSES - CUTTINGS AND AIR SPACE

SAMPLE NUMBER	R	DEPTH	GAS CONCENTRATION (VOLUME GAS PER MILLION VOLUMES CUTTINGS)							GAS COMPOSITION (PERCENT)									
			METHANE (C_1)	ETHANE (C_2)	PROPANE (C_3)	ISO-BUTANE (iC_4)	NORMAL BUTANE (nC_4)	WET (C_2-C_4)	TOTAL (C_1-C_4)	TOTAL GAS						WET GAS			
										C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
66036A	4	1610	845.09	5.77	1.16	0.61	0.06	7.60	852.69	0.8912	99.	1.	0.	0.	0.	76.	15.	8.	1.
66036B	4	1850	10955.84	15.31	3.74	3.23	4.77	27.04	10982.87	0.2462	100.	0.	0.	0.	0.	56.	14.	12.	18.
66036D	4	2360	3483.20	20.01	6.55	1.39	3.18	31.13	3514.33	0.8858	99.	1.	0.	0.	0.	65.	21.	4.	10.
66036G	4	3170	1041.85	8.59	4.01	0.63	1.70	14.93	1056.78	1.4127	99.	1.	0.	0.	0.	58.	27.	4.	11.
66036H	4	3410	5926.97	28.26	5.37	0.60	1.80	36.02	5962.99	0.6041	100.	0.	0.	0.	0.	78.	15.	2.	5.
66036I	4	3580	421.88	3.14	1.62	0.51	1.41	6.68	428.56	1.5586	99.	1.	0.	0.	0.	47.	24.	8.	21.
66036K	4	4090	3382.74	30.61	5.73	0.69	2.11	39.14	3421.88	1.1438	99.	1.	0.	0.	0.	78.	15.	2.	5.
66036M	4	4370	4652.15	57.62	12.42	3.92	7.77	81.73	4733.88	1.7265	99.	1.	0.	0.	0.	70.	15.	5.	10.
66036N	4	4500	1538.28	12.06	5.30	4.51	7.48	29.35	1567.63	1.8722	99.	1.	0.	0.	0.	42.	18.	15.	25.
66036O	4	4600	2075.83	7.44	3.46	1.78	3.14	15.82	2091.65	0.7563	100.	0.	0.	0.	0.	47.	22.	11.	20.
66036R	4	5500	7647.57	1728.39	1060.61	994.86	807.47	4591.31	12238.89	37.5141	62.	14.	9.	8.	7.	37.	23.	22.	18.
66036S	4	5600	1902.83	764.74	647.73	985.86	554.93	2953.26	4855.09	60.8281	39.	16.	13.	20.	11.	26.	22.	33.	19.
66037A	4	5850	33161.29	3581.94	1695.42	2050.35	1032.56	8360.25	41521.55	20.1347	80.	9.	4.	5.	2.	43.	20.	25.	12.
66037D	4	6300	1450.16	63.70	74.86	131.39	80.93	350.88	1801.04	19.4820	81.	4.	4.	7.	4.	18.	21.	38.	23.
66037E	4	6400	962.83	7.24	15.44	85.90	72.76	181.34	1144.17	15.8490	84.	1.	1.	8.	6.	4.	9.	47.	40.
66037F	4	6500	1940.94	1879.36	3529.46	1114.53	1353.88	7877.22	9818.16	80.2311	20.	19.	36.	11.	14.	24.	45.	14.	17.
66037H	4	6700	3660.99	1895.48	2986.16	1146.13	1745.28	7773.04	11434.03	67.9816	32.	17.	26.	10.	15.	24.	39.	15.	22.
66037K	4	7000	1010.92	13.46	166.66	172.41	285.67	638.20	1649.12	38.6994	62.	1.	10.	10.	17.	2.	26.	27.	45.

TABLE II Descriptions of Samples and Visual Kerogen Characteristics

(Kerogen by J. L. Morgan; T.O.M. by J. Roy and H. M. Fry)

Depth (ft)	EPR No.	Gross Lithology	GSA Color Code	Total Organic Matter %	Kerogen Alteration	Types of Kerogen: Predominant	Types of Kerogen: Secondary	Types of Kerogen: Other	Kerogen Source Ratings: Maturity	Kerogen Source Ratings: Richness	Kerogen Source Ratings: Source Type
3170	66036-G	Coal (lignite)	5YR2/1-N1	61.9	1+	W	-	H, C	Immature	-	Gas
3890	-J	Claystone, olive gray to med. olive gray, plus minor drilling mud.	5Y4/1-3/1	3.03							
4090	-K	Shale, olive gray	5Y4/1	.77	1+	H, W	-	C, M	Immature	Fair	Gas, Oil
4370	-M	As above.	5Y4/1	1.05							
4600	-O	Claystone, med. dk. gray to med. greenish gray.	N5-5GY5/1	1.90	1+	H, W	C	M	Immature	Good	Gas, Oil
4900	-P	Shale, olive gray, minor calc. drilling mud and flakes of rust.	5Y4/1	1.87							
5200	-Q	Shale, olive gray, sand-sized chips.	5Y4/1	.76	2-	W	Al,H,C	M	Immature	Fair	Gas, Oil
5500	-R	Shale, olive gray	5Y4/1	.76	2-	H, W	C	Al?,M	Immature	Fair	Gas, Oil
5600	-S	Shale, med. greenish gray	5GY5/1	.81							
5650	-T	Shale, olive gray to med. greenish gray, some sl. calc.	5Y4/1-5GY5/1	1.57							
5850	66037-A	Shale, med. dk. gray to med. lt. gray.	N4-N6	.88	1+	H	A, W	C	Immature	Fair	Oil, Gas
6060	-B	Shale, med. gray, minor drilling mud.	N5	.74	1+	H	A, W	C	Immature	Fair	Oil, Gas
6210	-C	Shale, med. olive gray, plus rust scales.	N5-5Y5/1	.98	2	A, W	H, C		Transitional	Fair	Oil, Gas
6300	-D	Shale, med. gray to brownish gray; swells.	N5-5YR4/1	.60	2	W	C, H	M	Transitional	Fair	Gas, Oil
6600	-G	Shale, med. gray to med. olive gray, tr. limestone, abdnt. rust scales.	N5-5Y5/1	2.03	2	A	Al.	W, C	Transitional	Good	Oil
6700	-H	Shale, olive gray, swells in acid; many very large chips.	5Y4/1	.61	2	H, W, C	-	A,Al,M	Transitional	Fair	Gas, Oil
6800	-I	Mixture of brown to gray shales, quartz grains, minor limestone; sand-sized grains.	-	3.88	2	A	C	Al,W,H	Mature ?	Rich	Oil, Gas
7000	-K	Shale, med. dr. gray to med. gray.	N4-N5	1.27	2	A	H, C	W	Mature ?	Good	Oil, Gas
7100	-L	Mixture of med. gray shale, brownish shales, quartz grains, rust flakes, minor sandstone.		.71	2	A, Al	C	H, W	Mature ?	Fair	Oil, Gas

* A - Amorphous H - Herbaceous C - Coaly
Al - Algal W - Woody M - Microplankton

TABLE III Total Organic Matter and Light Gasolines, 25/11-5 Cuttings

(Analyses by H. M. Fry, J. Roy)

Depth (ft)	EPR No.	Total Organic Matter (%)	Remarks	Total C_4-C_7* (ppm)	Correlation Ratios** C_1/C_2	A/D_2	C_1/D_2	CH/MCP†
3170	66036-G	61.7	Coal	4.98	4.23	4.44	7.44	1.74
3890	-J	3.03		4.45	2.59	2.23	5.16	1.24
4090	-K	.77		1.19	3.84	3.48	5.58	1.14
4370	-M	1.05		1.82	4.52	3.20	4.98	1.01
4600	-O	1.90		.53	3.83	6.52	4.84	.74
4900	-P	1.87		0. *	-	-	-	-
5200	-Q	.76		0. *	-	-	-	-
5500	-R	.76		2.27	3.02	5.42	7.63	.72
5600	-S	.81		19.80	2.22	2.53	10.28	1.37
5650	-T	1.57		3.18	3.08	1.51	12.27	1.36
5850	66037-A	.88		18.54	2.64	1.71	16.94	1.63
6060	-B	.74		0. *	-	-	-	-
6210	-C	.98		12.64*	1.00	3.52	7.07	1.36
6300	-D	.60		.72*	4.03	6.62	9.76	1.37
6600	-G	2.03		3.87	1.01	4.11	9.33	.99
6700	-H	.61	Large chips	17.83	1.74	4.26	11.80	1.05
6700	-H		Small chips	3.86	3.63	2.89	18.37	1.37
6800	-I	3.88		2.53	2.13	4.10	20.02	1.70
7000	-K	1.27		4.36	1.18	4.92	13.45	1.06
7100	-L	.71		1.50	2.82	4.60	7.24	1.11

*Note: Gasoline values are unreliable because many samples had dried out due to large holes rusting through the cans.

**See Table III-A

† CH - Cyclohexane
MCP - Methylcyclopentane

TABLE III A

DEFINITION OF SIGNIFICANT GASOLINE RATIOS

Light Gasoline Compounds Determined by Gas Chromatography

1. Pentane
2. Hexane
3. Heptane
4. Iso-Pentane
5. 2-Methylpentane
6. 3-Methylpentane
7. 2,3-Dimethylbutane
8. 2,2-Dimethylbutane
9. 3-Methylhexane
10. 2-Methylhexane + 1,1-Dimethylcyclopentane
11. 2,3-Dimethylpentane
12. 2,4-Dimethylpentane
13. 2,2-Dimethylpentane
14. 2,2,3-Trimethylbutane
15. 2,2,4-Trimethylpentane
16. Cyclopentane
17. Methylcyclopentane
18. 1-c-3-Dimethylcyclopentane
19. 1-t-3-Dimethylcyclopentane
20. 1-c-2-Dimethylcyclopentane
21. 1-t-2-Dimethylcyclopentane + 3-Ethylpentane*
22. Cyclohexane + 3,3-Dimethylpentane*
23. Methylcyclohexane
24. Benzene
25. Toluene

Significant Groupings of Molecular Data

A. Hexane + Heptane

B. Pentane + iso-Pentane + 2-Methylpentane + 3-Methylpentane

C. Naphthenes

C_1 2-Methylhexane + 1 , 1-Dimethylcyclopentane* + Cyclohexane + 3,3-Dimethylpentane* + Methylcyclohexane

C_2 Methylcyclopentane + 1-c-3-Dimethylcyclopentane + 1-t-3-Dimethylcyclopentane + 1-c-2-Dimethylcyclopentane + (1-t-2-Dimethylcyclopentane + 3-Ethylpentane)*

D. Aromatics Plus 3-Methylhexane

D_1 Benzene + Toluene

D_2 3-Methylhexane

*Analyzed together by gas chromatography.

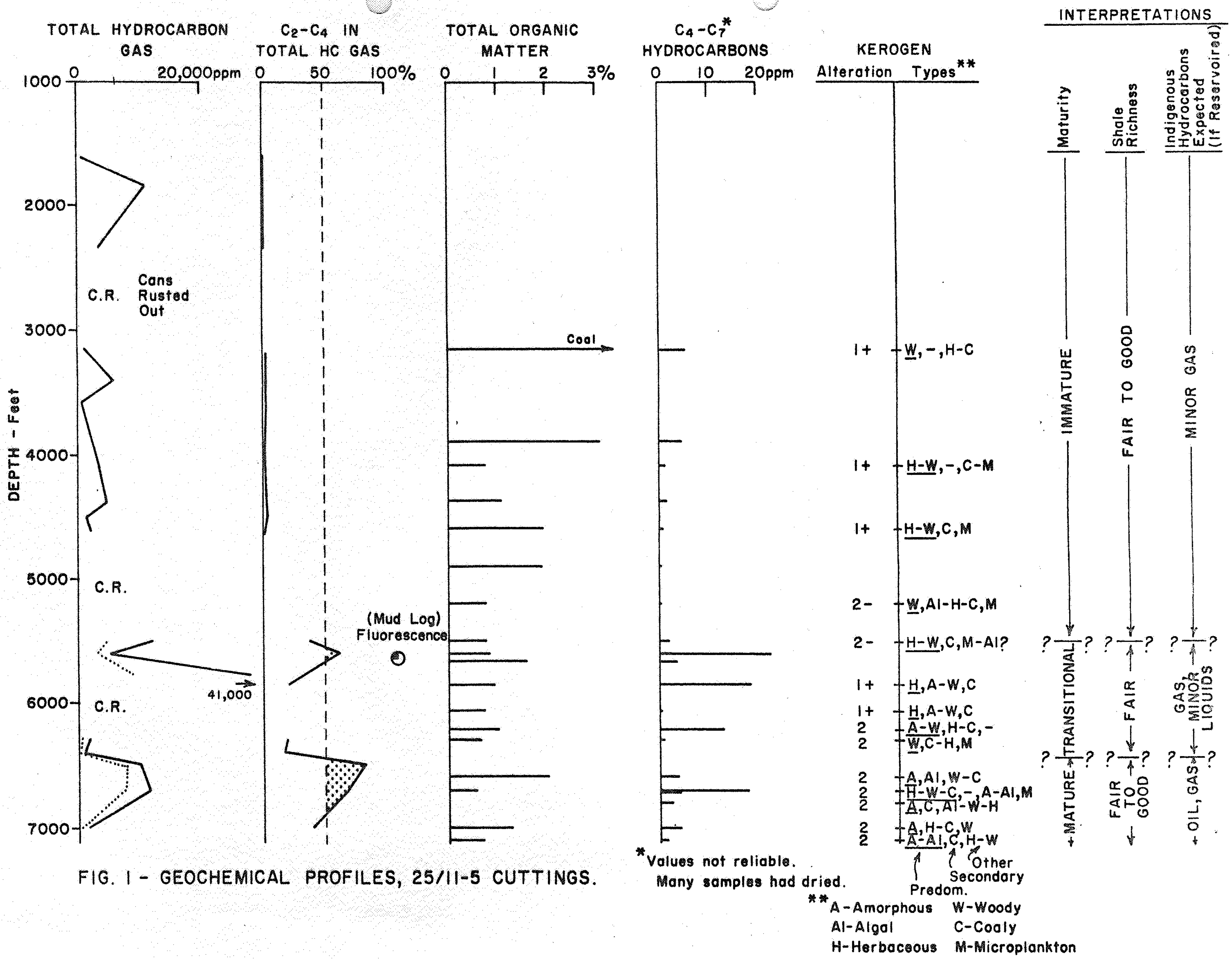

FIG. 1 - GEOCHEMICAL PROFILES, 25/11-5 CUTTINGS.

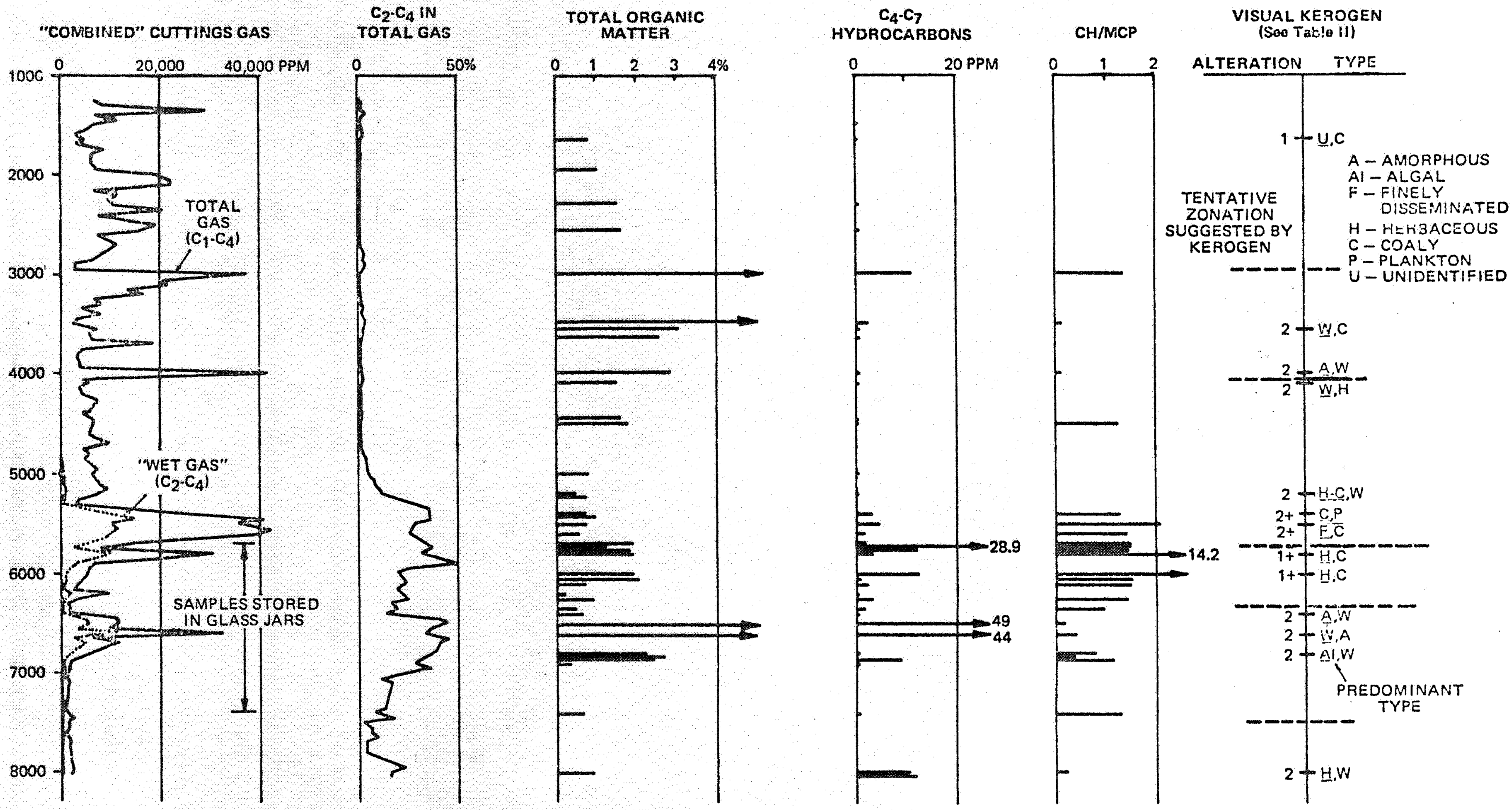

FIG. 2. GEOCHEMICAL PATTERNS, ESSO 25/11-1 WELL, NORWAY.

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