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HYDROCARBON SOURCE BED EVALUATION OF WELL 35/8-1 OFFSHORE NORWAY

By

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Technical Memorandum No. 4225TM199
June, 1981
(WPC #977)

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EXECUTIVE SUMMARY

Hydrocarbon source bed evaluation of canned cuttings (500 - 4260 m) from well 35/8-1 in the Norwegian North Sea suggests that the liquid hydrocarbons (oils) encountered at 3518 and 3567 m migrated updip from the Kimmeridge clay formation in the Viking graben. This conclusion is based on similar C_{15+} fingerprints for the saturate fraction of oils and extract for the depth interval containing the Kimmeridge formation and equivalent CPI's. It is also supported by pyrolysis data and maturity calculations, which suggests that the Kimmeridge in well 35/8-1 has not yet entered the oil window, and by kerogen analyses, which indicate that the organic material in this well is more gas/condensate prone, rather than oil-prone.

The top of the Kimmeridge (3185.5 m) in this well lies in the depth interval (3100 - 3200 m) which possesses the best source rock potential. Hydrocarbon source bed evaluation of this interval demonstrates that it contains 3.12% organic carbon, has an extractable organic matter content of 3614 ppm, and possesses an extractability of 11.58%. It also has a saturate/aromatic ratio of 0.86 and contains 41.68% C_1 in C_1 - C_4. Results from pyrolysis strengthen this assessment. This depth interval has over a factor of 3 more free hydrocarbons than the next best source rock interval (3700 - 3800 m), and its kerogen is rich in H and lean in O-containing volatiles.

Well 35/8-1 is located on the dip side of a fault, structurally above the Viking graben and is unofficially termed a gas/condensate producer. Liquid hydrocarbons occur beneath the Kimmeridge in this well and as discussed above are inferred to have migrated updip from the Kimmeridge in the graben. Such upwards migration implies that sands adjacent to the fault to the East may be prospective reservoirs. Closer spaced samples and structural cross-sections are required to strengthen this prognosis.

INTRODUCTION

Thirty-seven (100 m) composite cutting samples from 500 - 4260 m depths and 2 core samples from 3607 - 3608 and 3707 - 3708 m depths in well 35/8-1 were analyzed at GR&DC for hydrocarbon source bed evaluation. Sediment extracts were also compared to oils collected at 3518 and 3567 m and to oil recovered from the drilling mud at 3515 m. This report presents the results of those findings.

Well 35/8-1 is located on the Sogn Spur in the Norwegian North Sea at 3° 21' 46" E longitude and 61° 21' 26" N latitude. This region consists of a series of rotated Jurassic fault blocks lying between the Horda platform, a positive area which was probably most prominent in the Triassic, and the Viking graben, structurally the lowest region in the northern North Sea, which developed most strongly during the Late Jurassic to Cretaceous (Carstens and Finstad, 1981). The well rests on the dip side of a fault (see Figure 1) in 402 m of water and has an average thermal gradient of 3.28°C/100 m (Dewhirst, 1981).

The Kimmeridge clay formation, the richest and most extensive source rock in the North Sea (Barnard and Cooper, 1981), is 15 m thick in this well and has its top at a depth of 3185.5 m from the Kelly-Bushing. The Heather shale, another source rock in the North Sea, lies immediately beneath the Kimmeridge and is 18 m thick. Both formations consist of hot shales whose gamma ray response indicates that the Kimmeridge is a little over twice as radioactive as the overlying 1255 m of Cretaceous shales whereas the Heather is 60% hotter. In contrast, the Kimmeridge and Heather are 50 and 14% hotter than the underlying Jurassic shales, respectively.

The stratigraphic column above the Kimmeridge also contains 71 m of Cretaceous marls and silts and approximately 100 m of Early Eocene volcanics. The Kimmeridge is underlain by 510 m of Jurassic sands which are interbedded with 311 m of shales and 98 m of silt. The Jurassic sands are in turn underlain by 62 m of coal-bearing sands and silts and a gas/water contact occurs at a depth of 3657 m. Figure 2 illustrates the stratigraphy below 2000 m for this well. All depths are in meters from the Kelly-Bushing whose elevation is 25.9 m.

ANALYTICAL METHODS

Hydrocarbon source bed analyses were conducted on 37 canned cuttings and 2 canned core samples to determine which stratigraphic intervals are potential source horizons for liquid or gaseous hydrocarbons. The canned samples were first analyzed for light hydrocarbon (C_1 - C_4) headspace gases by gas chromatography. Next, the cuttings were water washed to remove drilling mud, and nonindigenous organic material (such as coals) was removed by using a CCl_4 flotation technique. The samples were then ground and extracted to characterize the soluble organic matter content and to assess its maturity. Organic and carbonate carbon was also determined on aliquots of the same samples.

The extract was separated into saturate (paraffin-naphthene), aromatic, NSO (polar resin) and asphaltene fractions to determine its hydrocarbon content and source quality. Qualitative estimates of organic matter type and thermal maturity were provided by gas chromatography of C_{15+} saturated hydrocarbons.

Similar procedures were used to separate and characterize the oil recovered from the drilling mud at 3515 m. The other oil samples were centrifuged to remove water and impurities, and their specific gravity, nitrogen, and sulfur contents were determined. They too were separated into the various organic fractions as above and characterized by gas chromatography of their C_{15+} saturated hydrocarbons.

RESULTS AND INTERPRETATION

The results of the analyses are presented in Appendix I. Note the organic carbon content, amount of extractables, and percent extractability for each interval.

A source rock is defined by its weight percent organic carbon (>.5), a large quantity of extractable organic matter (>500 ppm), and high extractability (extractable organic matter/organic carbon >5 - 15%). Source rocks are also rich in wet gas and have large concentrations (>10%) of C_2 - C_4 gaseous hydrocarbons.

Inspection of the data in Appendix I indicate that six intervals meet the above requirements. They are

(1) <u>3100 - 3200 m</u>: containing 3.12% organic carbon, an extractable organic matter content of 3614 ppm, 11.58% extractability, and 41.68% C_1 in C_1 - C_4.

(2) <u>3200 - 3300 m</u>: containing 1.60% organic carbon, an extractable organic matter content of 1274 ppm, 7.96% extractability, and 38.9% C_1 in C_1 - C_4.

(3) <u>3300 - 3400 m</u>: containing 1.82% organic carbon, an extractable organic matter content of 1172 ppm, 6.44% extractability, and 25.36% C_1 in C_1 - C_4.

(4) 3707 - 3708 m: core sample containing 0.96% organic carbon, an extractable organic matter content of 2954 ppm, 30.77% extractability, and 0.44% C_1 in $C_1 - C_4$.

(5) 3700 - 3800 m: containing 1.05% organic carbon, an extractable organic matter content of 1086 ppm, 10.34% extractability, and 16.28% C_1 in $C_1 - C_4$.

(6) 4100 - 4154 m: containing 2.57% organic carbon, an extractable organic matter content of 1454 ppm, 5.66% extractability, and 85.5% C_1 in $C_1 - C_4$.

Source rocks also contain appreciable quantities of saturate hydrocarbons and have saturate/aromatic ratios close to or greater than one. Reinspection of the data in Appendix I eliminates two of the above intervals (3300 - 3400, 4100 - 4154) as possible source rocks. Both intervals are depleted in saturates with saturate/aromatic ratios near 0 and 0.1, respectively.

Another criteria of a source rock is that its saturate hydrocarbons should have a carbon preference index (CPI) near 1. Table 1 lists the CPI values of the saturate hydrocarbons for the various depth intervals examined in this well. CPI's were calculated using the method of Bray and Evans (1961) from the following formula:

$$CPI = \frac{1}{2}\left[\frac{C_{25} + C_{27} + \dots + C_{33}}{C_{24} + C_{26} + \dots + C_{32}} + \frac{C_{25} + C_{27} + \dots + C_{33}}{C_{26} + C_{28} + \dots + C_{34}}\right]$$

However, there are several limitations in applying CPI values in source rock analysis. Both the type of organic matter and its maturity influence the CPI value. For instance, marine organisms synthesize odd-carbon chains only in the low molecular weight range, not in the C_{24} - C_{33} region. Consequently, their CPI values are very close to one, regardless of their depth of burial.

Inspection of the GC's in Appendix II of the saturate hydrocarbon fraction extracted from this well indicates that only the top 500 - 900 m contains predominantly marine organic matter. The hydrocarbon distribution in this interval peaks at 18 - 21 carbon atoms and contains few hydrocarbons with more than 27 carbon atoms. Between 900 - 1700 m the hydrocarbon distribution is radically different and suggests that the organic material consists of a mixture from marine and terrestrial sources. A strong bimodal hydrocarbon distribution is apparent which peaks at 17 - 18 and 27, 29 or 31 carbon atoms, respectively. Note the strong predominance of odd-carbon atoms in the C_{24} - C_{34} range (see Appendix II and Table 1).

Below 1700 m the hydrocarbon distribution is very irregular and the odd-carbon predominance gradually disappears. Evidence of a bimodal source is still present until a 2400 m depth. Below this depth the hydrocarbon distributions become more mature and the odd-predominance diminishes. The hydrocarbon distribution becomes very mature below 3700 m with either 15, 16 or 17 carbon atoms predominating.

Examination of the CPI values in Table 1 of the above 4 remaining possible source rock intervals suggests that the region between 3200 - 3300 m may be eliminated. It has a CPI of 1.40.

PYROLYSIS

Thirty-three 100 m composite cutting samples from 500 - 4150 m depths were also evaluated by pyrolysis using a rock-eval unit. The results are tabulated in Table 2 and depicted graphically in Figures 3 to 6.

The amount of hydrocarbons present in the sample in either a free or adsorbed state is indicated by S_1 (Figure 4); the larger its value, the better the source potential of the rock. Upon pyrolysis, hydrocarbons and hydrocarbon-like compounds (S_2) and oxygen-bearing volatiles such as CO_2 and H_2O (S_3) are also generated. The potential of the rock for generating additional hydrocarbons is indicated by S_2 (Figure 5).

Comparing the pyrolysis results in Figures 3 and 4 for the three remaining potential source rock intervals above, indicates that the depth interval from 3100 - 3200 m has the greatest potential for generating liquid hydrocarbons. Of all the depths sampled, this interval is the richest in free hydrocarbons. It has over a factor of 3 more free hydrocarbons than the interval between 3700 - 3800 m (Figure 4), and its kerogen is richer in hydrogen and leaner in O-containing volatiles (Figure 3). Other potential source rock intervals lie between 3200 - 3400 m; however, they are leaner than the depths between 3100 - 3200 m.

Pyrolysis also provides a means of assessing the maturity of organic material. T_{max} or the maximum temperature reached during pyrolysis is a maturity indicator. According to Tissot and Welte (1978, p. 454), organic material is generally immature when T_{max} values fall below 437°C, but is in the oil zone for T_{max} values between 437 and 460°C, and wet gas regions for T_{max} values above 460°C. The above maturation boundaries imply that the samples between 3200 - 3800 m are just entering the oil window, whereas those above 3200 m are immature and those below 3800 m are in the mature stage of oil generation (Figure 6). This analysis agrees with conclusions reached earlier from the GC's concerning CPI's and the range and distribution of saturate hydrocarbons.

COMPARISON OF OILS FROM WELL 35/8-1

Three oil samples and a drilling mud oil were recovered while drilling well 35/8-1. Table 3 lists the N, S, fractional composition, and CPI of these oils. Appendix III contains their GC's.

The oils are very similar but the oil collected at 3518 m appears to be more mature. This conclusion is based on similar C_{15+} fingerprints (Table 5), similar nitrogen and sulphur contents, but different CPI's. Figure 7 compares the C_{15+} fingerprints of the three oils and that of the drilling mud collected at 3515 m. Note that the oils labelled NO-1 and NO-2 are identical and have no appreciable odd-even predominance.

From Table 3 it is apparent that the oils collected at 3518 and 3567 m have different API gravity. This difference is attributed to a probable loss of volatiles during recovery of the 3518 meter sample. The oils probably originate from a common source at different depths and maturation levels and are better classified as being a high volatile rather than a condensate-type product.

COMPARISON OF GAS RATIOS FROM WELL 35/8-1

Per the request of N. H. Dewhirst of the Bergen, Norway, office, an evaluation of headspace gas data from the 35/8-1 well was undertaken in an attempt to differentiate between the probable production from the Middle Jurassic Brent formation and the Deep Jurassic Statfjord formation. Ratios of C_1/C_2, C_1/C_3, C_1/IC_4, and C_1/NC_4 were tabulated for the depth range from 2100 m to total depth to illustrate how the Jurassic (3185 - 4300 m) compares with both younger and older units. $C_1/(C_2 + C_3)$ and $C_2/(C_3 + NC_4)$ ratios were also calculated. They are a measure of "wetness" or the oil-prone nature of the sample; low ratios are indicative of oils whereas high values imply dry gas or condensate. Table 4 gives the values for the above ratios.

Figures 8 and 9 illustrate how C_1/C_3 and $C_1/(C_2 + C_3)$ change with depth. The other ratios display similar profiles. Note the sudden drop below 2400 m and sustained rise below 4100 m. The gases in this region are wetter than those either above or below. The most oil-prone samples are between 3500 - 3800 m; they contain the greatest proportion of C_2, C_3, and C_4.

Figure 10 verifies this assessment. Samples rich in wet gas, such as oils, would plot in the lower left corner whereas dry gas and condensate would lie in the upper portion of the figure. Inspection of Figure 10 reveals that two groups of samples (17, 18 and 21, 22, 23) fit these categories. The samples correspond to the Brent and Statfjord sands, respectively (see Table 4 and Figure 2). Hence, it can be concluded that the Middle Jurassic (Brent sand) is probably oil-prone whereas the Deep Jurassic (Statfjord) most likely contains condensate. The percent methane in C_1 - C_4 for 21, 22, 23 is 85.5, 84.2, and 76.0%, respectively.

OIL-SOURCE ROCK CORRELATION

Table 5 lists the n-C_{15-30} hydrocarbon composition for oil, core, and cutting samples below 3100 m depths from well 35/8-1. This fingerprint provides another means of identifying the source for the oils encountered in this well. The interval between 3100 - 3200 m provides the best match to the C_{15+} fingerprint for the oils. The overlay for Figure 7 illustrates this comparison.

Inspection of Figure 7 and its overlay illustrates an odd-predominance in the fingerprint from the cutting sample. This predominance suggests that the source interval was not buried deep enough. Alternatively, the strong odd-predominance at C_{17} and C_{19} may reflect a contribution from the original organic material. Closer spaced samples are required to resolve this discrepancy and to improve source rock identification.

Maturity Calculations

In this paper, maturity is modelled using an expression called the time-temperature index (TTI), originally defined by Lopatin (1971), calibrated and refined by Waples (1980), and approximated by the following algorithm:

$$TTI = \int_{t=o}^{t} 2^{(T - 105)/10} dt$$

where T is temperature in degrees C and t is time in millions of years. The above expression indicates that maturity is linearly dependent on time but exponentially dependent on temperature and is based on the assumption that the rate of reaction doubles for every 10° rise in temperature.

According to Waples, the onset and peak stage of oil generation coincide with TTI's of 15 and 75, respectively. In this well, (Figure 11), these values are not reached until depths below sea level of 3220 m and 3670 m, respectively. Both depths are below the location of the best source rock interval (3100 - 3200 m), and suggest that the Kimmeridge in this well has not yet entered the oil window.

The hydrocarbon distribution of the saturate fraction from the extracts (Appendix II) and pyrolysis results, as discussed earlier, supports this interpretation. Very mature hydrocarbon distributions occur below 3700 m and have either 15, 16 or 17 carbon atoms predominating.

Analysis of kerogen and interpretation of vitrinite reflectance values in this well by Jack Burgess (1981) provides additional support for this conclusion. There are three distinct gradients in the reflectance-depth profile, implying that reworking of kerogen and vitrinite is obviously a problem in this well. The reflectance values in the Cretaceous section are considerably higher than those either above or below and suggests that mature vitrinite was redeposited in less mature sediments. Because of the reworked vitrinite data in the Cretaceous, Burgess concluded that the sediment above 3700 m may not be mature. He further regards the rocks below 3700 m as within the active gas/condensate generating stage of maturity. The kerogen in 35/8-1 is a mixture of coaly-herbaceous types and is more gas/condensate prone, rather than oil-prone. Hence, the oils encountered in this well were probably not generated in place.

Exploration Significance

The Kimmeridge clay formation has its top at 3185.5 m and is the most likely source for the oils encountered between 3500 - 3600 m in this well. The occurrence of oil beneath the Kimmeridge suggests that the oils are migrating updip from an adjacent down faulted section. The Viking graben lies to the west and structurally below where this well was drilled. The oils could be migrating from the Kimmeridge in the graben.

Well 35/8-1 also lies on the dip side of a fault. If the strata dip to the west and if there is closure on the faults to the east, then the Brent sands adjacent to the fault could be prospective reservoirs. Closer spaced samples and structural cross-sections for this area may strengthen this prognosis.

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TABLE 1

CPI Values for the Saturate Hydrocarbons
Extracted from Cutting and Core Samples in Well 35/8-1

Depth (m)	CPI
500 - 600	1.00
600 - 700	1.42
800 - 920	1.01
920 - 1000	2.93
1000 - 1100	2.82
1100 - 1200	3.60
1200 - 1300	2.91
1300 - 1400	2.54
1400 - 1500	3.19
1500 - 1600	----
1600 - 1700	2.18
1700 - 1800	----
1800 - 1900	----
1900 - 2000	1.63
2000 - 2100	----
2200 - 2300	1.99
2300 - 2400	1.34
2400 - 2500	----
2500 - 2600	1.48
2600 - 2700	----

Depth (m)	CPI
2800 - 2900	1.26
2900 - 3000	1.17
3000 - 3100	----
3100 - 3200	1.15
3200 - 3300	1.40
3400 - 3500	1.28
3607 - 3608	1.38
3707 - 3708	1.23
3700 - 3800	1.02
3800 - 3900	1.15
4000 - 4100	1.09
4100 - 4154	1.10
4154 - 4230	1.24
4230 - 4260	1.21

TABLE 2

Pyrolysis Results for Cutting Samples from Well 35/8-1

Depth (m)	S_1	S_2	S_3	T_{max}	C_{org}	P.I.	H-Index	O-Index
500 - 600	27.1	0.0	3249.1	0	0.09	1.00	0.	3610.
600 - 700	0.0	0.0	359.3	0	0.05	0.00	0.	719.
700 - 800	0.0	0.0	358.5	0	0.05	0.00	0.	717.
800 - 920	0.0	0.0	5058.4	0	0.14	0.00	0.	3613.
920 - 1000	63.4	2152.2	2357.1	418	0.74	0.03	291.	319.
1000 - 1100	36.7	3276.5	2120.6	422	0.92	0.01	356.	231.
1100 - 1200	24.2	2119.9	1218.0	422	0.84	0.01	252.	145.
1200 - 1300	44.3	1277.8	1180.8	423	1.16	0.03	110.	102.
1300 - 1400	0.0	123.7	806.6	422	0.51	0.00	24.	158.
1400 - 1500	0.0	0.0	1132.0	422	0.51	0.00	0.	222.
1500 - 1600	0.0	215.9	955.5	422	0.41	0.00	53.	233.
1600 - 1700	0.0	189.5	831.8	423	0.41	0.00	46.	203.
1700 - 1800	0.0	29.4	567.2	422	0.37	0.00	8.	153.
1800 - 1900	0.0	42.3	727.1	422	0.50	0.00	8.	145.
1900 - 2000	19.4	26.1	1681.8	422	0.37	0.43	7.	455.
2000 - 2100	19.4	161.9	889.2	422	0.56	0.11	29.	159.
2100 - 2200	0.0	171.0	3241.6	423	0.65	0.00	26.	499.
2200 - 2300	61.6	137.6	1171.5	422	0.65	0.31	21.	180.
2300 - 2400	25.3	22.1	1498.3	423	0.46	0.53	5.	326.
2400 - 2500	31.9	351.2	746.5	432	0.88	0.08	40.	85.
2500 - 2600	29.0	99.6	1206.8	422	0.40	0.23	25.	302.
2600 - 2700	61.8	95.1	1258.3	433	0.53	0.39	18.	237.
2700 - 2800	42.5	168.8	1160.0	433	0.59	0.20	29.	197.
2800 - 2900	55.3	202.6	1107.4	433	0.50	0.21	41.	221.
2900 - 3000	47.3	481.6	2827.5	431	0.59	0.09	82.	479.
3000 - 3100	22.0	61.5	1103.3	431	0.18	0.26	34.	613.
3100 - 3200	1891.9	14877.3	1059.4	427	3.12	0.11	477.	34.
3200 - 3300	597.2	4740.9	1551.4	440	1.60	0.11	296.	97.
3300 - 3400	883.6	7055.7	1496.6	436	1.82	0.11	388.	82.
3400 - 3500	804.1	2865.5	1516.1	438	3.07	0.22	93.	49.
3700 - 3800	596.0	341.0	1334.3	438	1.05	0.64	32.	127.
3800 - 3900	689.1	445.0	1300.7	440	0.49	0.61	91.	265.
4100 - 4150	822.0	1696.5	311.6	448	2.57	0.33	66.	12.

TABLE 3

Depth, Composition, and CPI for Three Oils and a Drilling Mud Oil Recovered in Well 35/8-1

Sample	Depth	Specific Gravity	API	CPI	N Content	S Content	Fractional Composition (%) Asphaltene	Saturate	Aromatic	Resins
NO-1	3518	.8422	36.5	1.06	0.013	<0.04	0.5	74.0	21.7	3.8
NO-2	?	.8427	36.4	1.04	0.014	0.05	0.6	46.8	47.3	5.3
3567	3567	.8030	44.7	1.15	52 ppm	<0.04	0	79.9	19.9	0.2
Drilling Mud	3515	-----	----	1.12	------	-----	4.3	69.4	20.7	5.6

TABLE 4

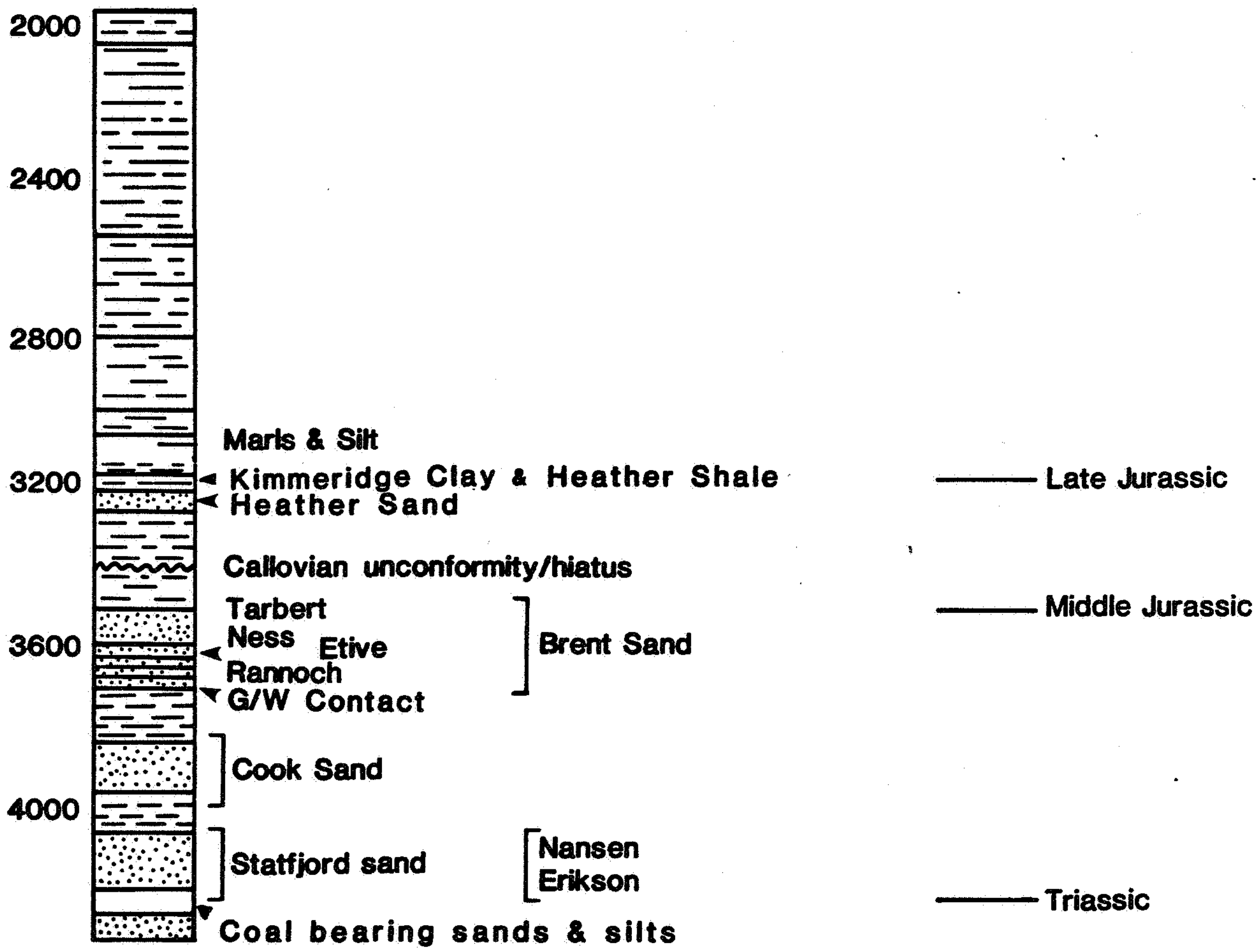
Hydrocarbon Ratios Calculated from Headspace Gas Analysis of Cuttings from Well 35/8-1

Sample No.	Depth (m)	C_1/C_2	C_1/C_3	C_1/IC_4	C_1/NC_4	$\frac{C_1}{C_2 + C_3}$	$\frac{C_2}{C_3 + NC_4}$
1	2100 - 2200	226.00	150.67	502.22	------	90.4	0.67
2	2200 - 2300	229.00	229.00	208.18	229.00	114.5	0.50
3	2300 - 2400	------	------	------	------	------	------
4	2400 - 2500	8.56	8.29	19.62	37.55	4.21	0.79
5	2500 - 2600	6.16	6.79	27.40	33.65	3.23	0.92
6	2600 - 2700	5.26	6.89	25.37	34.13	2.16	1.05
7	2600 - 2700	3.89	4.88	18.65	25.28	2.98	1.09
8	2700 - 2800	5.00	4.43	11.20	14.91	2.35	0.68
9	2800 - 2900	5.44	4.88	12.34	16.71	2.57	0.69
10	2900 - 3000	3.58	3.03	6.86	10.41	1.64	0.66
11	2900 - 3000	18.00	5.75	11.11	9.75	4.35	0.20
12	3000 - 3100	1.73	0.71	2.47	1.86	0.51	0.30
13	3100 - 3200	1.72	1.76	14.86	5.45	0.87	0.77
14	3200 - 3300	1.89	1.54	12.72	3.19	0.85	0.55
15	3300 - 3400	1.28	0.73	5.54	1.65	0.46	0.39
16	3400 - 3500	0.98	0.92	8.79	4.01	0.47	0.76
17	3500 - 3600	0.87	0.38	2.78	0.68	0.26	0.28
18	3700 - 3800	0.92	0.41	2.88	0.79	0.28	0.29
19	3800 - 3900	------	------	------	------	------	------
20	4000 - 4100	1.67	0.92	5.29	1.73	0.59	0.36
21	4100 - 4154	7.22	36.90	473.52	518.01	6.04	4.77
22	4154 - 4230	6.97	26.35	459.54	296.88	5.51	3.47
23	4230 - 4260	3.89	19.79	233.03	278.96	3.25	4.75

TABLE 5

Percent n-C_{15-30} for Oil, Core, and Cutting Samples from Well 35/8-1

Sample	C_{15}	C_{16}	C_{17}	C_{18}	C_{19}	C_{20}	C_{21}	C_{22}	C_{23}	C_{24}	C_{25}	C_{26}	C_{27}	C_{28}	C_{29}	C_{30}
Oils:																
NO-1	13.45	11.24	9.95	8.81	7.93	7.29	6.51	6.02	5.65	5.00	4.33	3.76	3.31	2.69	2.34	1.72
NO-2	12.81	11.04	9.89	8.92	7.77	7.25	6.48	5.97	5.41	5.08	4.52	4.04	3.39	2.74	2.58	2.11
3567	12.71	11.75	11.64	9.80	8.10	6.78	6.93	6.40	5.60	4.44	4.11	3.26	3.06	2.08	1.97	1.38
DMO	14.52	13.24	10.91	9.88	8.38	5.93	6.56	5.17	4.86	4.85	3.88	3.30	3.20	2.15	1.90	1.27
Cuttings:																
3100 - 3200	13.90	11.03	11.89	8.27	9.65	7.17	6.24	5.50	5.62	4.23	4.30	3.41	2.58	2.37	2.29	1.55
3200 - 3300	11.14	10.01	10.53	7.79	8.03	6.33	5.97	5.95	5.66	4.68	5.09	4.10	5.06	3.22	4.09	2.34
3400 - 3500	10.15	10.52	8.62	8.86	8.40	6.50	7.68	6.71	6.09	5.35	5.81	4.33	4.13	2.61	2.61	1.63
3700 - 3800	16.53	15.08	13.15	12.74	9.93	8.04	5.65	4.28	3.77	2.88	2.24	1.94	1.25	0.98	0.85	0.68
3800 - 3900	16.09	14.82	13.41	11.68	9.49	8.47	6.43	5.01	3.78	2.61	2.32	1.69	1.47	1.02	1.03	0.68
4000 - 4100	16.17	15.02	14.07	12.58	10.79	7.75	6.68	5.42	4.29	2.66	1.89	0.92	0.80	0.96	----	----
4100 - 4154	11.62	11.62	11.08	10.55	9.49	8.96	7.23	6.52	5.57	4.74	3.92	2.91	2.14	1.77	1.10	0.79
4154 - 4230	14.98	13.26	12.55	12.46	10.41	7.96	7.64	6.00	4.67	3.19	2.11	1.41	1.36	1.27	0.47	0.26
4230 - 4260	13.07	13.25	11.94	10.37	8.64	8.63	7.36	7.30	4.80	4.04	3.54	2.40	1.97	1.27	0.93	0.49
Core:																
3607 - 3608	8.29	8.50	9.26	8.05	8.17	7.38	7.21	6.62	6.47	5.45	6.28	4.57	5.14	3.28	3.62	1.71
3707 - 3708	5.62	6.22	6.87	6.70	7.47	6.25	7.36	6.58	7.10	5.48	6.40	5.63	6.12	5.59	6.45	4.17



STRATIGRAPHY FOR WELL IS BASED PRIMARILY ON LOG RESPONSE AND ON PROVISIONAL PALEONTOLOGICAL DATING. ALL DEPTHS ARE IN METERS FROM RKB. (KB ELEVATION, 25.9m).

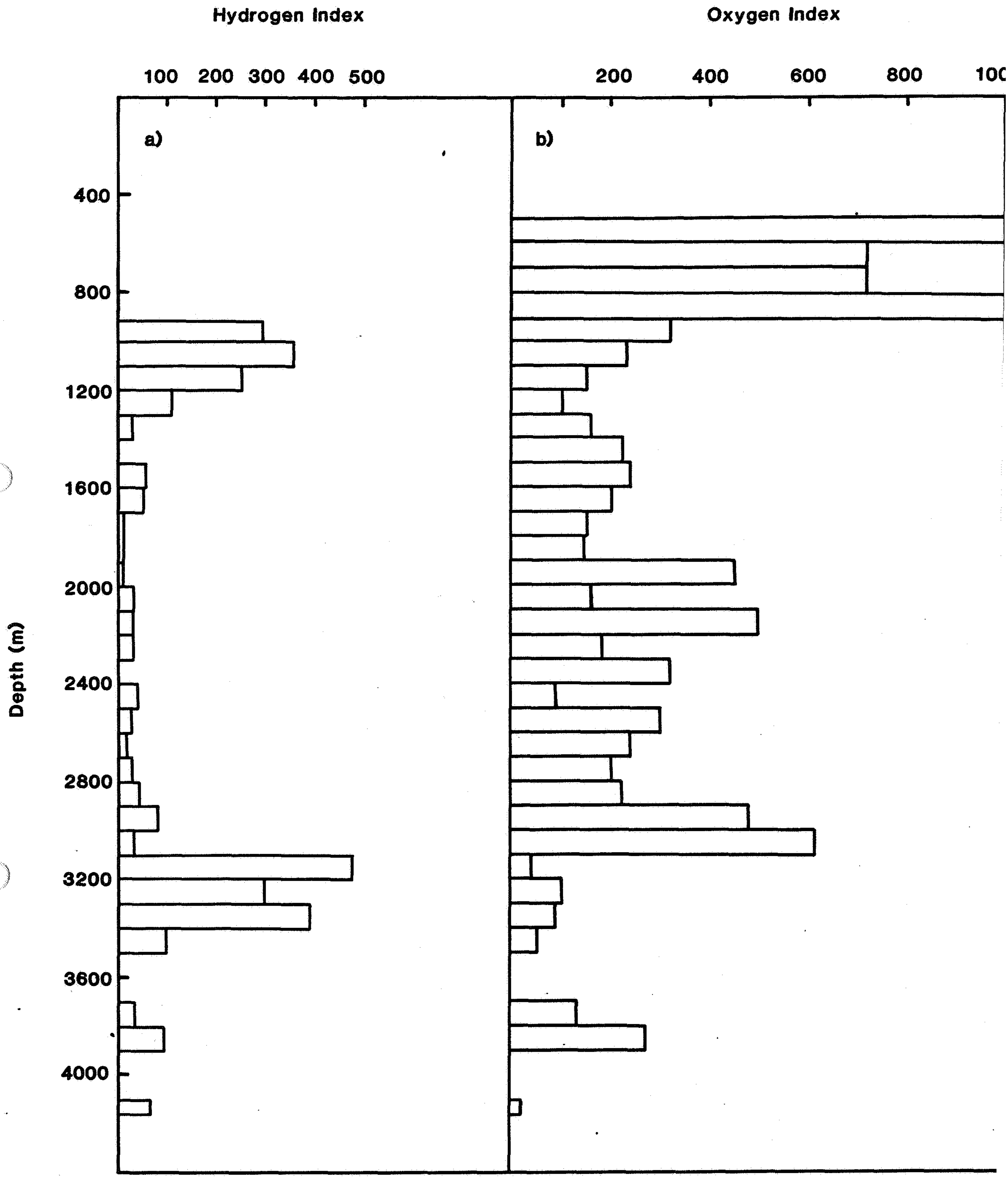


Figure 3. Variations in a.) Hydrogen index and b.) Oxygen index of cutting samples for Well 35/8-1, Hydrogen index = S_2/organic carbon: oxygen index = S_3/organic carbon.

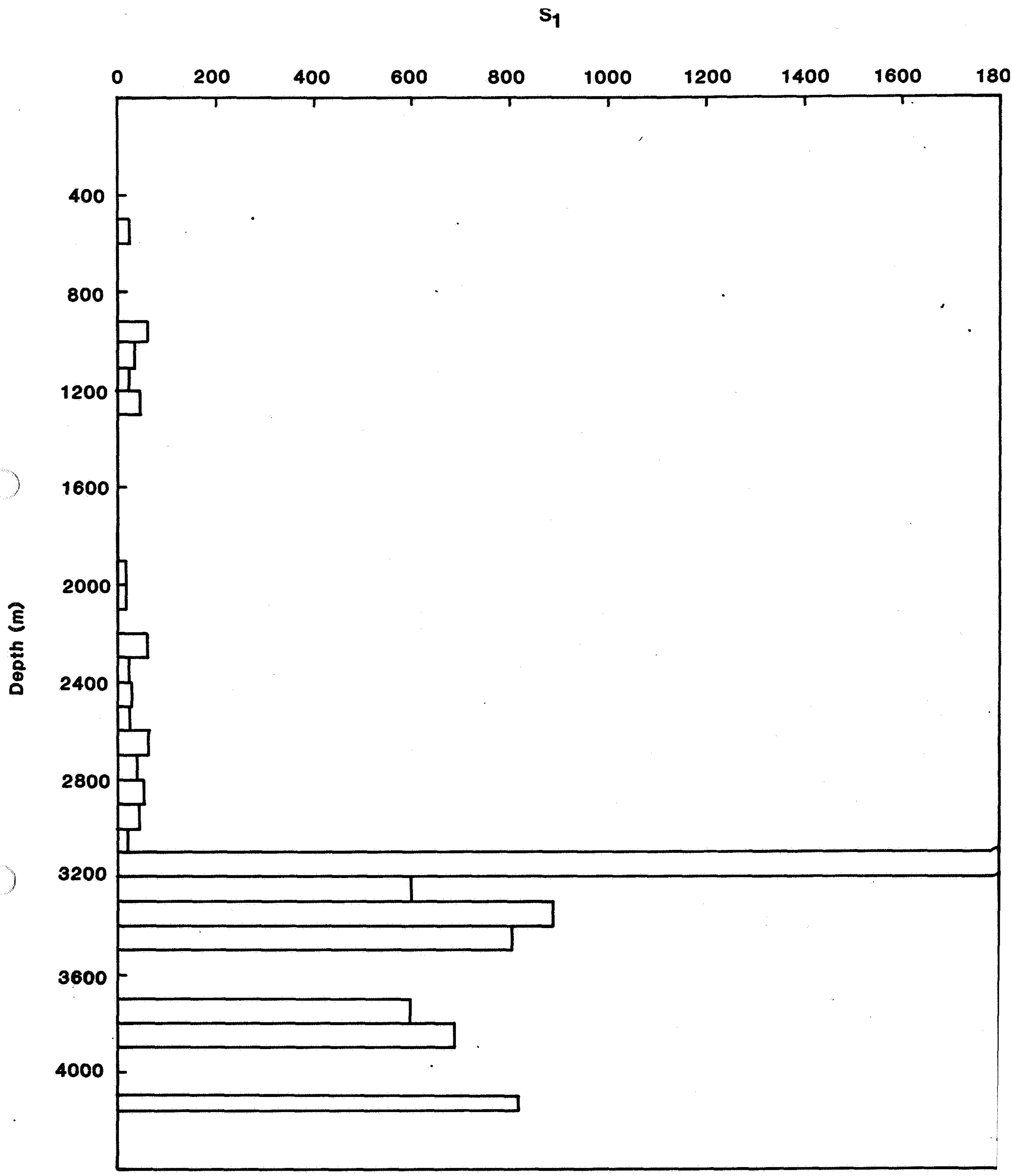


Figure 4. Variation in the free or absorbed hydrocarbon content of cutting samples with depth for well 35/8-1.

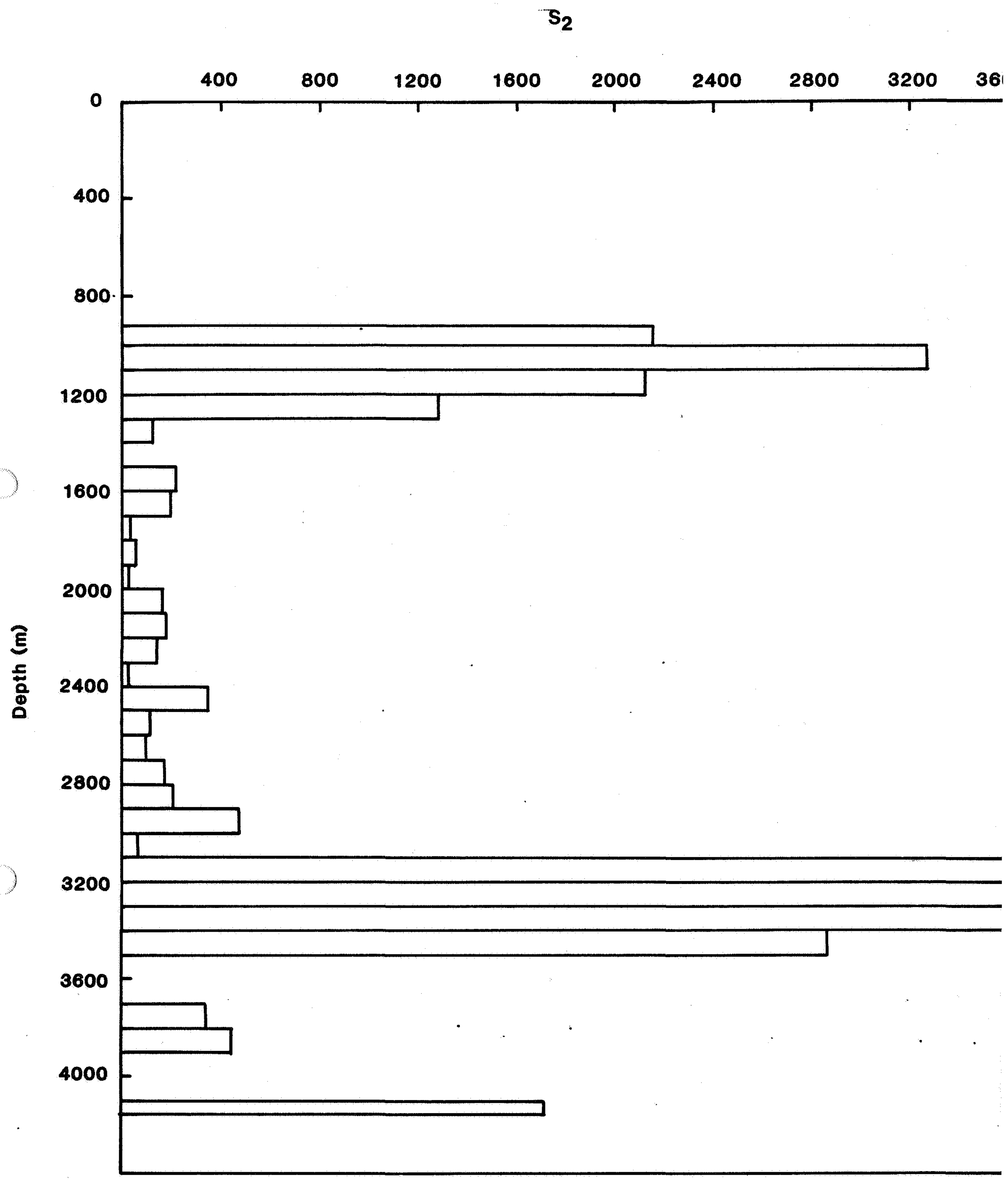


Figure 5. Variations in the hydrocarbon generating potential of kerogen with depth for cutting samples from well 35/8-1.

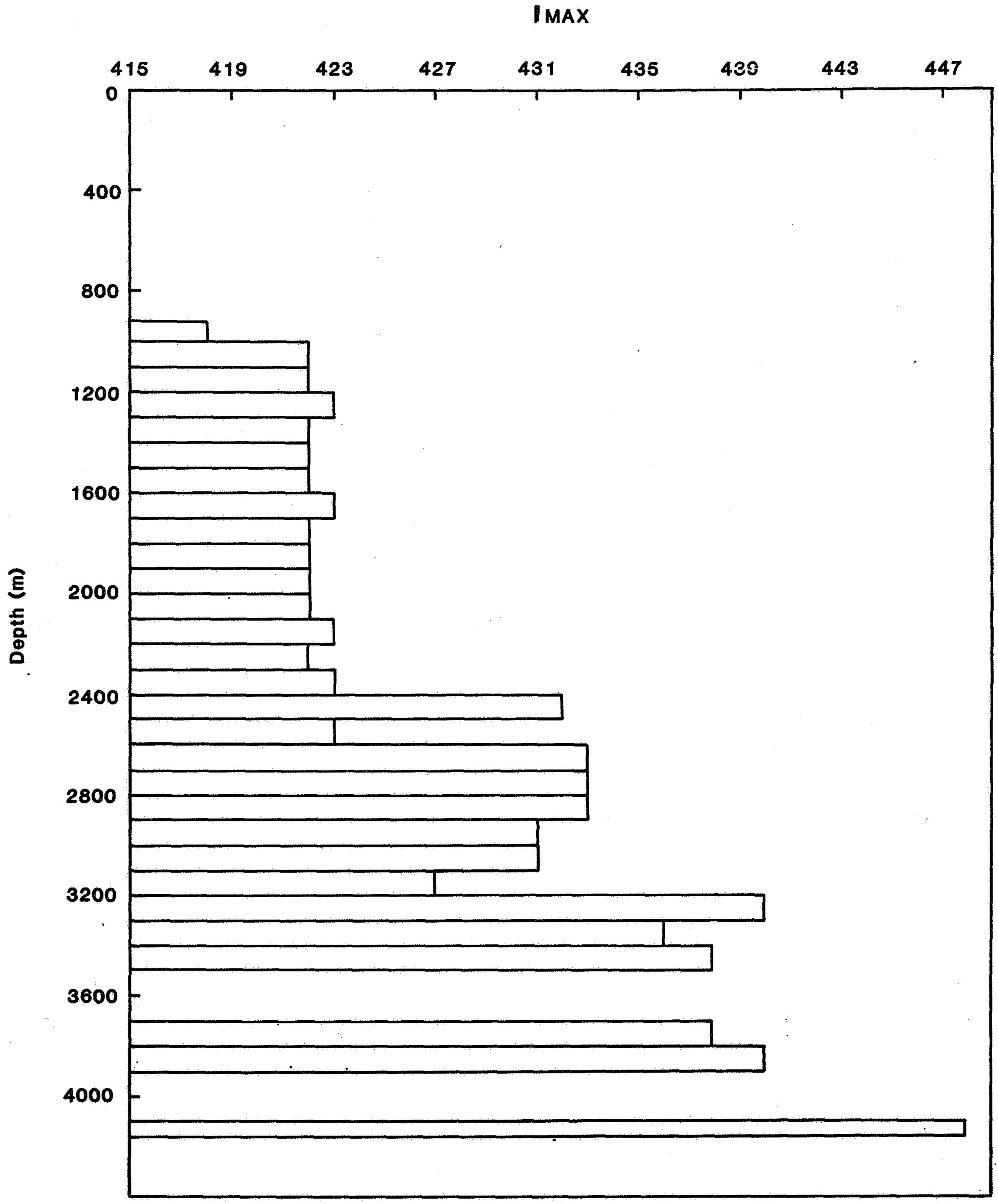


Figure 6. Change in maximum temperature of pyrolysis with depth for cutting samples from well 35/8-1.

C15+ fingerprint for 3100-3200m. depth interval in Well 35/8-1

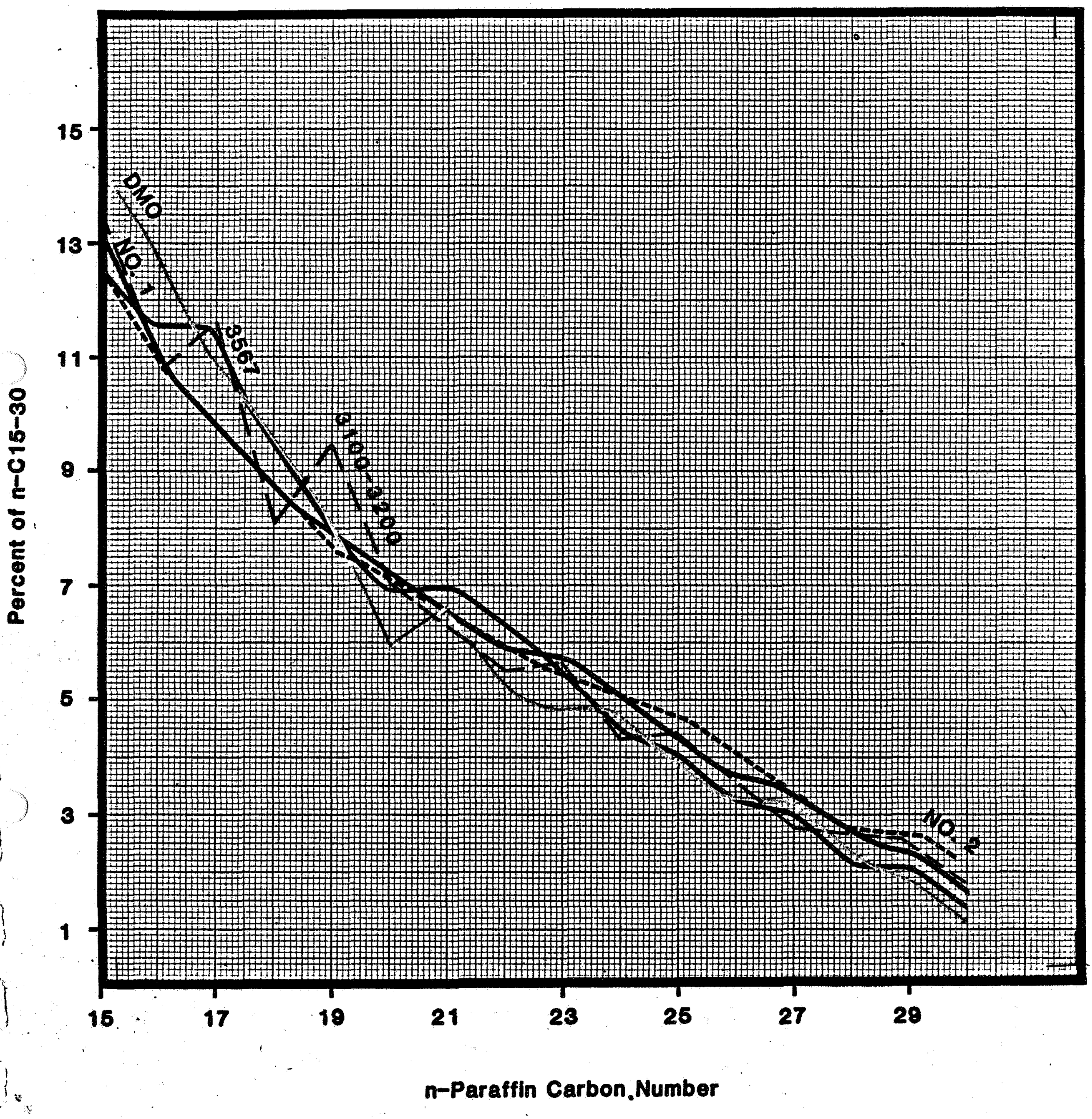


Figure 7. Comparison of C15+ fingerprint for three oils and a drilling mud oil recovered in Well 35/8-1.

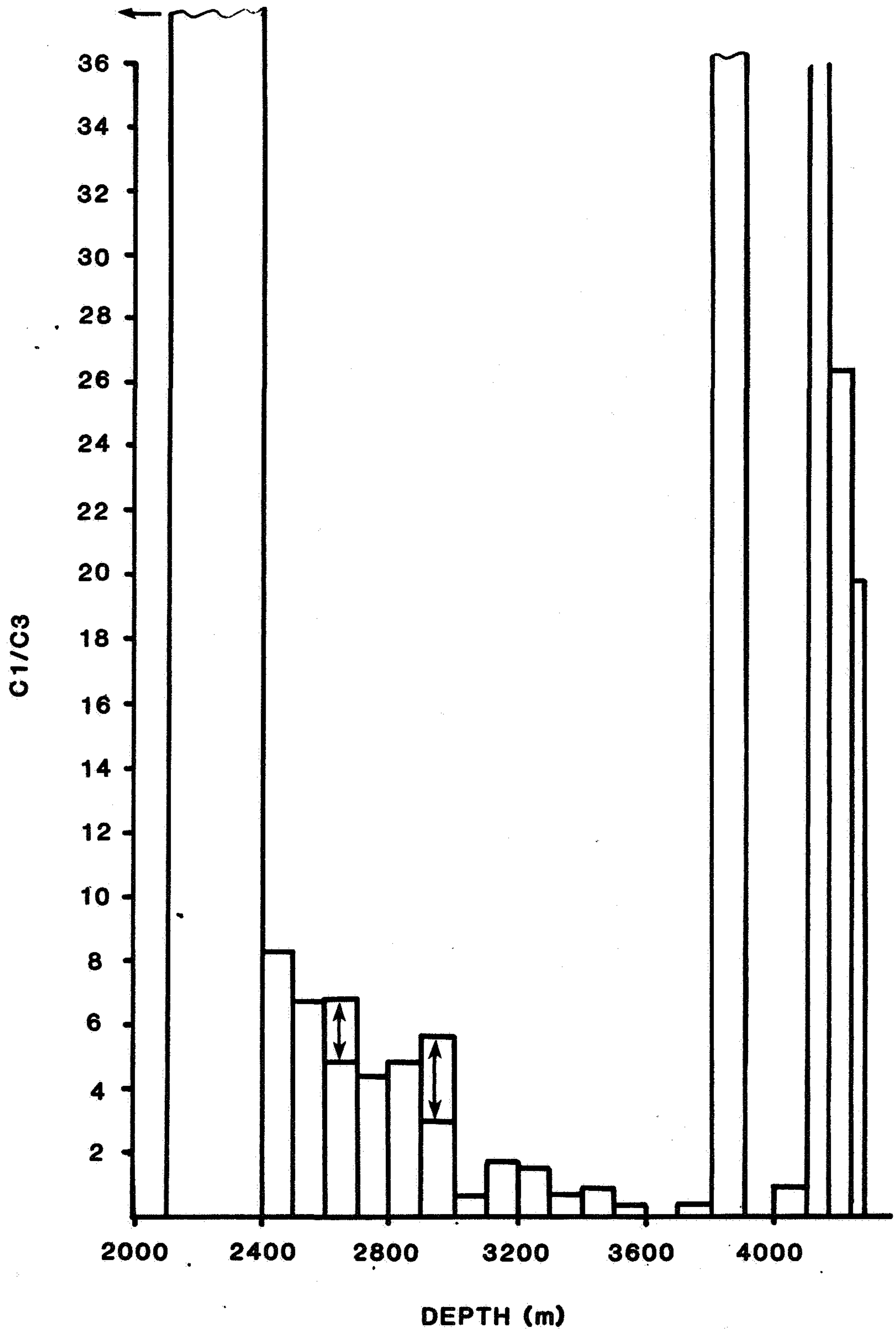


Figure 8. C1/C3 Depth profile for Well 35/8-1. The ratios between 2100-2400m. and 3800-3900m. fall off the scale (Table 4)

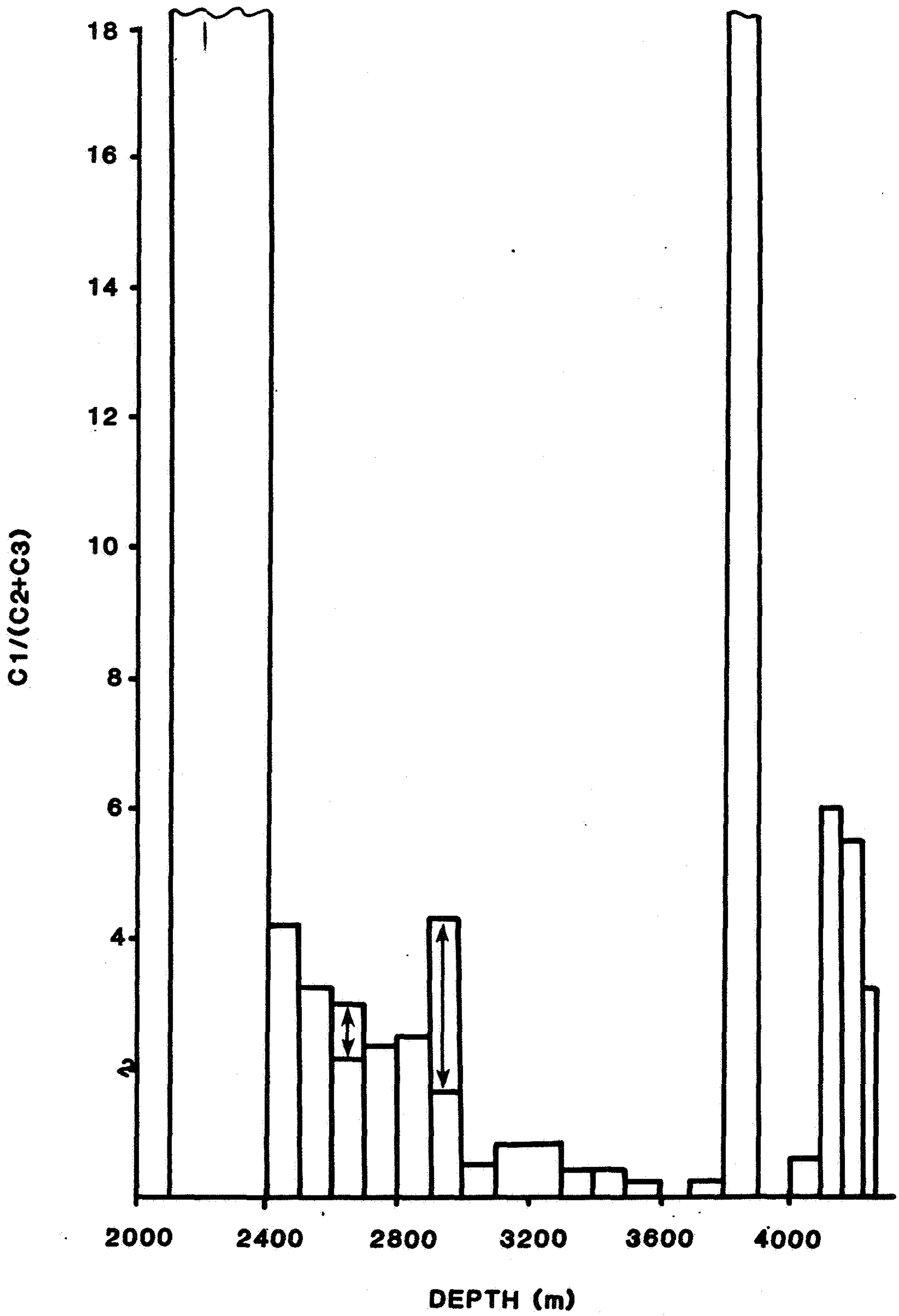


Figure 9. C1/(C2+C3) Depth profile for Well 35/8-1. The ratios between 2100-2400m. and 3800-3900m. fall off the scale (table 4).

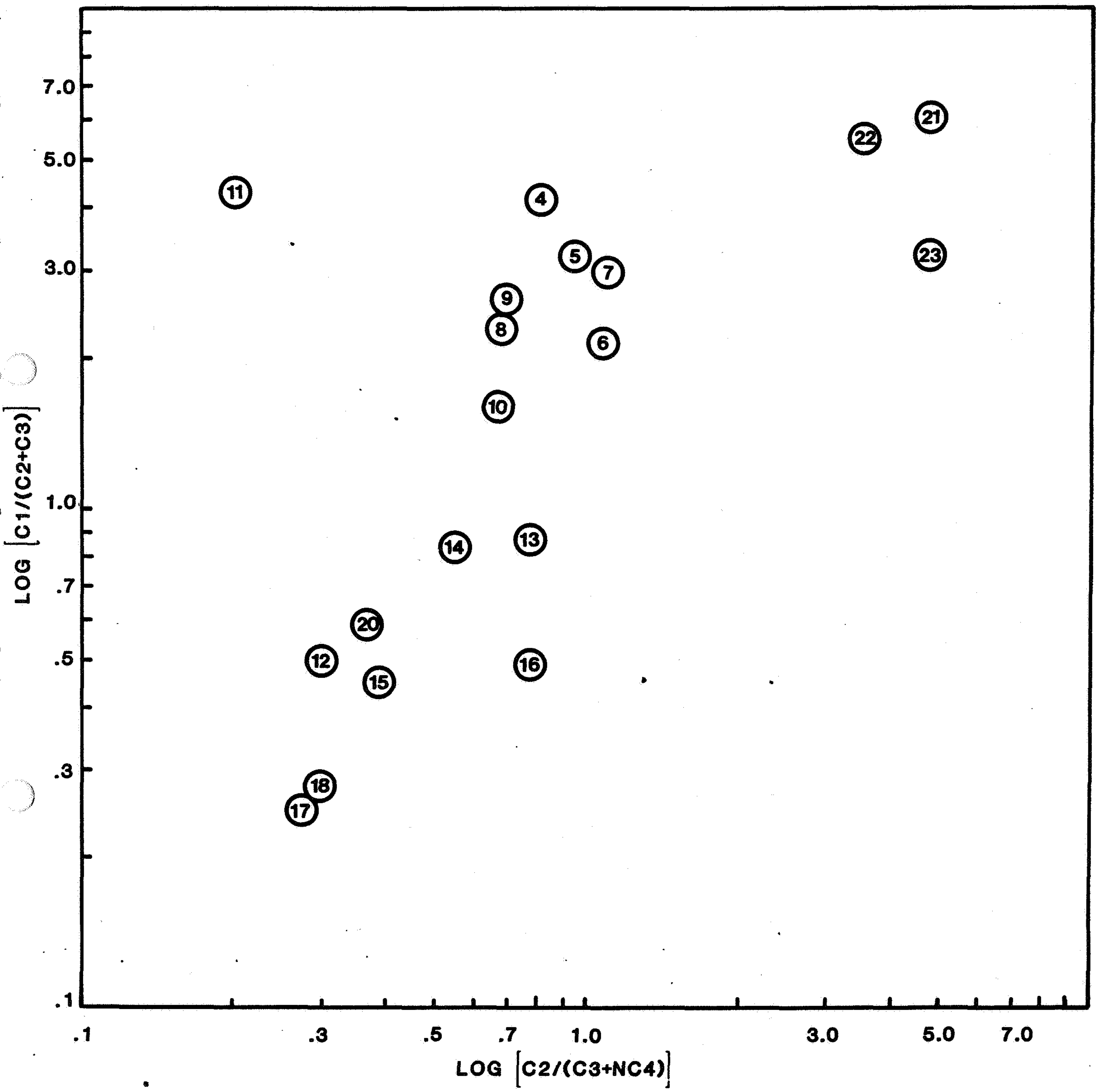
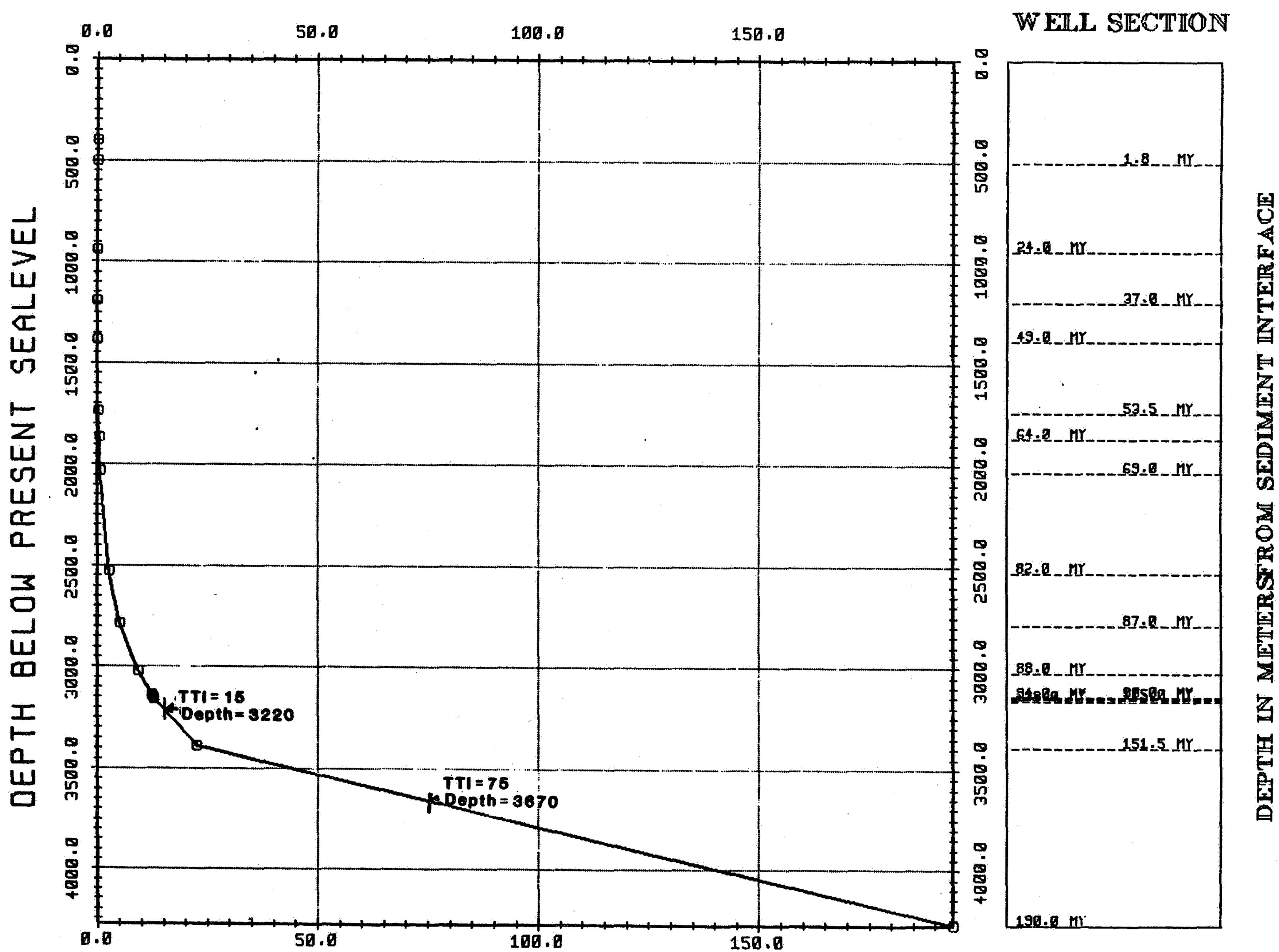


Figure 10. Log-Log plot of C1/(C2 + C3) against C2/(C3+ C4) for samples from Well 35/8-1. Sample numbers increase with depth as indicated, in table 4.

Figure 11. Change in TTI with depth for Well 35/8-1.

Thermal Gradient 3.28 deg C/100m

Surface Temperature 4.4 deg C.



APPENDIX I

Hydrocarbon Source Rock Data for Well 35/8-1

Data includes headspace gas analysis of C_1 - C_4 gaseous hydrocarbons, organic and carbonate carbon contents, quantity of extractable organic matter, and percent composition of extract for cuttings and core samples. Also included is the headspace gas analysis for the drilling mud oil sample.

A. Source Rock Data for Cutting Samples:

RESULTS OF CARBON AND EXTRACTION ANALYSIS

WELL NUMBER	INTERVAL FROM	TO	PERCENT FREE SULFUR	PERCENT TOTAL CARBON	PERCENT ORGANIC CARBON	PERCENT CARBONATE CARBON	PERCENT CHCL3 EXTRACT	PERCENT EXTRACT-ABILITY	PERCENT 'CALCITE' (CALC'D)	PERCENT 'DOLOMITE' (CALC'D)	SAMPLE TYPE	STRAT
BA0221	500	600	.0	1.18	0.09	1.09	0.0370	41.11	9.08	8.37	CU	
BA0221	600	700	.0	0.61	0.05	0.56	0.0202	40.40	4.66	4.30	CU	
BA0221	700	800	.0	0.53	0.05	0.48	0.0054	10.80	4.00	3.69	CU	
BA0221	800	920	.0	2.18	0.14	2.04	0.0180	12.86	16.99	15.66	CU	
BA0221	920	1000	.0	1.91	0.74	1.17	0.0272	3.68	9.74	8.98	CU	
BA0221	1000	1100	.0	2.01	0.92	1.09	0.0410	4.46	9.08	8.37	CU	
BA0221	1100	1200	.0	1.49	0.84	0.65	0.0404	4.81	5.41	4.99	CU	
BA0221	1200	1300	.0	2.05	1.16	0.89	0.0396	3.41	7.41	6.83	CU	
BA0221	1300	1400	.0	0.87	0.51	0.36	0.0214	4.20	3.00	2.76	CU	
BA0221	1400	1500	.0	0.86	0.51	0.35	0.0214	4.20	2.91	2.69	CU	
BA0221	1500	1600	.0	1.10	0.41	0.69	0.0210	5.12	5.75	5.30	CU	
BA0221	1600	1700	.0	1.09	0.41	0.68	0.0190	4.63	5.66	5.22	CU	
BA0221	1700	1800	.0	1.00	0.37	0.63	0.0232	6.27	5.25	4.84	CU	
BA0221	1800	1900	.0	1.28	0.50	0.78	0.0150	3.00	6.49	5.99	CU	
BA0221	1900	2000	.0	1.51	0.37	1.14	0.0098	2.65	9.49	8.75	CU	
BA0221	2000	2100	.0	1.51	0.56	0.95	0.0126	2.25	7.91	7.29	CU	
BA0221	2100	2200	.0	2.27	0.65	1.62	0.0074	1.14	13.49	12.44	CU	
BA0221	2200	2300	.0	0.92	0.65	0.27	0.0074	1.14	2.25	2.07	CU	
BA0221	2300	2400	.0	0.76	0.46	0.30	0.0060	1.30	2.50	2.30	CU	
BA0221	2400	2500	.0	1.39	0.88	0.51	0.0162	1.84	4.25	3.92	CU	
BA0221	2500	2600	.0	1.47	0.40	1.07	0.0108	2.70	8.91	8.22	CU	
BA0221	2600	2700	.0	1.16	0.53	0.63	0.0156	2.94	5.25	4.84	CU	
BA0221	2700	2800	.0	1.86	0.59	1.27	0.0174	2.95	10.57	9.75	CU	
BA0221	2800	2900	.0	2.20	0.50	1.70	0.0844	16.88	14.15	13.05	CU	
BA0221	2900	3000	.0	3.39	0.59	2.80	0.0406	6.88	23.31	21.50	CU	
BA0221	3000	3100	.0	5.33	0.18	5.15	0.0182	10.11	42.88	39.54	CU	
BA0221	3100	3200	.0	5.59	3.12	2.47	0.3614	11.58	20.57	18.96	CU	
BA0221	3200	3300	.0	3.44	1.60	1.84	0.1274	7.96	15.32	14.13	CU	
BA0221	3300	3400	.0	4.29	1.82	2.47	0.1172	6.44	20.57	18.96	CU	
BA0221	3400	3500	.0	5.26	3.07	2.19	0.1408	4.59	18.23	16.81	CU	
BA0221	3700	3800	.0	1.85	1.05	0.80	0.1086	10.34	6.66	6.14	CU	
BA0221	3800	3900	.0	1.48	0.49	0.99	0.0908	18.53	8.24	7.60	CU	
BA0221	4000	4100	.0	1.08	0.18	0.90	0.0188	10.44	7.49	6.91	CU	
BA0221	4100	4154	.0	3.22	2.57	0.65	0.1454	5.66	5.41	4.99	CU	
BA0221	4154	4230	.0	0.62	0.40	0.22	0.0440	11.00	1.83	1.69	CU	
BA0221	4230	4260	.0	1.04	0.72	0.32	0.0680	9.44	2.66	2.46	CU	

CARBON ENRICHMENT COMPARISONS

WELL NO.	INTERVAL FROM	INTERVAL TO	CARBON ENRICHMENT INDEX OF SAMPLE	CARBON ENRICHMENT INDEXES OF RONOV LIMITS CORRESPONDING TO CARBONATE CARBON CONTENT OF THE SAMPLE: UPPER LIMIT	AVERAGE LIMIT	LOWER LIMIT	AMOUNT BY WHICH SAMPLE INDEX EXCEEDS INDEXES OF RONOV LIMITS: UPPER LIMIT	AVERAGE LIMIT	LOWER LIMIT	SAMPLE TYPE	STRAT
BA0221	500	600	4	62	45	28	-58	-41	-24	CU	
BA0221	600	700	2	61	44	28	-59	-42	-26	CU	
BA0221	700	800	2	61	44	28	-59	-42	-26	CU	
BA0221	800	920	10	64	46	30	-54	-36	-20	CU	
BA0221	920	1000	46	62	45	28	-16	1	18	CU	
BA0221	1000	1100	51	62	45	28	-11	6	23	CU	
BA0221	1100	1200	47	61	44	28	-14	3	19	CU	
BA0221	1200	1300	57	61	44	28	-4	13	29	CU	
BA0221	1300	1400	32	61	44	27	-29	-12	5	CU	
BA0221	1400	1500	32	61	44	27	-29	-12	5	CU	
BA0221	1500	1600	27	61	44	28	-34	-17	-1	CU	
BA0221	1600	1700	27	61	44	28	-34	-17	-1	CU	
BA0221	1700	1800	25	61	44	28	-36	-19	-3	CU	
BA0221	1800	1900	33	61	44	28	-28	-11	5	CU	
BA0221	1900	2000	26	62	45	28	-36	-19	-2	CU	
BA0221	2000	2100	37	62	45	28	-25	-8	9	CU	
BA0221	2100	2200	44	63	46	29	-19	-2	15	CU	
BA0221	2200	2300	38	61	44	27	-23	-6	11	CU	
BA0221	2300	2400	29	61	44	27	-32	-15	2	CU	
BA0221	2400	2500	48	61	44	28	-13	4	20	CU	
BA0221	2500	2600	28	62	45	28	-34	-17	0	CU	
BA0221	2600	2700	34	61	44	28	-27	-10	6	CU	
BA0221	2700	2800	39	62	45	29	-23	-6	10	CU	
BA0221	2800	2900	36	63	46	30	-27	-10	6	CU	
BA0221	2900	3000	46	65	48	31	-19	-2	15	CU	
BA0221	3000	3100	22	69	52	34	-47	-30	-12	CU	
BA0221	3100	3200	87	64	47	31	23	40	56	CU	
BA0221	3200	3300	70	63	46	30	7	24	40	CU	
BA0221	3300	3400	76	64	47	31	12	29	45	CU	
BA0221	3400	3500	86	64	47	30	22	39	56	CU	
BA0221	3700	3800	54	61	44	28	-7	10	26	CU	
BA0221	3800	3900	33	62	45	28	-29	-12	5	CU	
BA0221	4000	4100	12	61	44	28	-49	-32	-16	CU	
BA0221	4100	4154	77	61	44	28	16	33	49	CU	
BA0221	4154	4230	25	60	44	27	-35	-19	-2	CU	
BA0221	4230	4260	41	61	44	27	-20	-3	14	CU	

MARCH 5, 1981

GROSS FRACTIONAL COMPOSITION OF MALTENE FRACTION

WELL NO.	INTERVAL FROM	INTERVAL TO	PERCENT SAT'D HC	PERCENT AROM. HC	PERCENT RESIN	PERCENT TOTAL HC	RATIO SHC/AHC	SAMPLE STRAT	SAMPLE TYPE
BA0221	500	600	47.03	30.81	22.16	77.84	1.53		CU
BA0221	600	700	23.96	43.75	32.29	67.71	0.55		CU
BA0221	800	920	26.19	38.10	35.71	64.29	0.69		CU
BA0221	920	1000	14.17	26.67	59.17	40.83	0.53		CU
BA0221	1000	1100	19.74	20.39	59.87	40.13	0.97		CU
BA0221	1100	1200	14.92	40.33	44.75	55.25	0.37		CU
BA0221	1200	1300	16.57	29.59	53.85	46.15	0.56		CU
BA0221	1300	1400	8.16	40.82	51.02	48.98	0.20		CU
BA0221	1400	1500	20.41	38.78	40.82	59.18	0.53		CU
BA0221	1500	1600	30.93	38.14	30.93	69.07	0.81		CU
BA0221	1600	1700	24.21	36.84	38.95	61.05	0.66		CU
BA0221	1700	1800	26.72	37.07	36.21	63.79	0.72		CU
BA0221	1800	1900	13.89	36.11	50.00	50.00	0.38		CU
BA0221	1900	2000	26.83	31.71	41.46	58.54	0.85		CU
BA0221	2000	2100	6.12	28.57	65.31	34.69	0.21		CU
BA0221	2100	2200	44.83	3.45	51.72	48.28	13.00		CU
BA0221	2200	2300	4.17	50.00	45.83	54.17	0.08		CU
BA0221	2300	2400	41.67	37.50	20.83	79.17	1.11		CU
BA0221	2400	2500	14.93	32.84	52.24	47.76	0.45		CU
BA0221	2500	2600	28.57	35.71	35.71	64.29	0.80		CU
BA0221	2600	2700	15.87	44.44	39.68	60.32	0.36		CU
BA0221	2700	2800	1.35	51.35	47.30	52.70	0.03		CU
BA0221	2800	2900	78.70	12.03	9.27	90.73	6.54		CU
BA0221	2900	3000	24.87	26.42	48.70	51.30	0.94		CU
BA0221	3000	3100	1.39	38.89	59.72	40.28	0.04		CU
BA0221	3100	3200	30.69	35.71	33.60	66.40	0.86		CU
BA0221	3200	3300	30.84	38.69	30.47	69.53	0.80		CU
BA0221	3300	3400	0.19	80.86	18.96	81.04	0.0		CU
BA0221	3400	3500	28.06	34.84	37.10	62.90	0.81		CU
BA0221	3700	3800	37.93	37.28	24.78	75.22	1.02		CU
BA0221	3800	3900	25.51	47.45	27.04	72.96	0.54		CU
BA0221	4000	4100	28.24	24.71	47.06	52.94	1.14		CU
BA0221	4100	4154	5.87	59.62	34.51	65.49	0.10		CU
BA0221	4154	4230	24.00	29.33	46.67	53.33	0.82		CU
BA0221	4230	4260	9.27	47.58	43.15	56.85	0.19		CU

GROSS FRACTIONAL COMPOSITION OF TOTAL EXTRACT (WEIGHT PERCENT)

WELL NUMBER	DEPTH FROM	DEPTH TO	SATURATED HYDROCARBONS	AROMATIC HYDROCARBONS	RESINS	ASPHALTENES	TOTAL HYDROCARBONS	SAMPLE TYPE
BA0221	500	600	47.03	30.81	22.16	0.0	77.84	CU
BA0221	600	700	22.77	41.58	30.65	4.95	64.36	CU
BA0221	800	920	24.44	35.56	33.33	6.67	60.00	CU
BA0221	920	1000	12.50	23.53	52.21	11.76	36.03	CU
BA0221	1000	1100	14.63	15.12	44.39	25.85	29.76	CU
BA0221	1100	1200	13.37	36.14	40.10	10.40	49.50	CU
BA0221	1200	1300	14.14	25.25	45.96	14.65	39.39	CU
BA0221	1300	1400	7.48	37.38	46.73	8.41	44.86	CU
BA0221	1400	1500	18.69	35.51	37.38	8.41	54.21	CU
BA0221	1500	1600	28.57	35.24	28.57	7.62	63.81	CU
BA0221	1600	1700	24.21	36.84	38.95	0.0	61.05	CU
BA0221	1700	1800	26.72	37.07	36.21	0.0	63.79	CU
BA0221	1800	1900	13.33	34.67	48.00	4.00	48.00	CU
BA0221	1900	2000	22.45	26.53	34.69	16.33	48.98	CU
BA0221	2000	2100	4.76	22.22	50.79	22.22	26.98	CU
BA0221	2100	2200	35.14	2.70	40.54	21.62	37.84	CU
BA0221	2200	2300	2.70	32.43	29.73	35.14	35.14	CU
BA0221	2300	2400	33.33	30.00	16.67	20.00	63.33	CU
BA0221	2400	2500	12.35	27.16	43.21	17.28	39.51	CU
BA0221	2500	2600	22.22	27.78	27.78	22.22	50.00	CU
BA0221	2600	2700	12.82	35.90	32.05	19.23	48.72	CU
BA0221	2700	2800	1.15	43.68	40.23	14.94	44.83	CU
BA0221	2800	2900	74.41	11.37	8.77	5.45	85.78	CU
BA0221	2900	3000	23.65	25.12	46.31	4.93	48.77	CU
BA0221	3000	3100	1.10	30.77	47.25	20.88	31.87	CU
BA0221	3100	3200	28.06	32.65	30.71	8.58	60.71	CU
BA0221	3200	3300	26.53	33.28	26.22	13.97	59.81	CU
BA0221	3300	3400	0.17	74.23	17.41	8.19	74.40	CU
BA0221	3400	3500	21.16	26.28	27.98	24.57	47.44	CU
BA0221	3700	3800	32.41	31.86	21.18	14.55	64.27	CU
BA0221	3800	3900	22.03	40.97	23.35	13.66	63.00	CU
BA0221	4000	4100	25.53	22.34	42.55	9.57	47.87	CU
BA0221	4100	4154	3.44	34.94	20.22	41.40	38.38	CU
BA0221	4154	4230	16.36	20.00	31.82	31.82	36.36	CU
BA0221	4230	4260	6.76	34.71	31.47	27.06	41.47	CU

March 5, 1981

FREE GAS CONTENTS

WELL NO.	FROM	TO	PPM METHANE	PPM ETHANE	PPM PROPANE	PPM N-BUTANE	PPM ISOBUTANE	PPM ETHYLENE	PPM PROPYLENE	STRAT	SAMPLE TYPE	ALKANE SUM
BA0221	500	600	9.50	0.61	0.44	0.378	0.220	0.940	0.729		CU	11.148
BA0221	600	700	80.51	0.59	0.66	0.262	0.194	0.813	0.566		CU	82.216
BA0221	700	800	18.66	0.33	0.24	0.155	0.102	0.769	0.463		CU	19.487
BA0221	800	920	11.48	0.44	0.40	0.357	0.182	0.768	0.637		CU	12.859
BA0221	920	1000	515.09	76.56	11.43	1.435	2.630	3.729	0.847		CU	607.144
BA0221	1000	1100	110.09	1.78	1.72	0.394	0.619	0.964	0.329		CU	114.603
BA0221	1100	1200	39.56	0.82	0.70	0.261	0.120	0.665	0.288		CU	41.461
BA0221	1200	1300	321.72	0.75	0.66	0.365	0.116	1.257	0.609		CU	323.611
BA0221	1300	1400	1473.93	1.70	1.17	0.537	0.083	1.781	0.364		CU	1477.419
BA0221	1400	1500	4.97	0.08	0.08	0.037	0.005	0.076	0.079		CU	5.172
BA0221	1500	1600	250.63	0.85	0.94	0.219	0.094	0.924	0.539		CU	252.733
BA0221	1600	1700	124.57	5.70	1.32	0.600	1.252	0.898	0.523		CU	133.442
BA0221	1700	1800	163.21	7.60	3.11	1.615	4.792	0.897	0.242		CU	180.327
BA0221	1800	1900	2.72	0.05	0.02	0.0	0.0	0.0	0.0		CU	2.790
BA0221	2100	2200	4.52	0.02	0.03	0.0	0.009	0.011	0.0		CU	4.579
BA0221	2200	2300	4.58	0.02	0.02	0.020	0.022	0.004	0.0		CU	4.662
BA0221	2300	2400	0.14	0.0	0.0	0.0	0.0	0.0	0.0		CU	0.140
BA0221	2400	2500	5.22	0.61	0.63	0.139	0.266	0.0	0.0		CU	6.865
BA0221	2500	2600	1719.90	279.24	253.19	51.109	62.781	0.0	55.255		CU	2366.219
BA0221	2600	2700	3862.66	734.83	560.31	113.185	152.233	7.704	0.0		CU	5423.211
BA0221	2700	2800	1826.91	365.07	412.49	122.536	163.070	23.796	0.0		CU	2890.075
BA0221	2800	2900	568.20	104.51	116.48	34.000	46.038	7.383	0.0		CU	869.228
BA0221	2900	3000	1985.14	553.90	654.43	190.725	289.358	5.266	2.910		CU	3673.552
BA0221	3000	3100	222.62	128.62	311.65	120.027	90.126	2.536	0.0		CU	873.043
BA0221	3100	3200	111439.25	64654.31	63353.69	20437.410	7498.863	0.0	0.0		CU	267383.375
BA0221	3200	3300	11693.84	6192.55	7582.96	3672.028	919.600	0.0	0.0		CU	30060.969
BA0221	3300	3400	18133.91	14126.90	24942.44	11016.078	3276.073	0.0	0.0		CU	71495.375
BA0221	3400	3500	26589.04	27226.12	29018.05	6629.395	3023.571	0.0	0.0		CU	92486.125
BA0221	3500	3600	27.97	32.12	73.84	41.186	10.055	0.0	0.0		CU	185.171
BA0221	3700	3800	46.02	50.12	112.16	58.428	15.990	0.0	0.0		CU	282.718
BA0221	3800	3900	46.02	0.0	0.0	0.0	0.0	0.0	0.0		CU	46.020
BA0221	4000	4100	180.92	108.64	196.45	104.682	34.227	0.336	0.0		CU	624.918
BA0221	4100	4154	204577.25	28324.23	5543.89	394.926	432.031	0.0	0.0		CU	239272.188
BA0221	4154	4230	113364.94	16275.81	4302.72	381.849	246.690	0.0	0.0		CU	134571.875
BA0221	4230	4260	217600.44	55896.94	10996.59	780.044	933.807	0.0	0.0		CU	286207.688

GAS COMPONENT RATIOS

WELL NO.	INTERVAL FROM	TO	PCT C1 IN C1-C4	C2/C1	(C3+C4) /C1	C1/C2	C1/C3	C1/BUT	N-C4 /I-C4
BA0221	500	600	85.22	0.064	0.109	15.574	21.591	13.886	1.718
BA0221	600	700	97.92	0.007	0.014	136.458	121.985	176.557	1.351
BA0221	700	800	95.76	0.018	0.027	56.545	77.750	72.607	1.520
BA0221	800	920	89.28	0.038	0.082	26.091	28.700	21.299	1.962
BA0221	920	1000	84.84	0.149	0.030	6.728	45.065	126.713	0.546
BA0221	1000	1100	96.06	0.016	0.025	61.848	64.006	108.677	0.637
BA0221	1100	1200	95.41	0.021	0.027	48.244	56.514	103.832	2.175
BA0221	1200	1300	99.42	0.002	0.004	428.960	487.454	668.856	3.147
BA0221	1300	1400	99.76	0.001	0.001	867.018	1259.770	2377.307	6.470
BA0221	1400	1500	96.09	0.016	0.025	62.125	62.125	118.333	7.400
BA0221	1500	1600	99.17	0.003	0.005	294.859	266.627	800.735	2.330
BA0221	1600	1700	93.35	0.046	0.025	21.854	94.371	67.262	0.479
BA0221	1700	1800	90.51	0.047	0.058	21.475	52.479	25.474	0.337
BA0221	1800	1900	97.49	0.018	0.007	54.400	136.000	99999.875	99999.875
BA0221	2100	2200	98.71	0.004	0.009	226.000	150.667	502.222	0.0
BA0221	2200	2300	98.24	0.004	0.014	229.000	229.000	109.048	0.909
BA0221	2300	2400	100.00	0.0	0.0	99999.875	99999.875	99999.875	99999.875
BA0221	2400	2500	76.04	0.117	0.198	8.557	8.286	12.889	0.523
BA0221	2500	2600	72.69	0.162	0.213	6.159	6.793	15.101	0.814
BA0221	2600	2700	71.22	0.190	0.214	5.257	6.894	14.553	0.743
BA0221	2700	2800	63.21	0.200	0.382	5.004	4.429	6.397	0.751
BA0221	2800	2900	65.37	0.184	0.346	5.437	4.878	7.099	0.739
BA0221	2900	3000	54.04	0.279	0.572	3.584	3.033	4.135	0.659
BA0221	3000	3100	25.50	0.578	2.344	1.731	0.714	1.059	1.332
BA0221	3100	3200	41.68	0.580	0.819	1.724	1.759	3.989	2.725
BA0221	3200	3300	38.90	0.530	1.041	1.888	1.542	2.547	3.993
BA0221	3300	3400	25.36	0.779	2.164	1.284	0.727	1.269	3.363
BA0221	3400	3500	28.75	1.024	1.454	0.977	0.916	2.754	2.193
BA0221	3500	3600	15.10	1.148	4.472	0.871	0.379	0.546	4.096
BA0221	3700	3800	16.28	1.089	4.054	0.918	0.410	0.618	3.654
BA0221	3800	3900	100.00	0.0	0.0	99999.875	99999.875	99999.875	99999.875
BA0221	4000	4100	28.95	0.600	1.854	1.665	0.921	1.302	3.058
BA0221	4100	4154	85.50	0.138	0.031	7.223	36.901	247.386	0.914
BA0221	4154	4230	84.24	0.144	0.043	6.965	26.347	180.363	1.548
BA0221	4230	4260	76.03	0.257	0.058	3.893	19.788	126.966	0.835

AN ENTRY OF 99999.875 INDICATES A VALUE OF INFINITY FOR THAT RATIO (DENOMINATOR = ZERO).

B. Source Rock Data for Core Samples:

MARCH 6, 1981

Well Number	Interval From	Interval To	Percent Free Sulfur	Percent Total Carbon	Percent Organic Carbon	Percent Carbonate Carbon	Percent $CHCL_3$ Extract	Percent Extractability	Percent 'Calcite' (Calc'd)	Percent 'Dolomite' (Calc'd)	Sample Type	Strat
BA0221	3607	3608	.0	7.52	6.20	1.32	0.0746	1.20	10.99	10.13	CC	
BA0221	3707	3708	.0	1.46	0.96	0.50	0.2954	30.77	4.16	3.84	CC	

MARCH 6, 1981

Well Number	Interval From	Interval To	Carbon Enrichment Index of Sample	Carbon Enrichment Indexes of Ronov Limits Corresponding To Carbonate Carbon Content of the Sample: Upper Limit	Average Limit	Lower Limit	Amount by Which Sample Index Exceeds Indexes of Ronov Limits: Upper Limit	Average Limit	Lower Limit	Sample Type	Strat
BA0221	3607	3608	93	62	45	29	31	48	64	CC	
BA0221	3707	3708	50	61	44	28	-11	6	22	CC	

FREE GAS CONTENTS

Well No.	From	To	ppm Methane	ppm Ethane	ppm Propane	ppm N-Butane	ppm Iso-Butane	ppm Ethylene	ppm Propylene	Strat	Sample Type	Sum
BA0221	3607	3608	5.05	0.22	4.52	23.661	5.836	0.032	0.051		CC	39.284
BA0221	3707	3708	6.82	39.47	890.71	475.820	155.294	0.102	0.083		CC	1568.109

GAS COMPONENT RATIOS

Well No.	Interval From	Interval To	PCT C_1 In $C_1 - C_4$	C_2/C_1	$(C_3 + C_4)/C_1$	C_1/C_2	C_1/C_3	C_1/But	$N-C_4/I-C_4$
BA0221	3607	3608	12.85	0.044	6.740	22.543	1.117	0.171	4.055
BA0221	3707	3708	0.44	5.783	222.996	0.173	0.008	0.011	3.064

MARCH 6, 1981

Well Number	Depth From	Depth To	Saturated HC(%)	Aromatic HC(%)	Resin (%)	S/A Ratio	Total HC(%)	Sample Type
BA0221	3607	3608	53.45	28.74	17.82	1.86	82.18	CC
BA0221	3707	3708	38.98	35.22	25.80	1.11	74.20	CC

C. Headspace Gas Analyses for Drilling Mud Oil Sample:

NORWAY 35/8-7
MAP SAMPLE TAKEN AT
12:30 HRS
9/14/80

FREE GAS CONTENTS

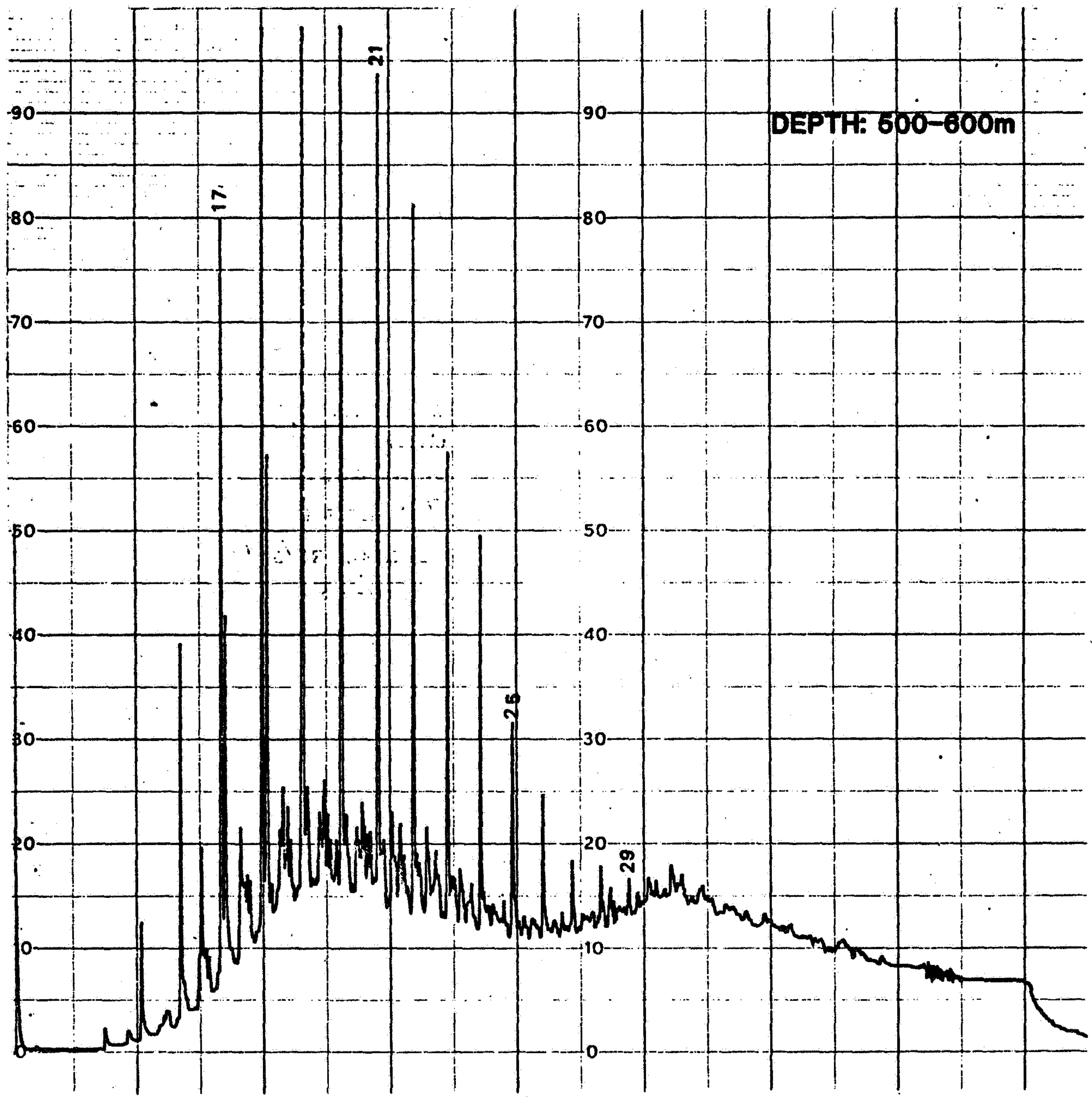
Well No.	From	To	ppm Methane	ppm Ethane	ppm Propane	ppm N-Butane	ppm Iso-Butane	ppm Ethylene	ppm Propylene	Strat	Sample Type	Sum
BA0221	1	1	16650.47	123466.63	233335.06	130502.938	35977.223	0.0	0.0		CU	39932.250

GAS COMPONENT RATIOS

Well No.	Interval From	Interval To	PCT C_1 In $C_1 - C_4$	C_2/C_1	$(C_3 + C_4)/C_1$	C_1/C_2	C_1/C_3	C_1/But	$N-C_3/I-C_4$
BA0221	1	1	3.08	7.415	24.012	0.135	0.071	0.100	3.627

APPENDIX II

GC of Saturate Hydrocarbons Extracted from Cutting and Core Samples in Well 35/8-1



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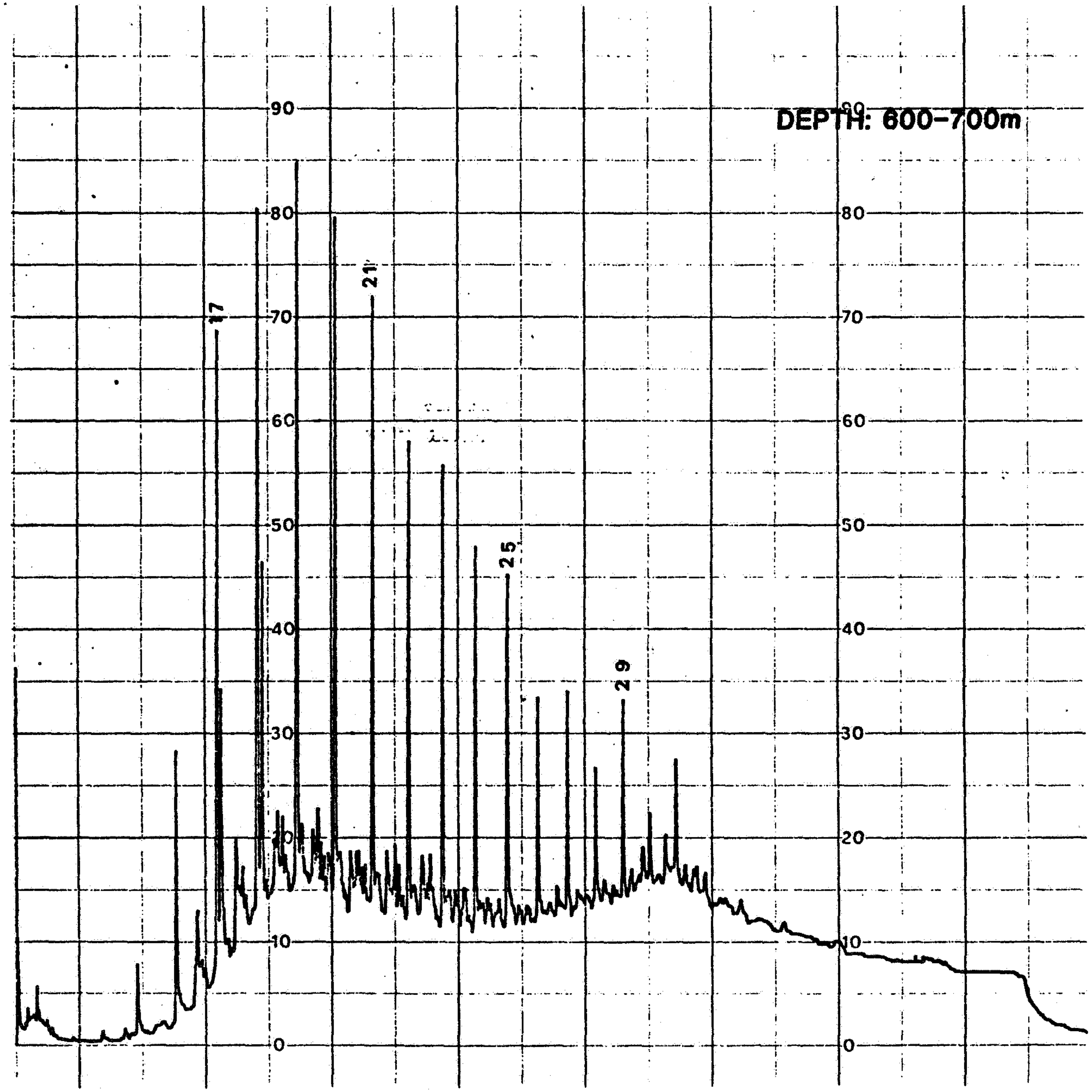

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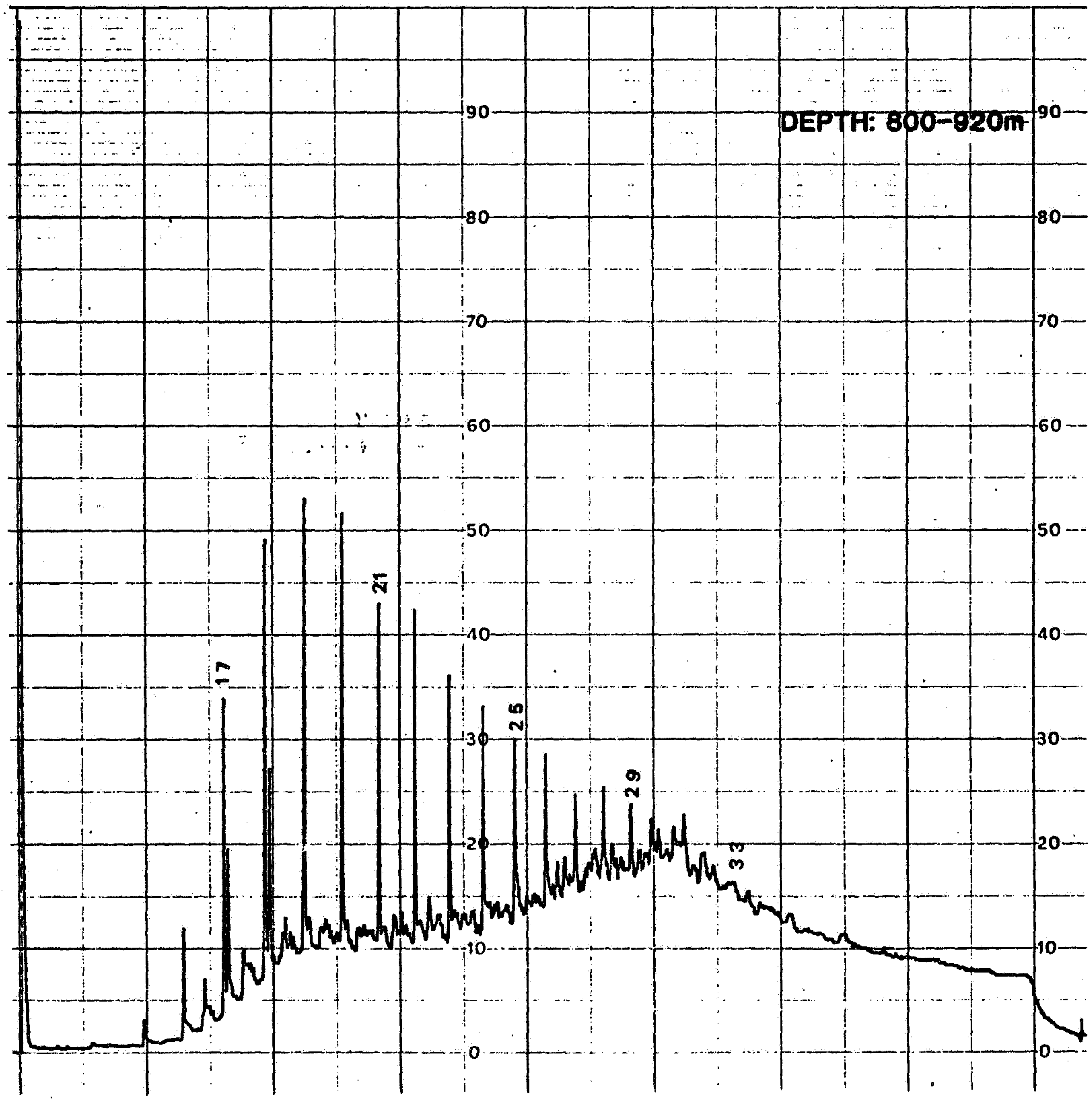
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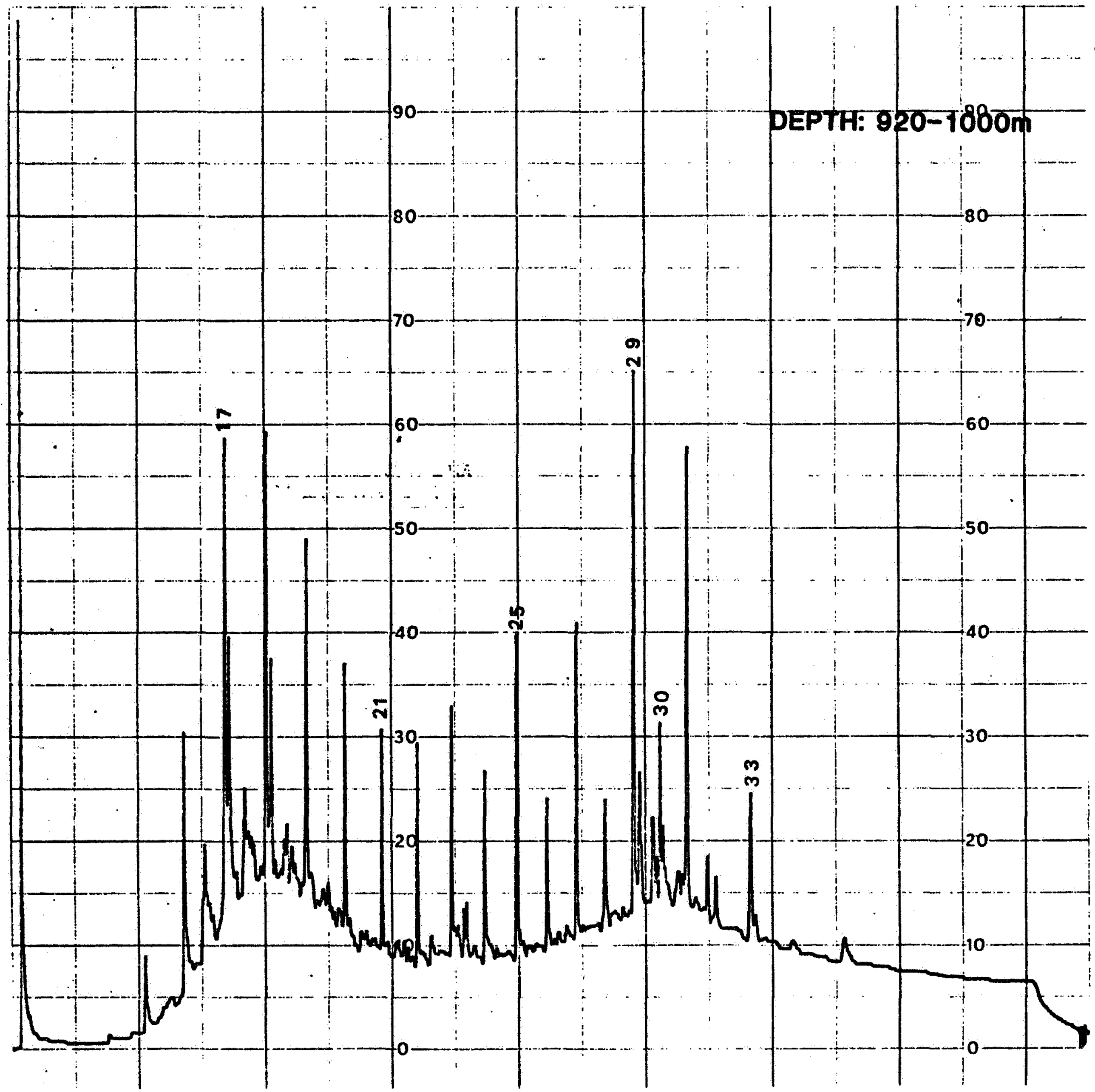

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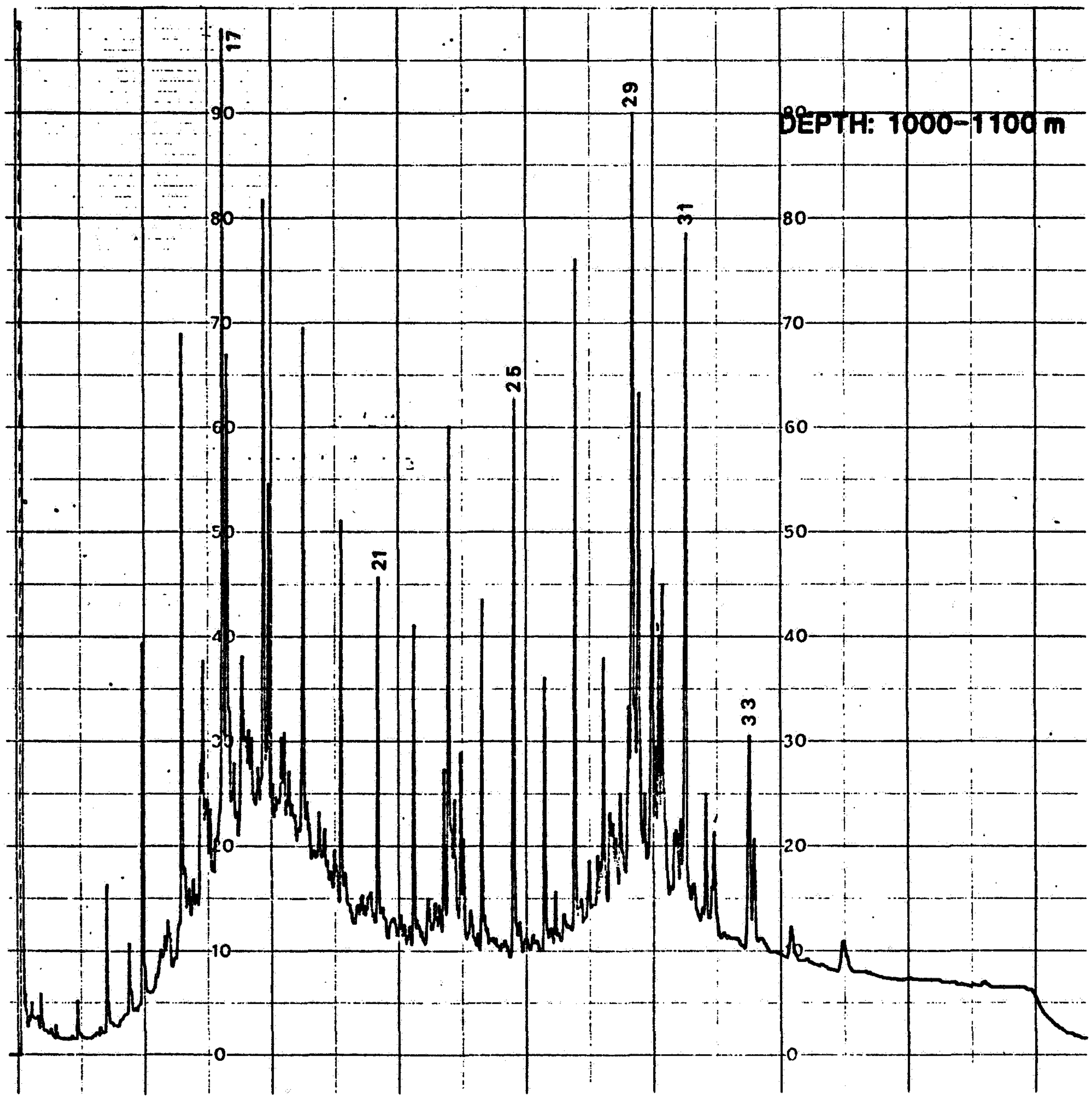
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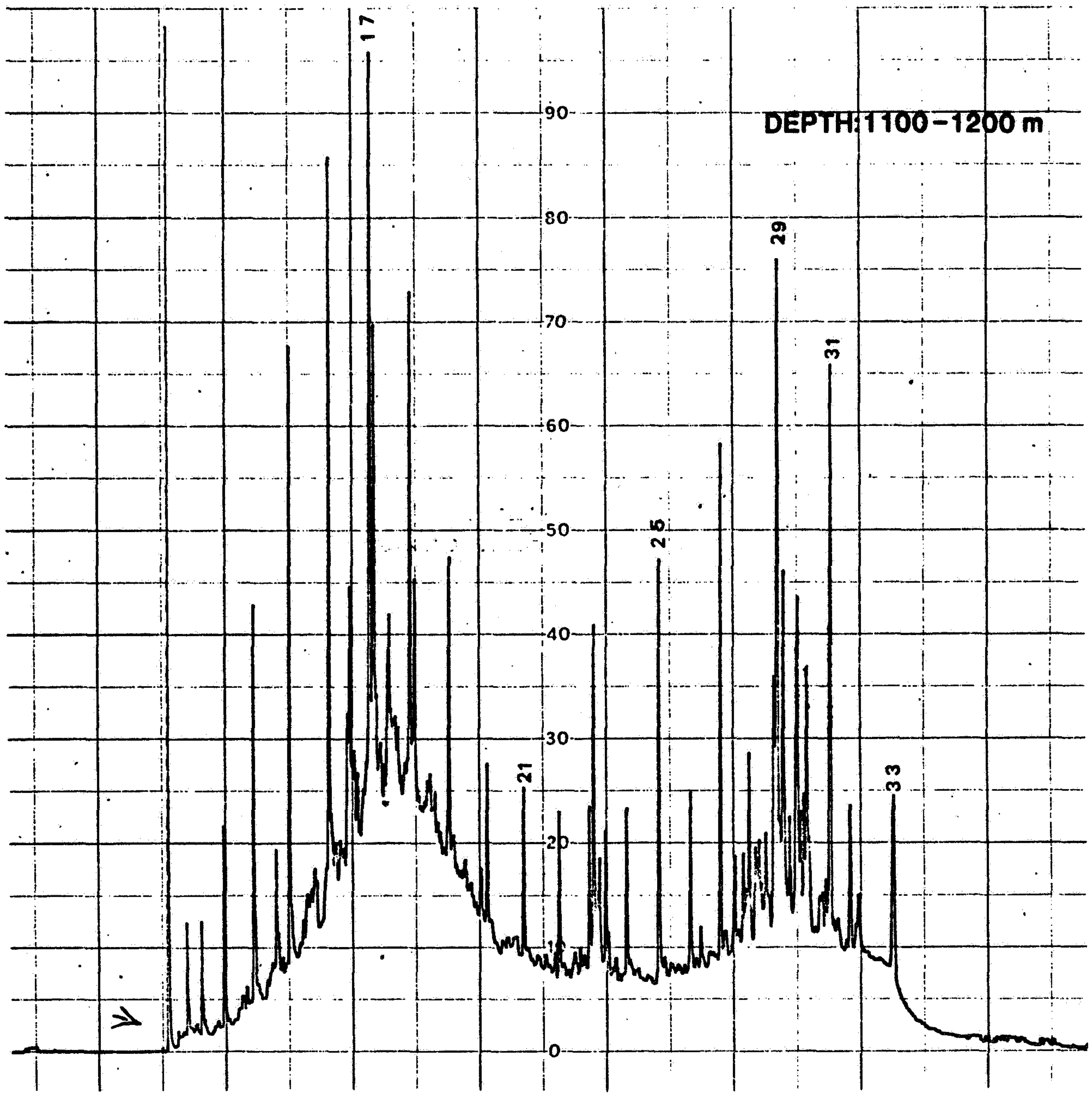
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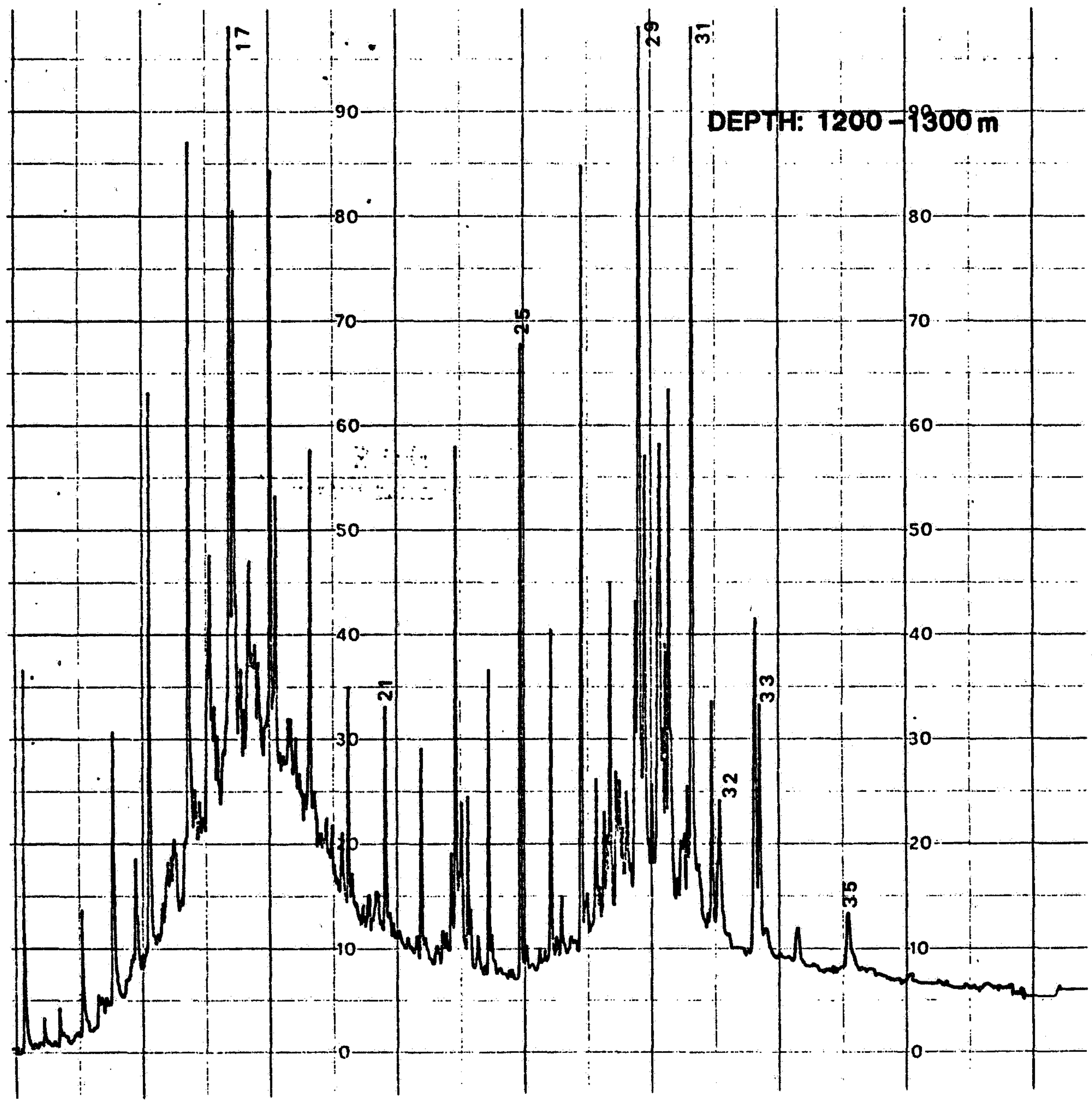

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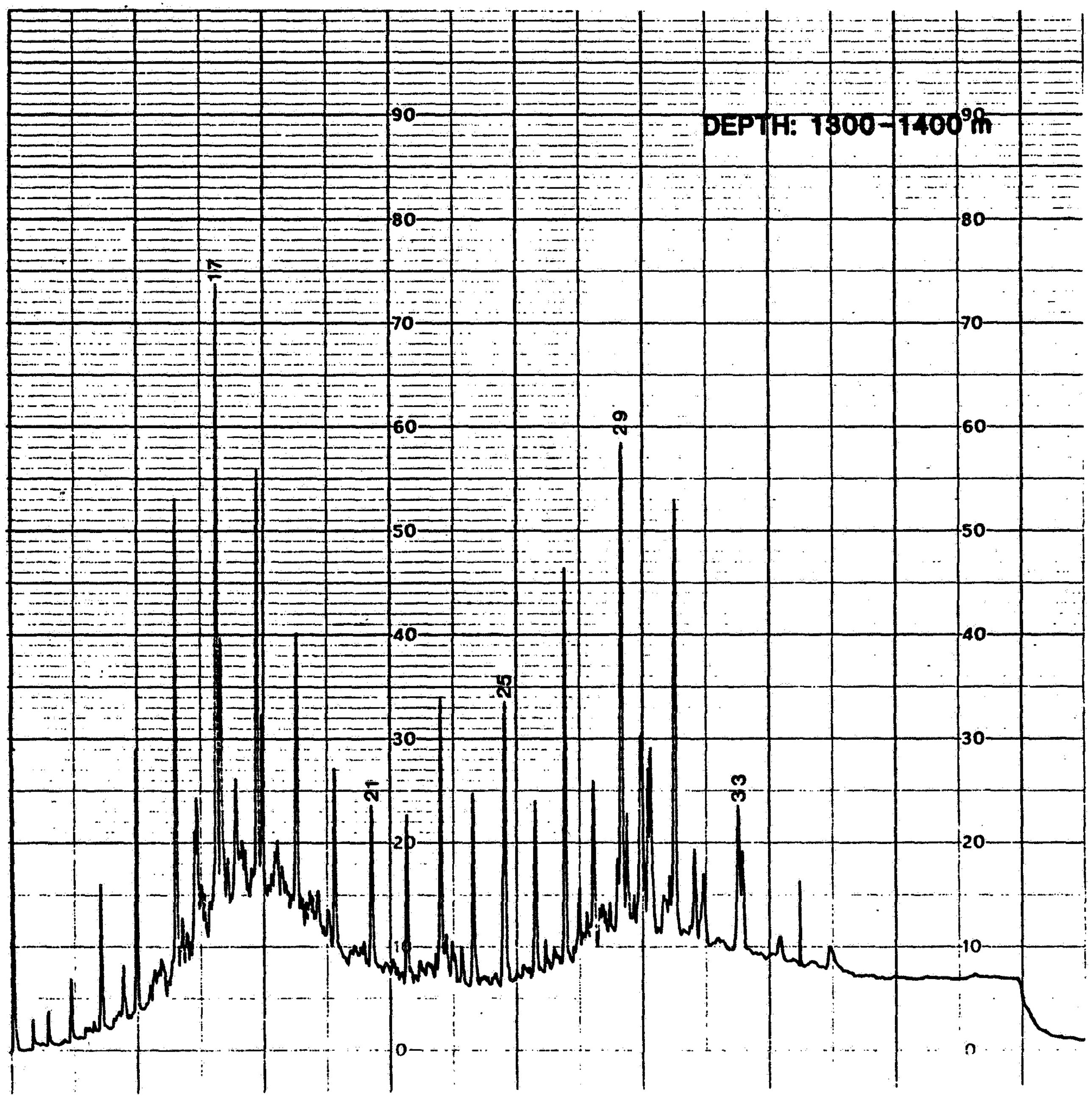
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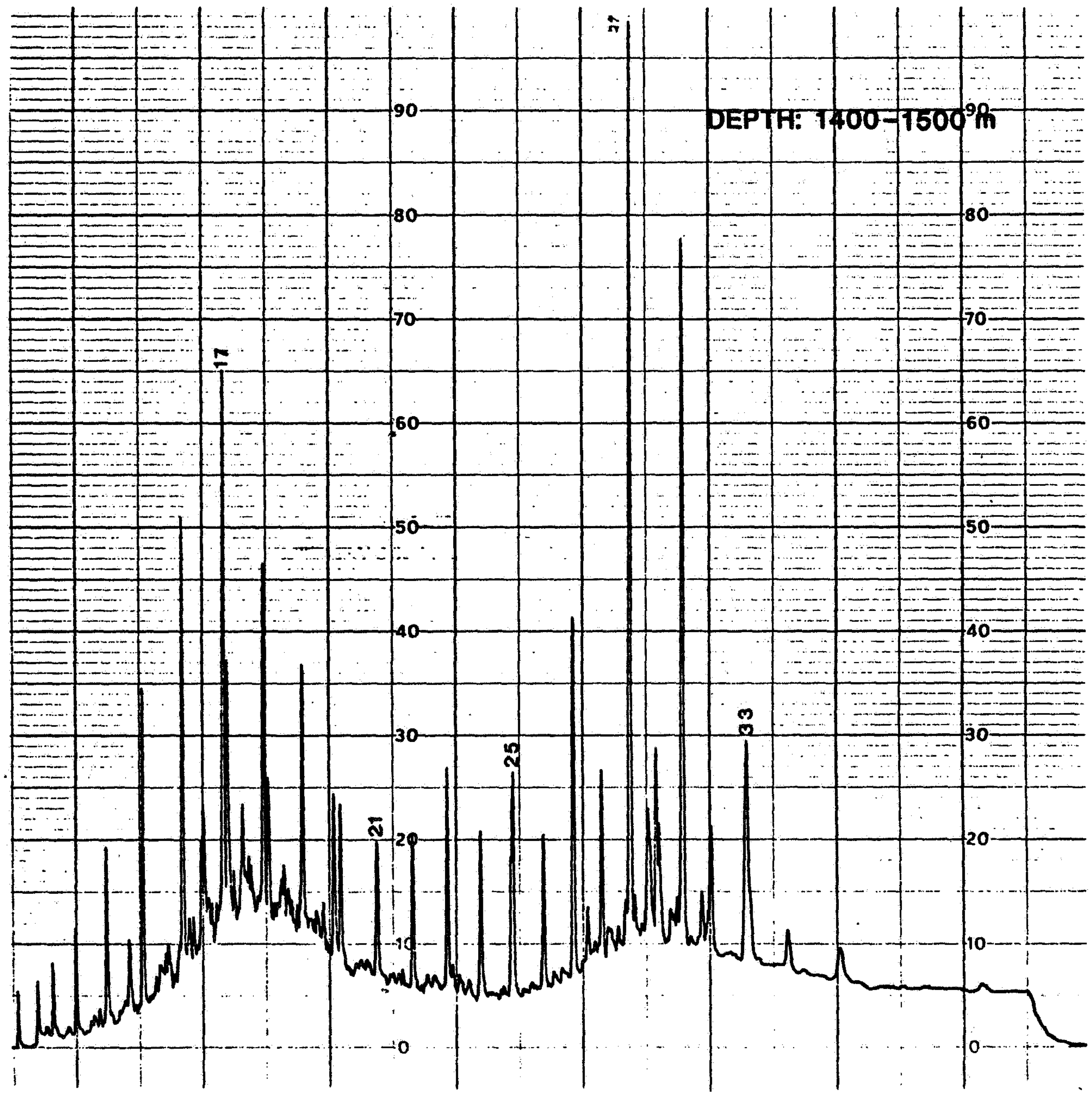
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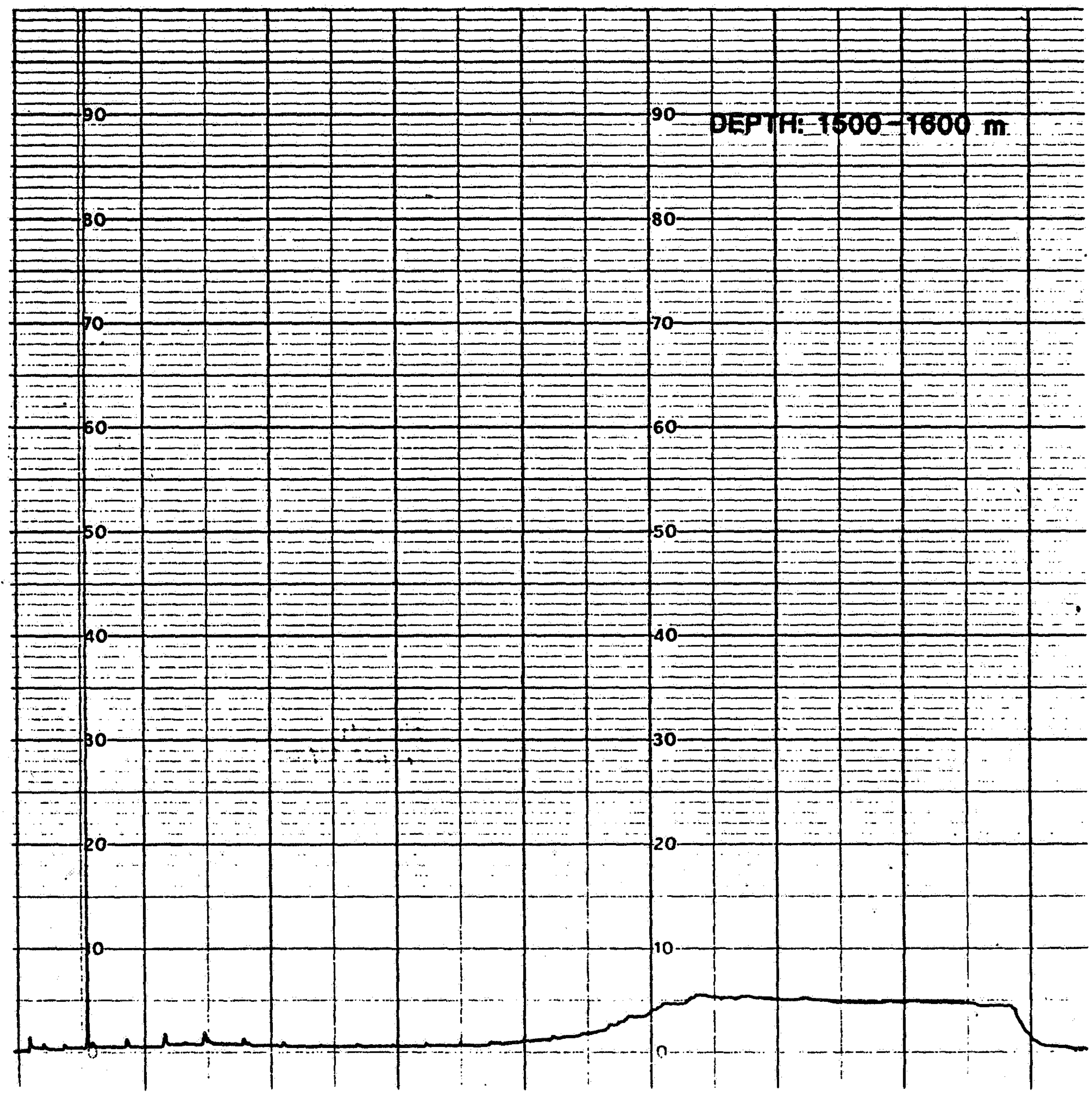
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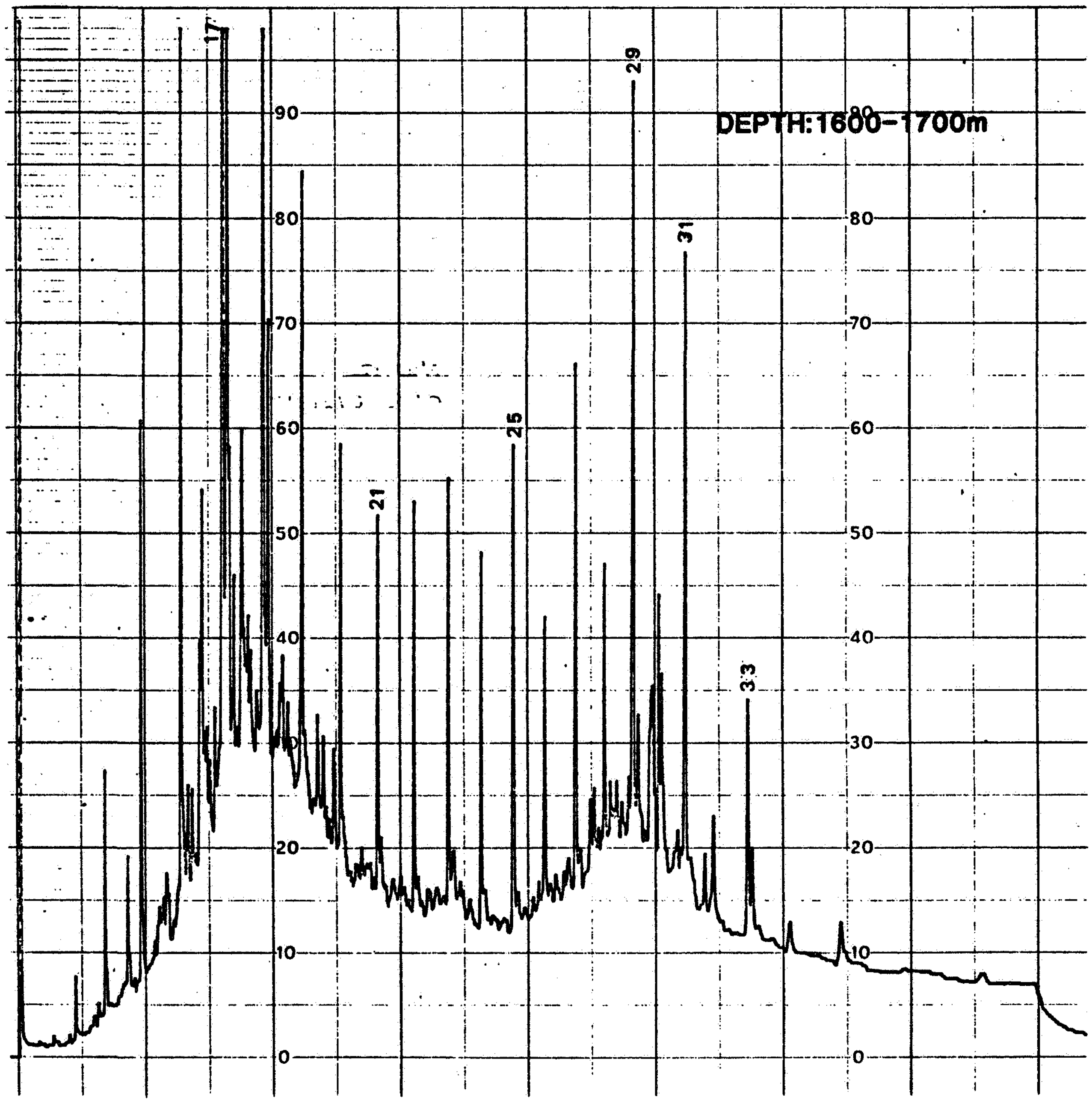

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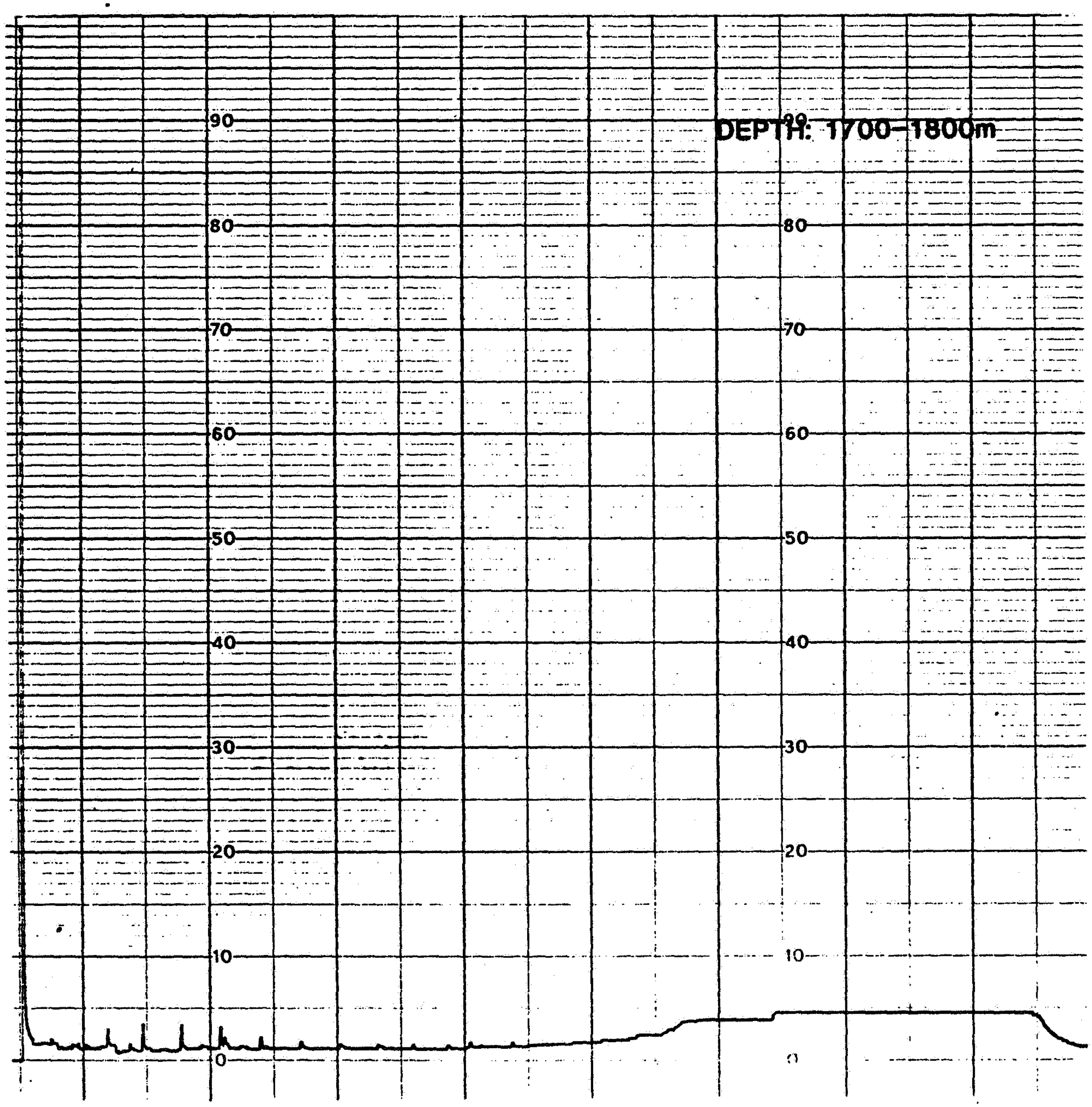
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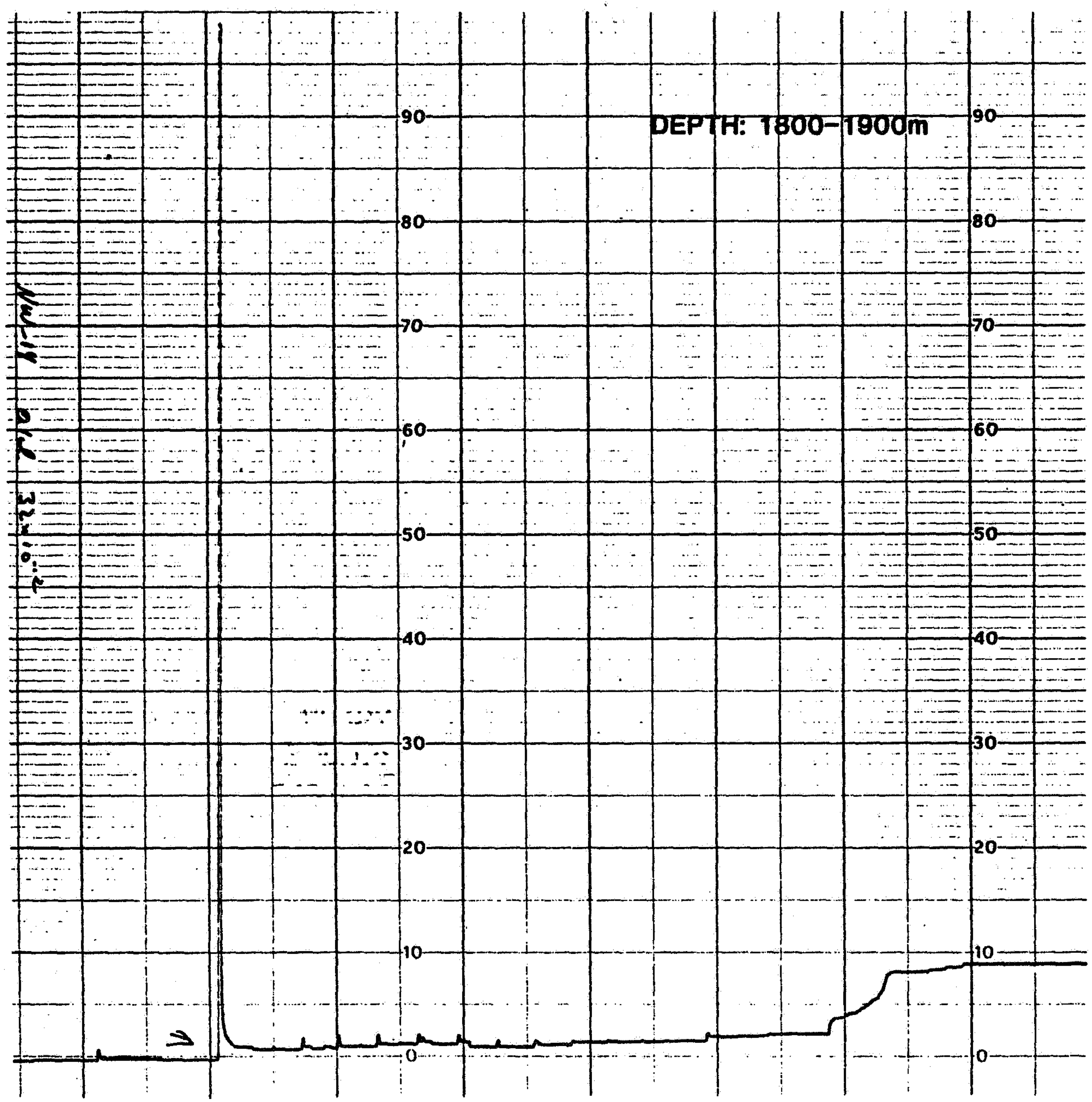
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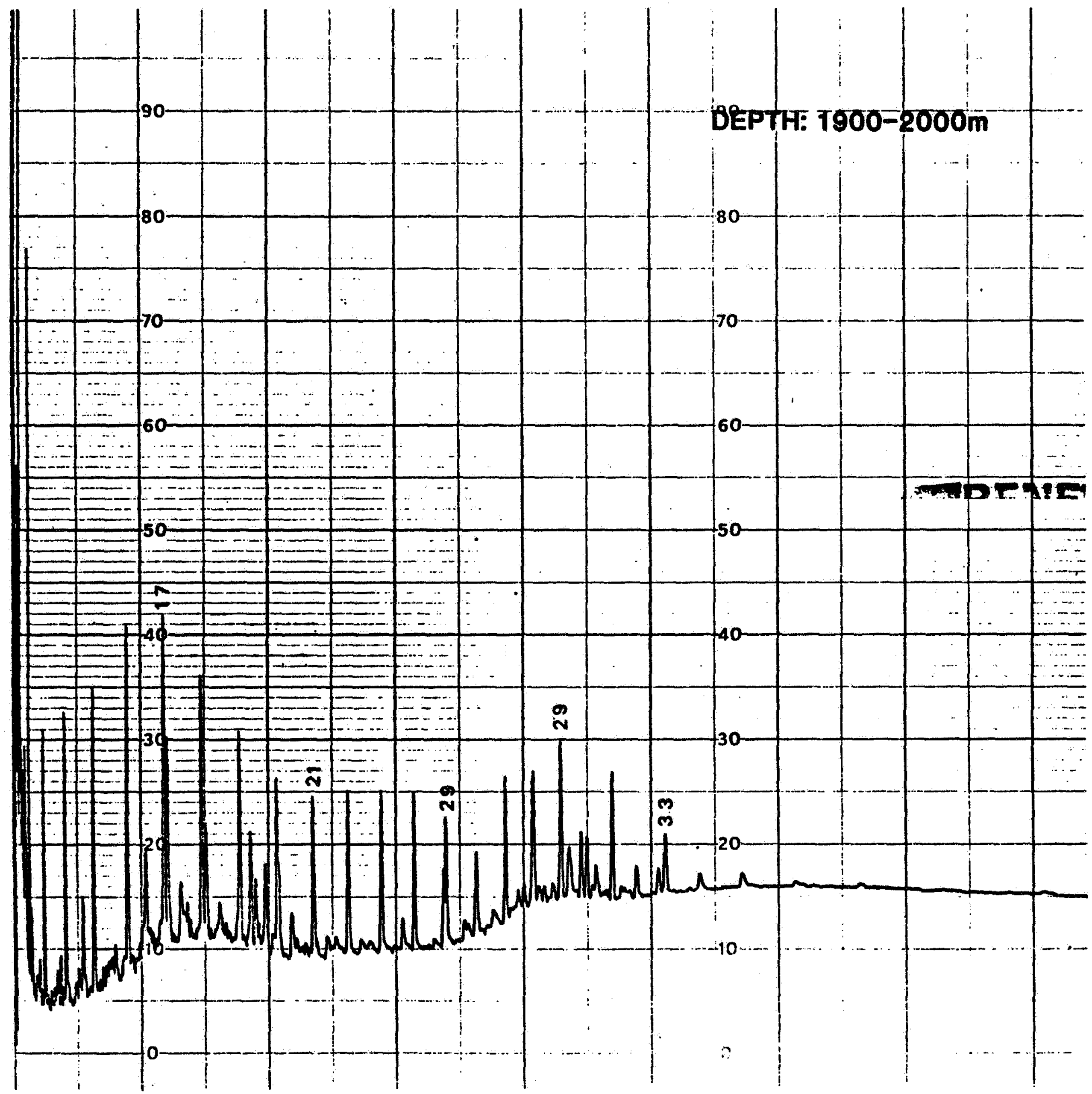

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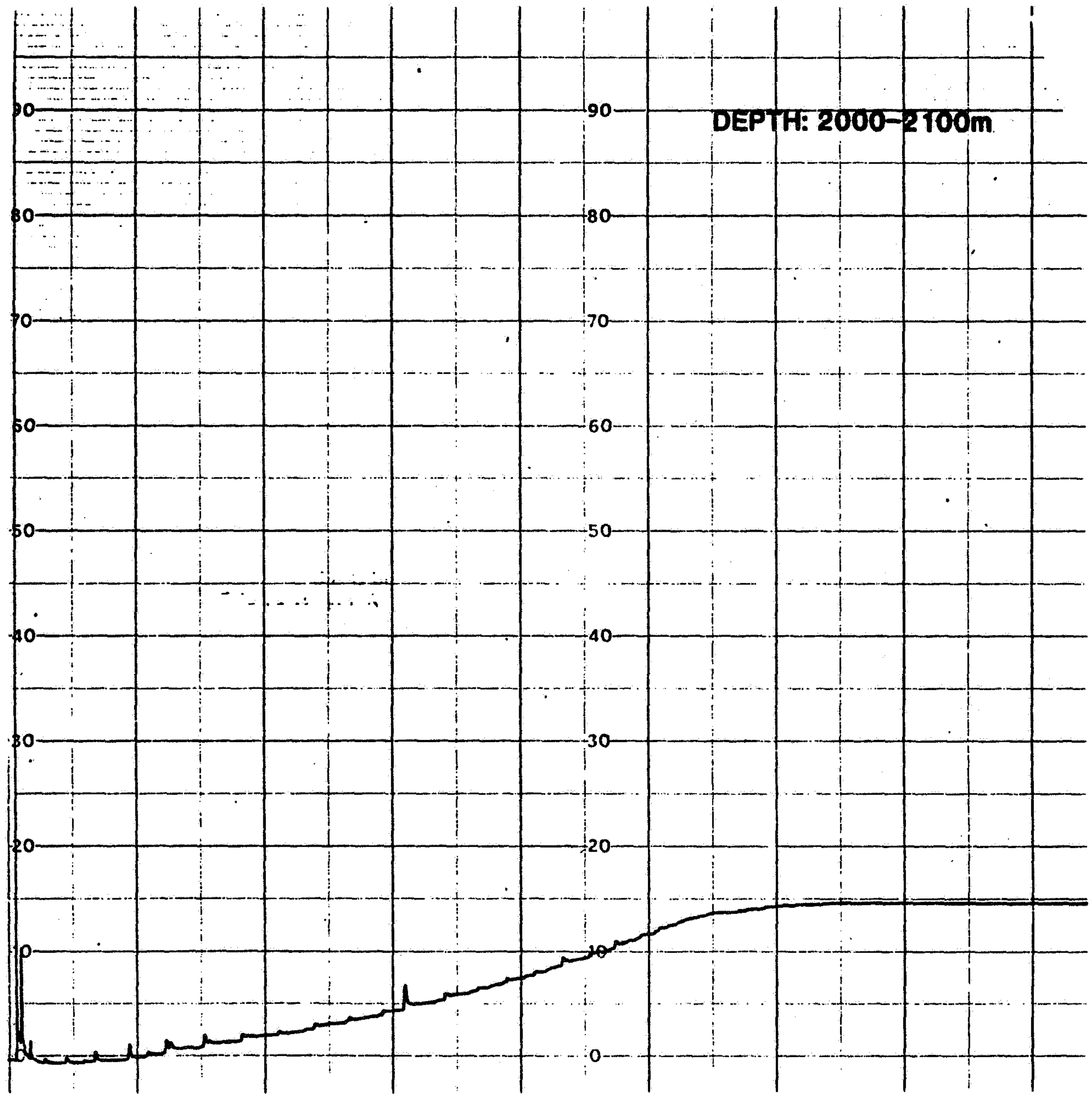
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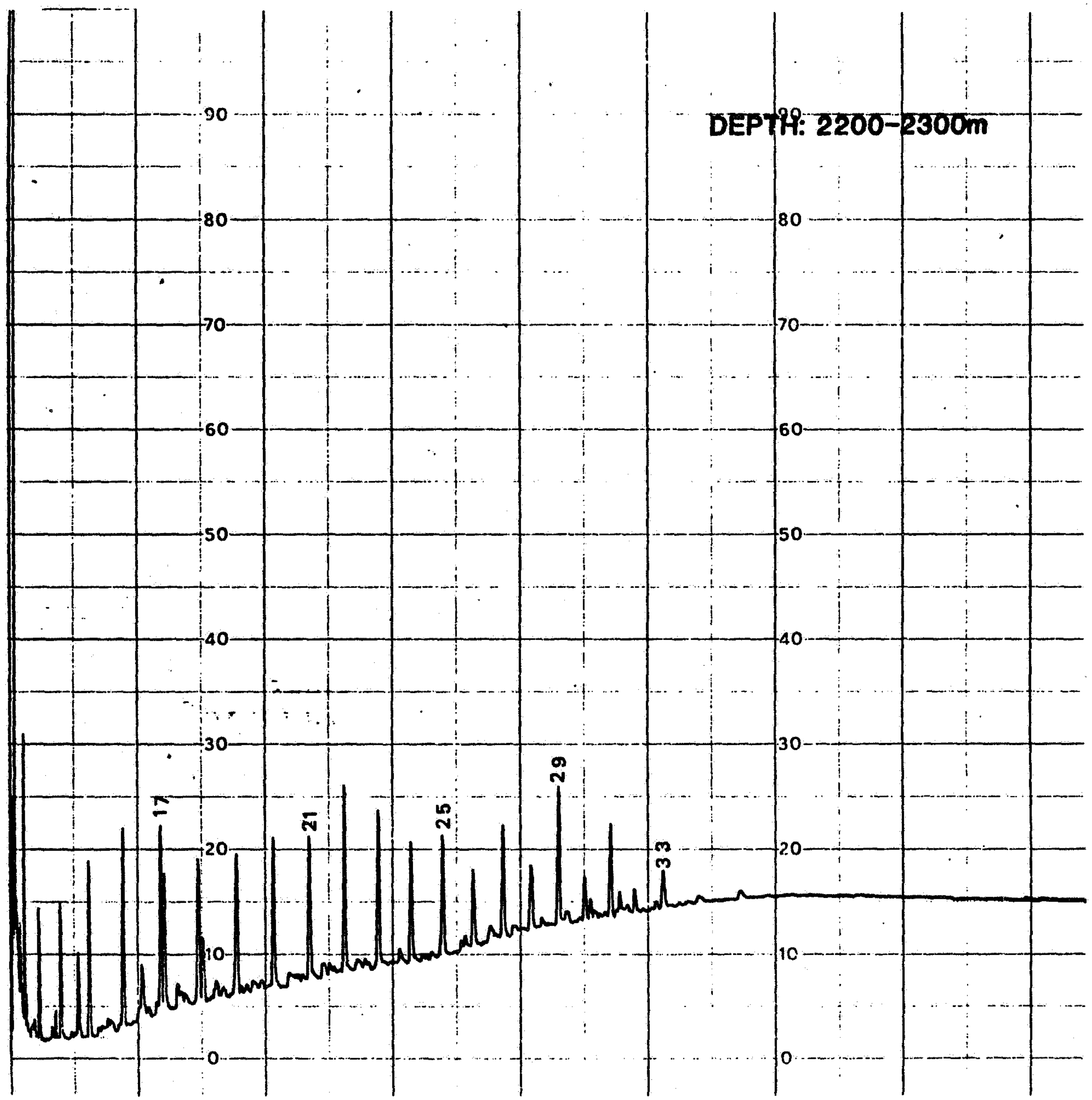

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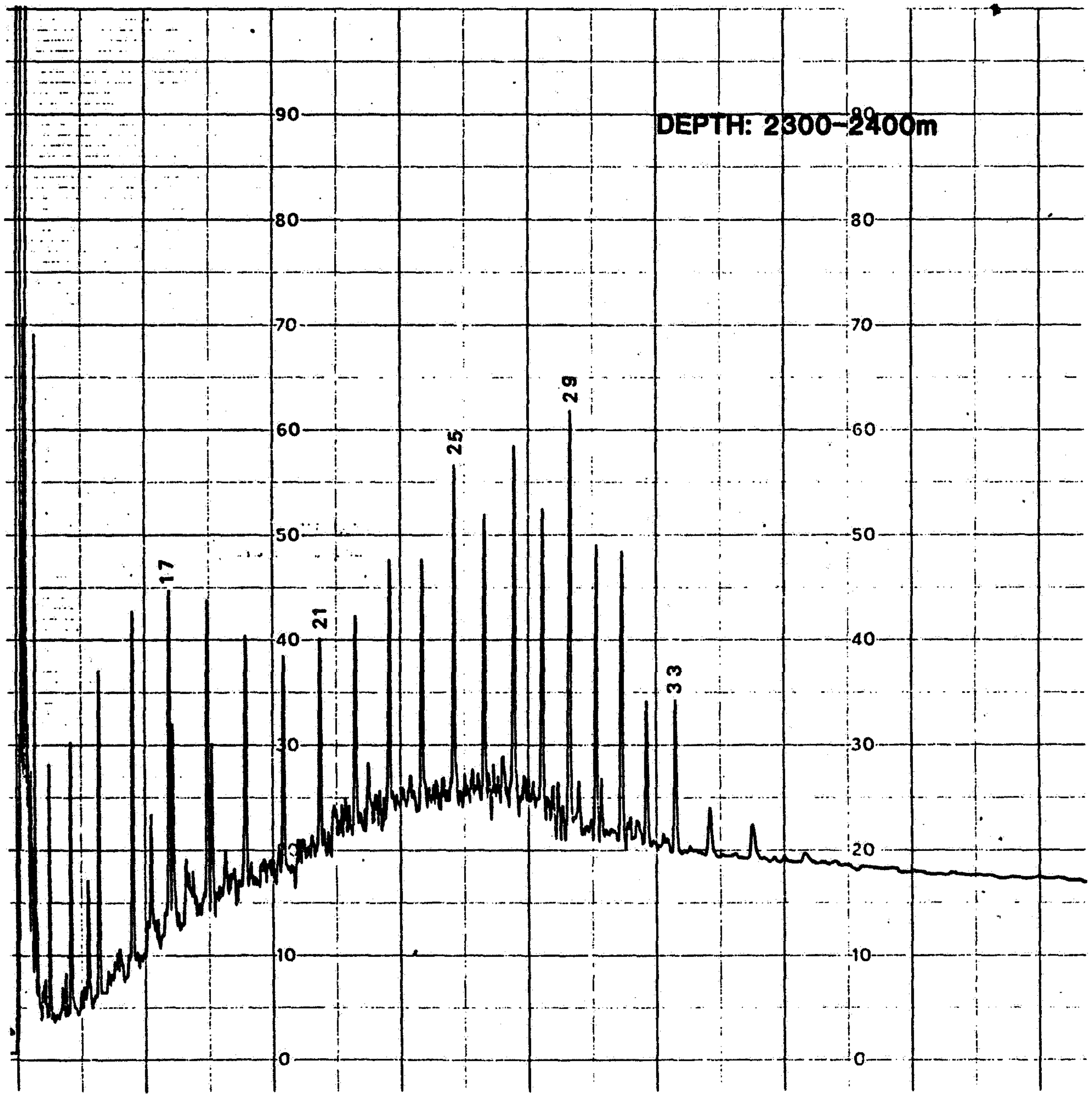
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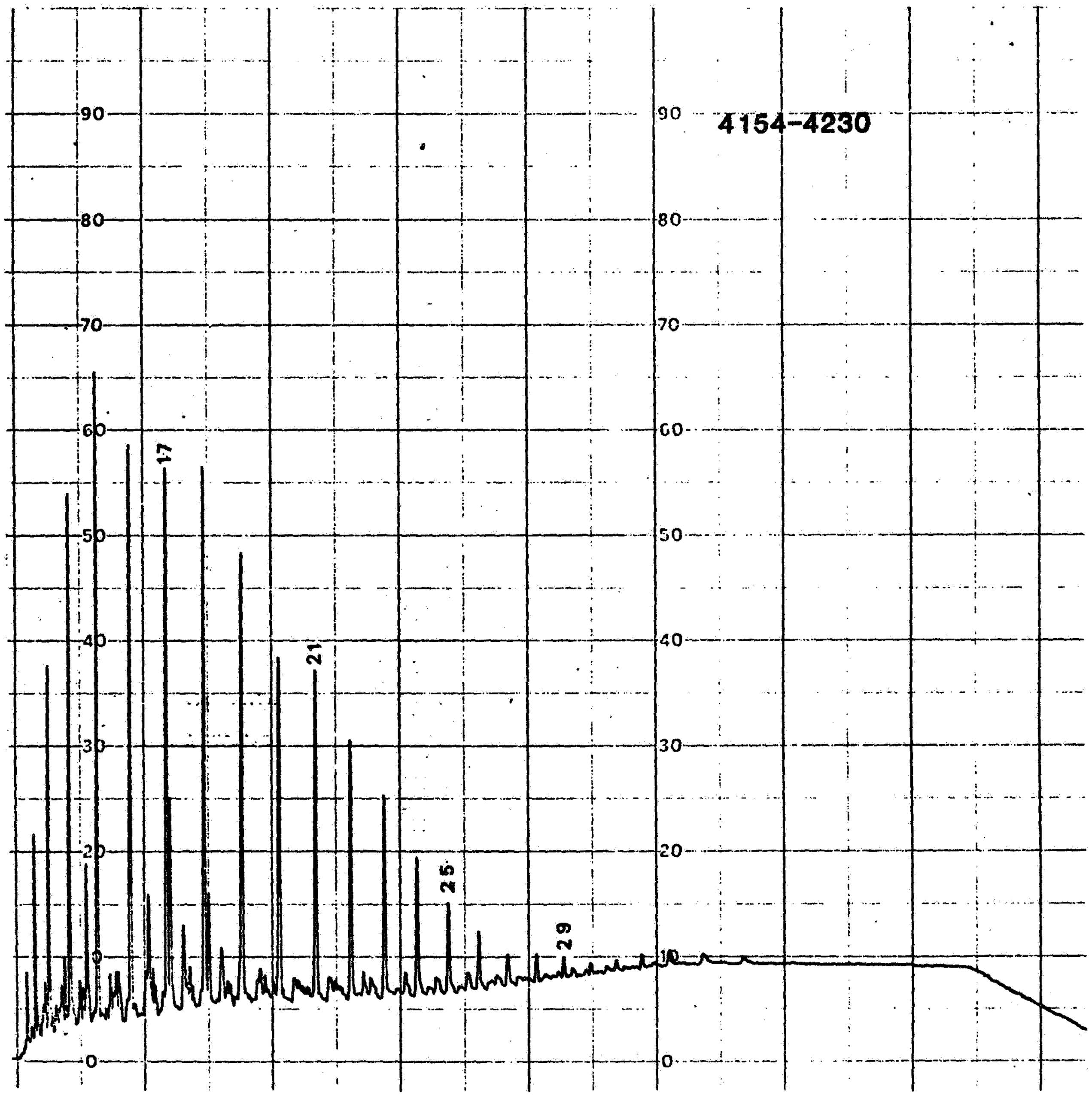
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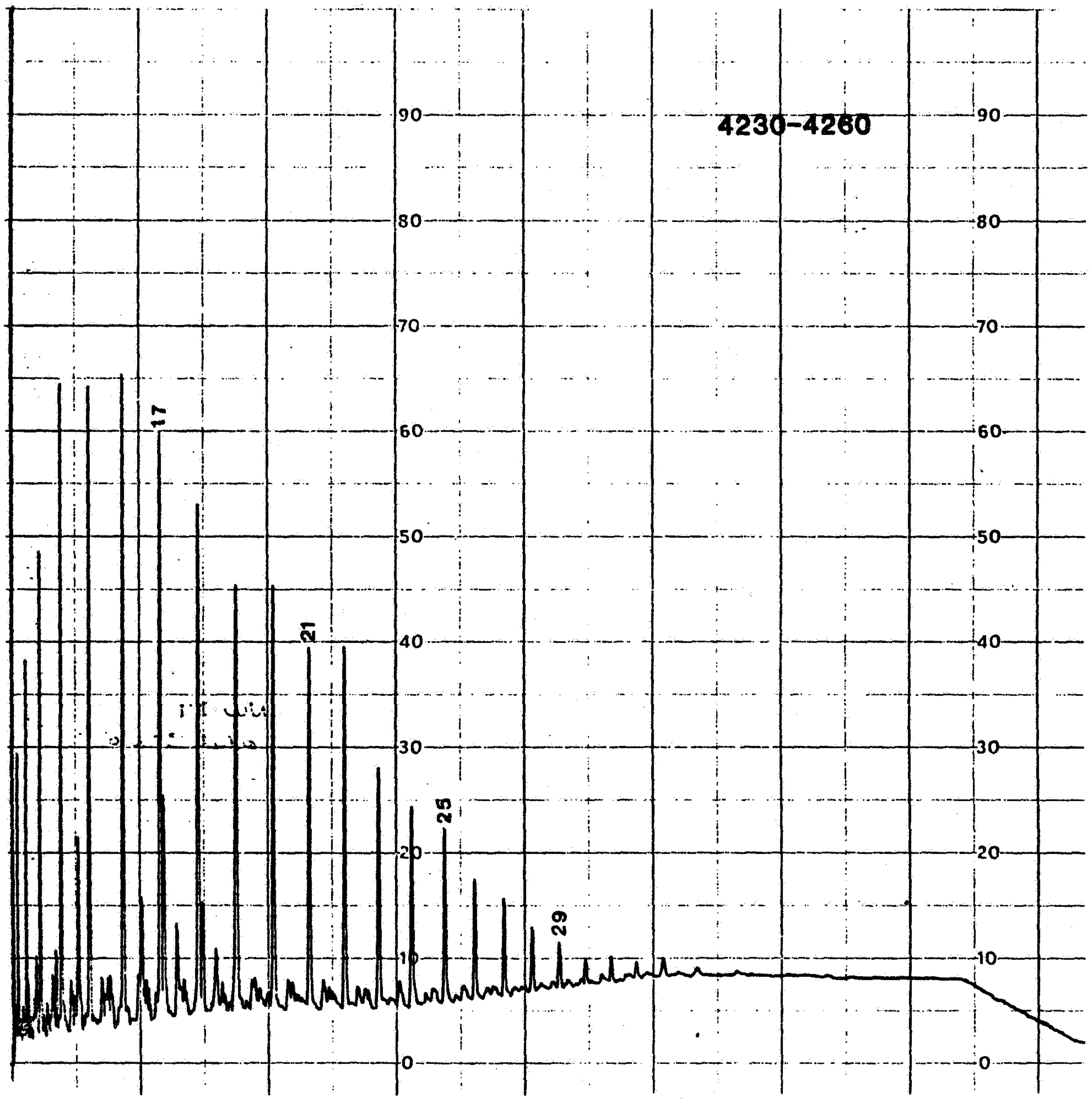

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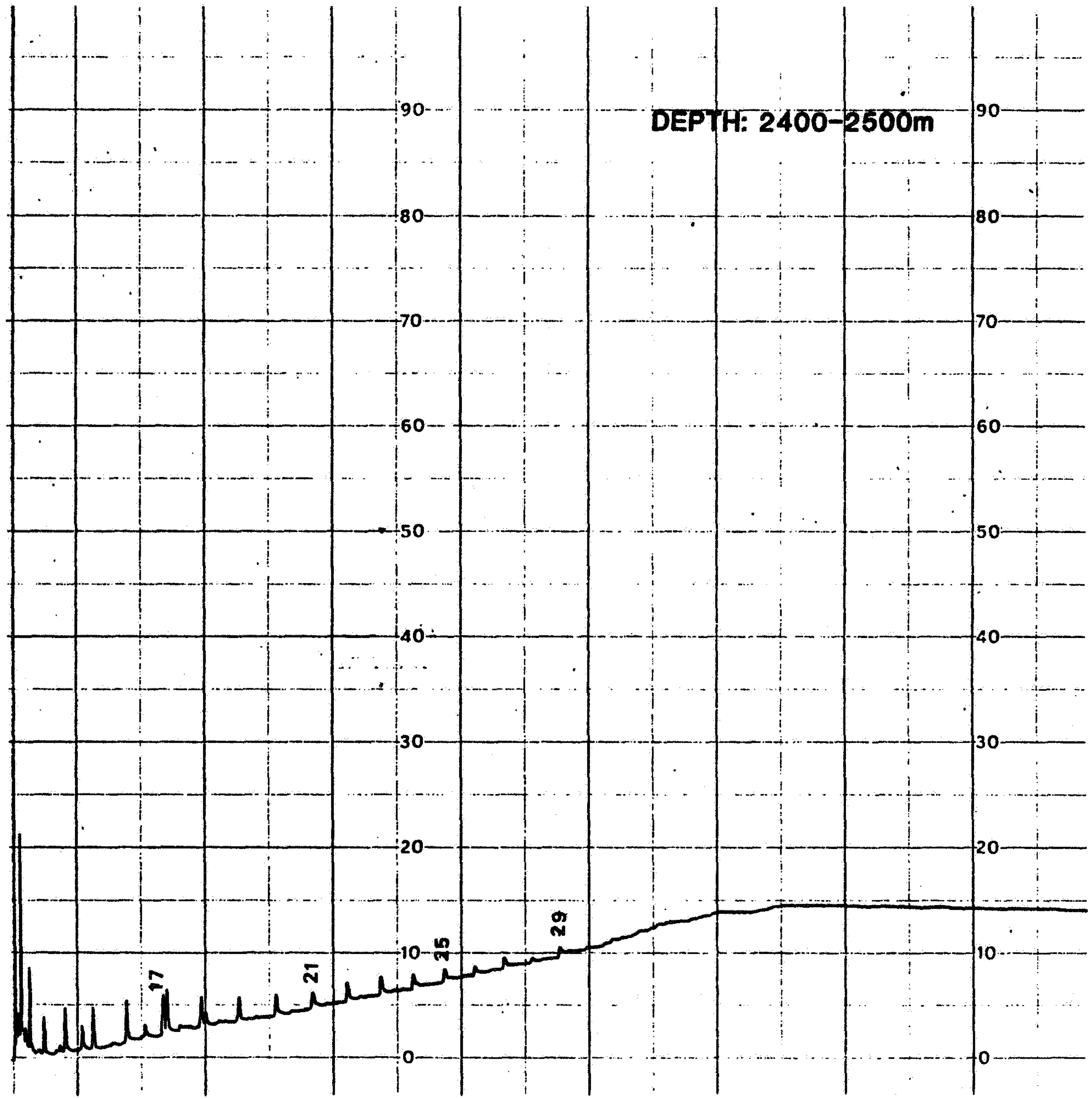
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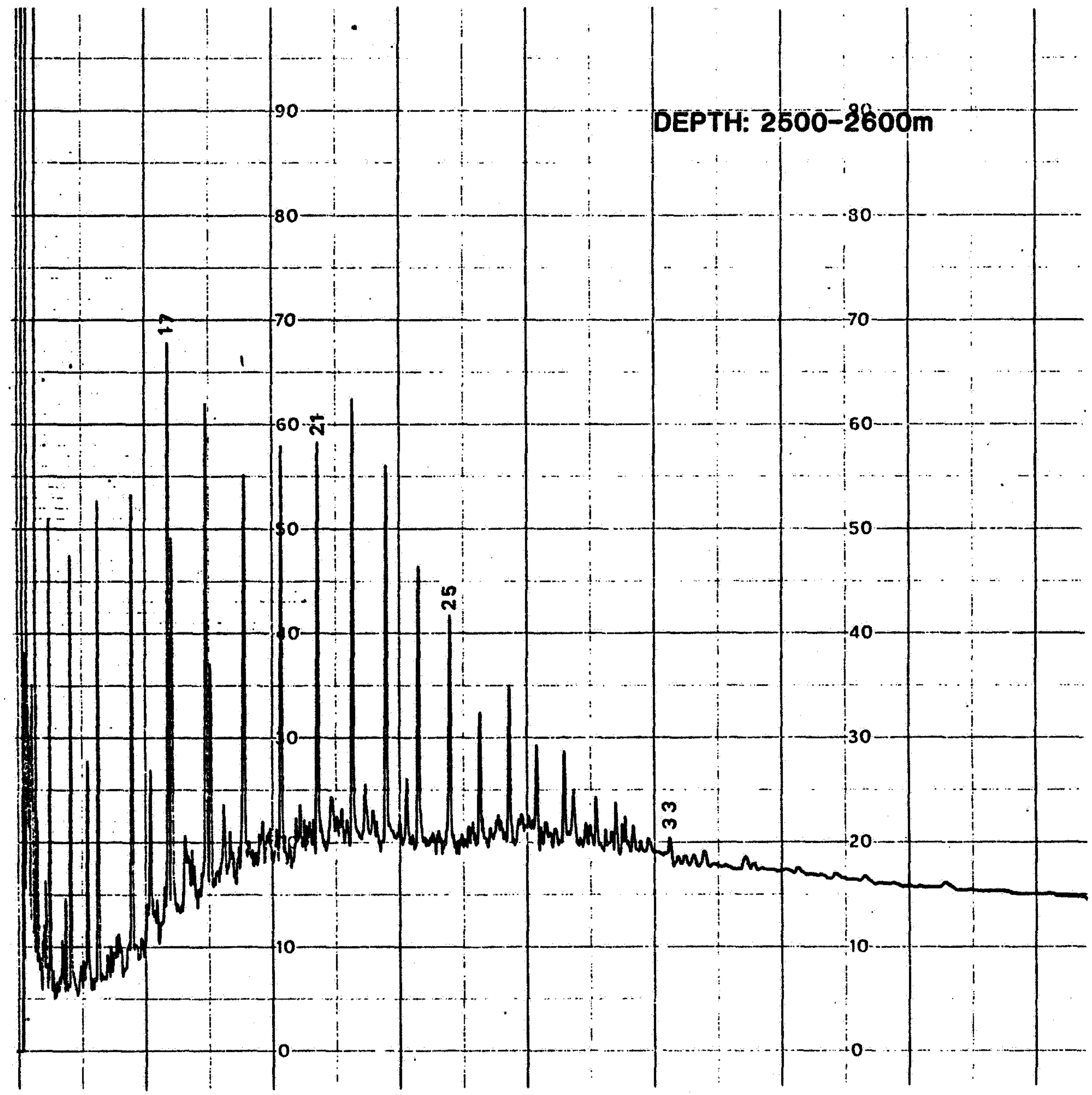

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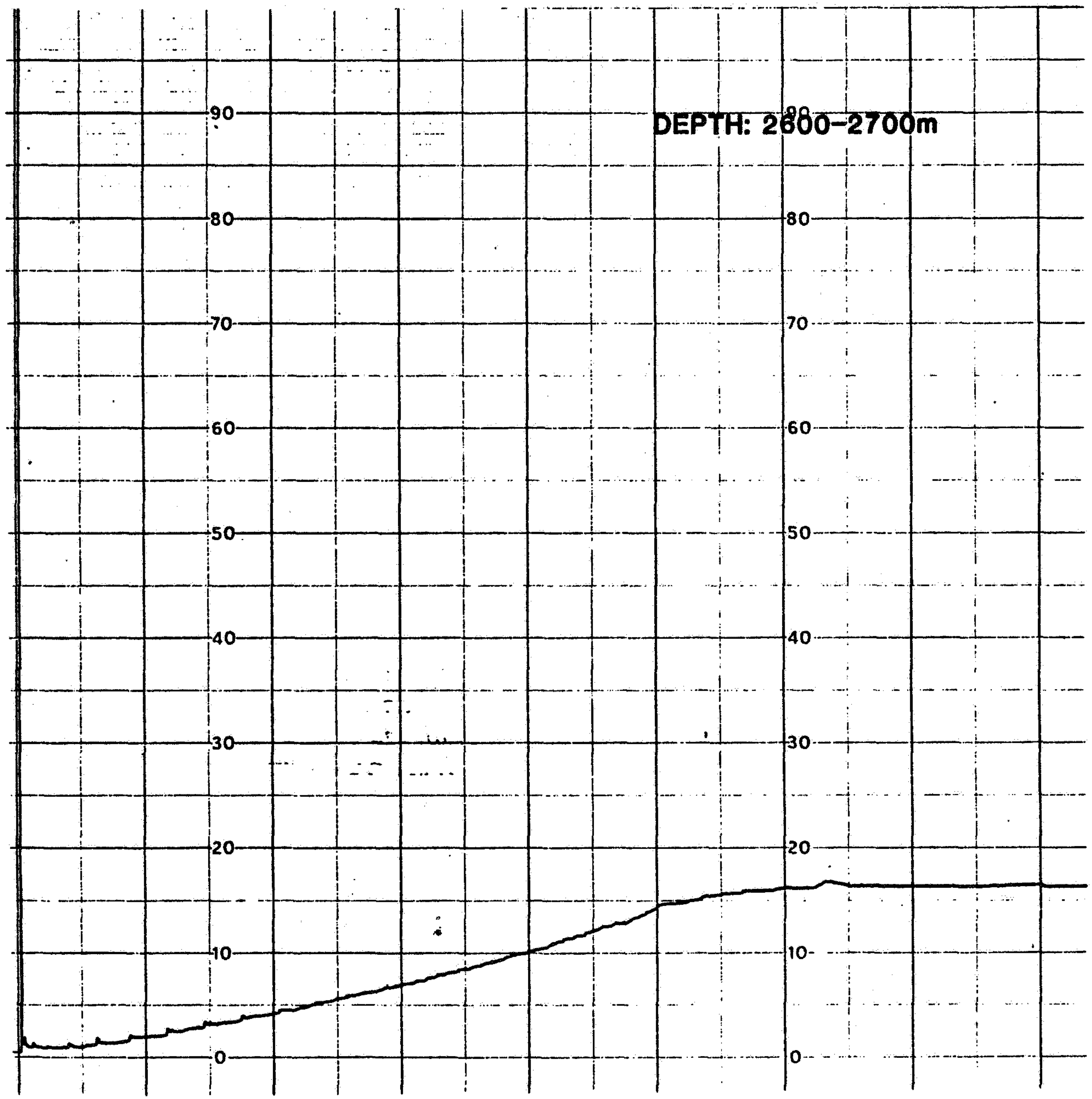
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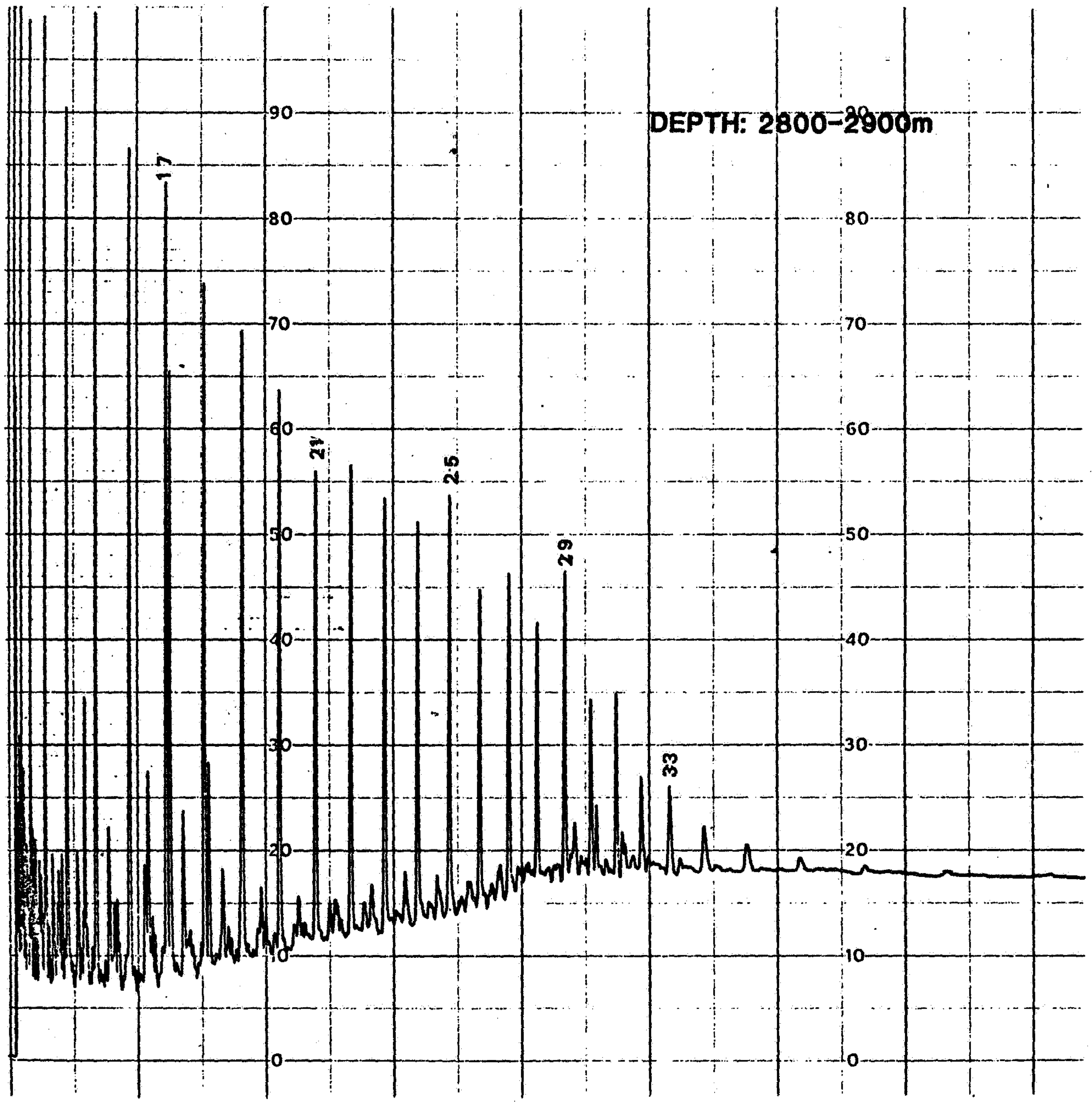
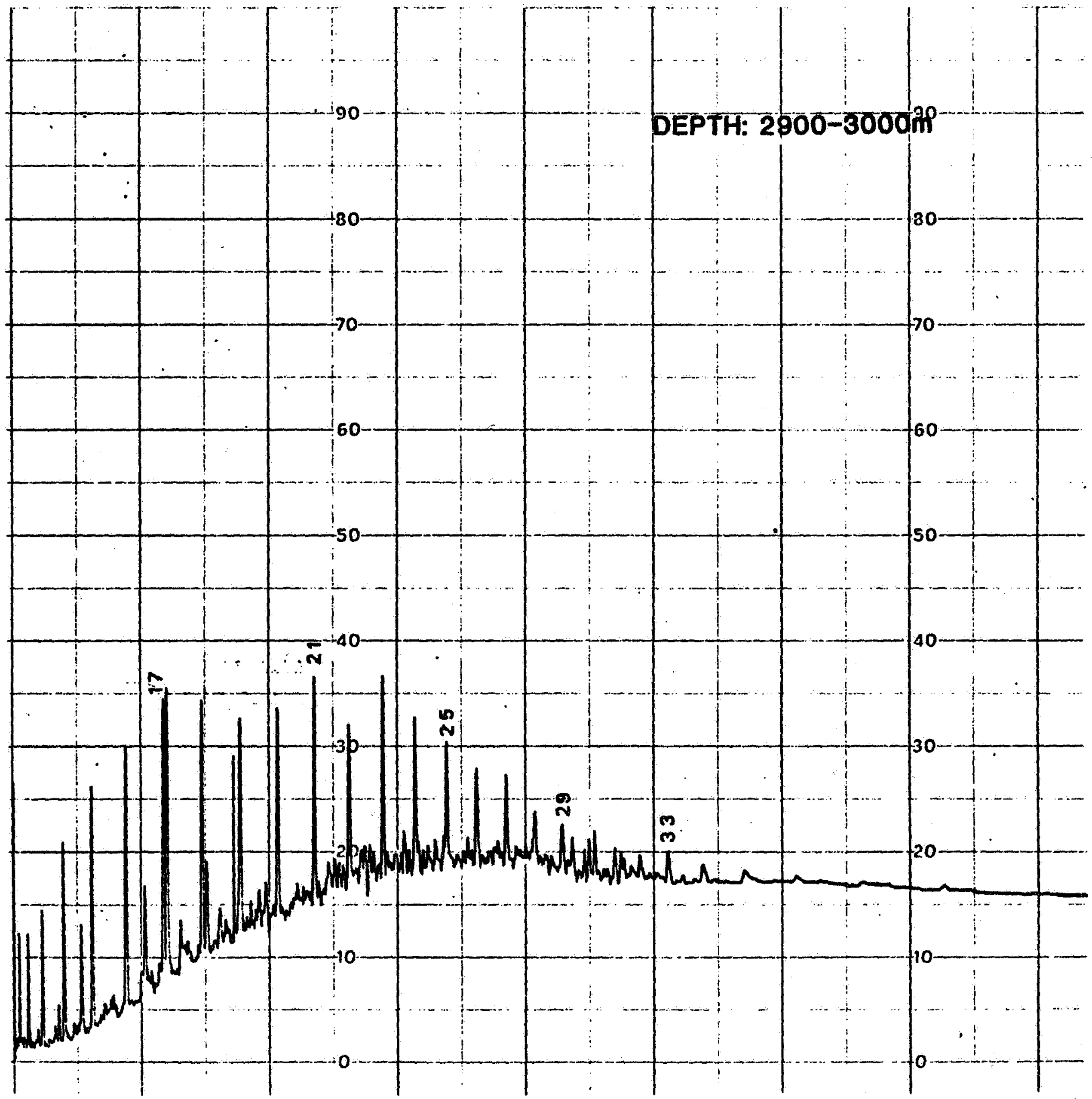
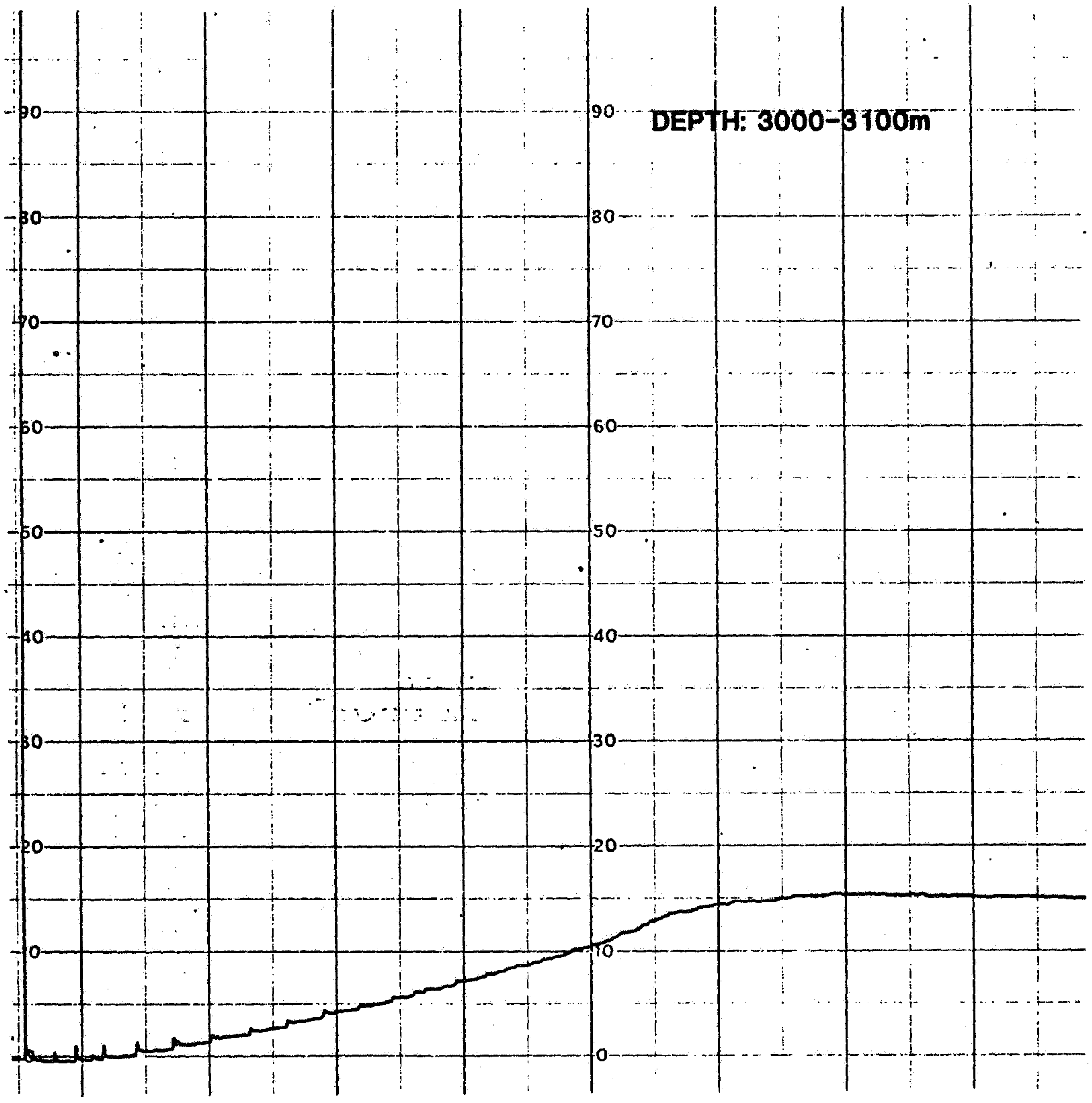
0



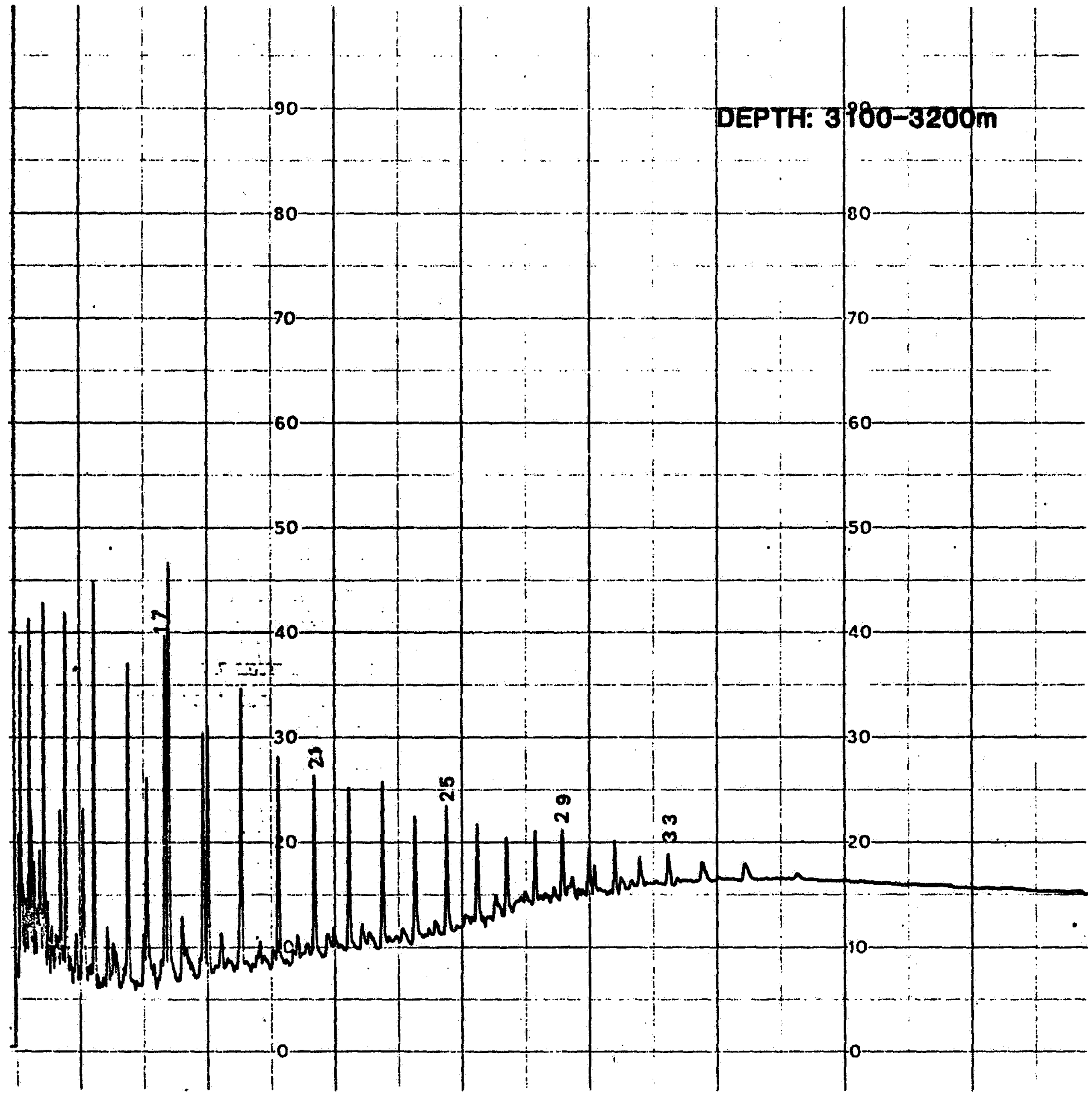
DEPTH: 2800-2900m
17
21
25
29
33
90
80
70
60
50
40
30
20
10
0

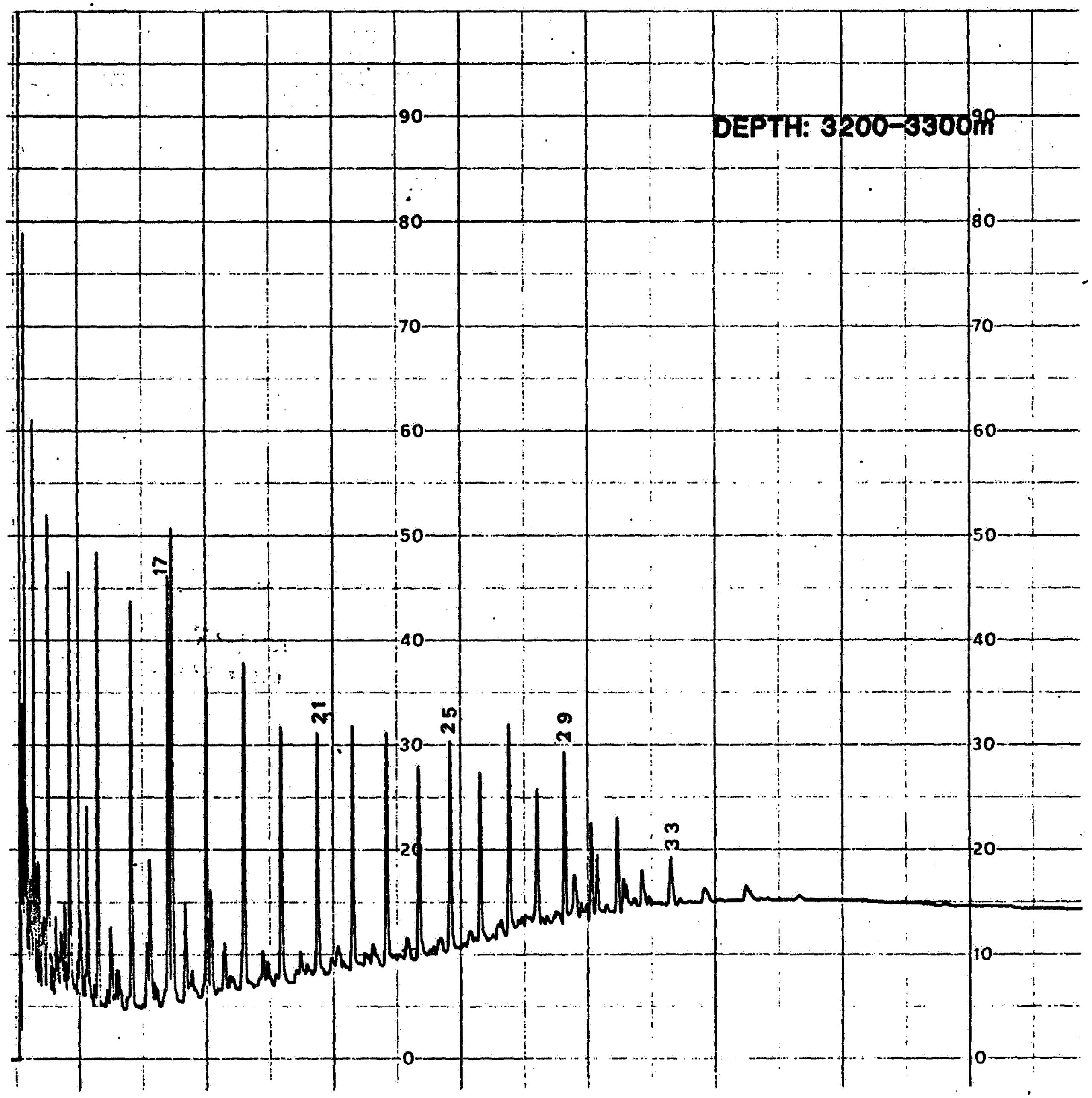


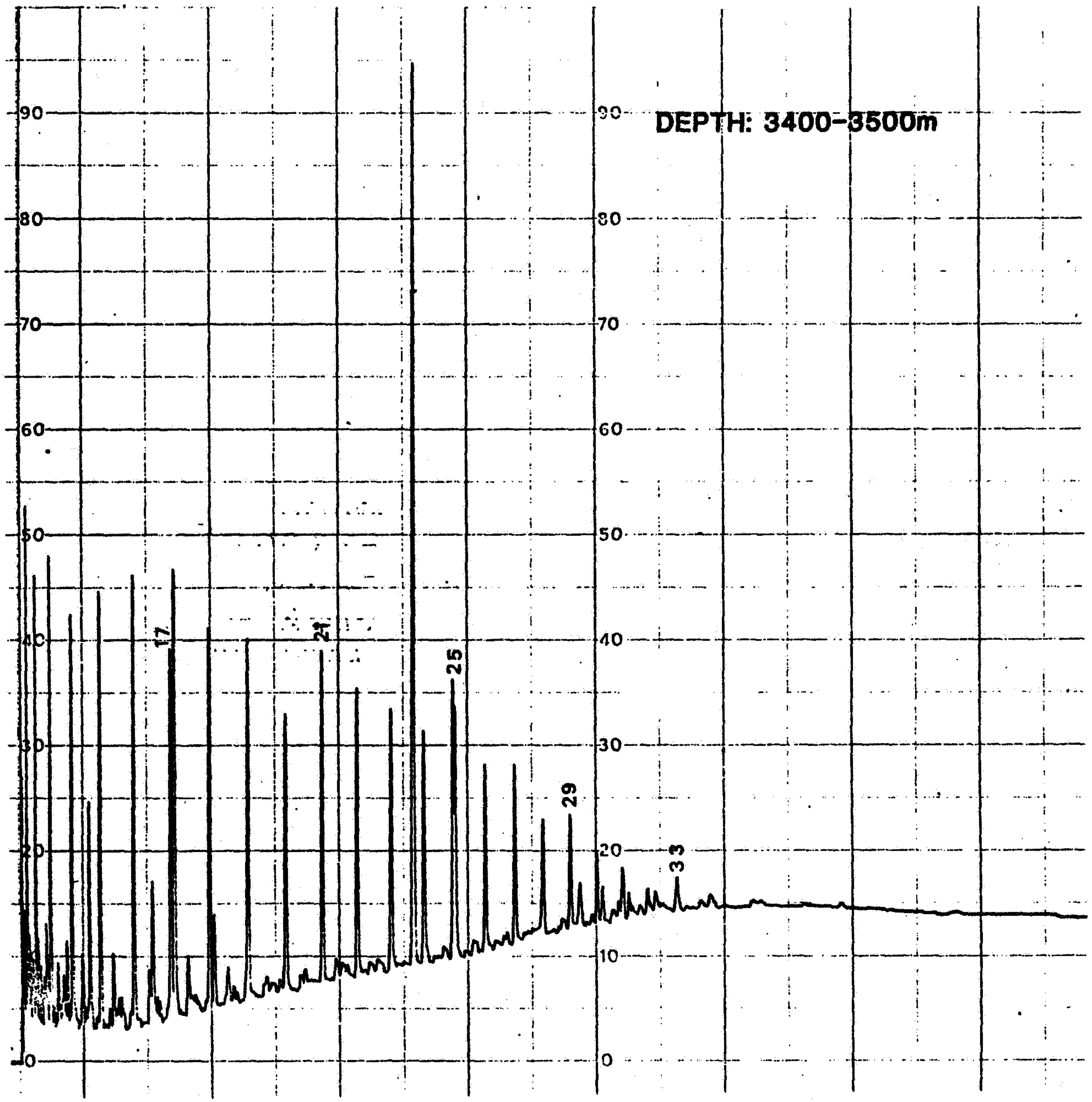
DEPTH: 2900-3000m
90
80
70
60
50
40
30
20
10
0
17
21
25
29
33

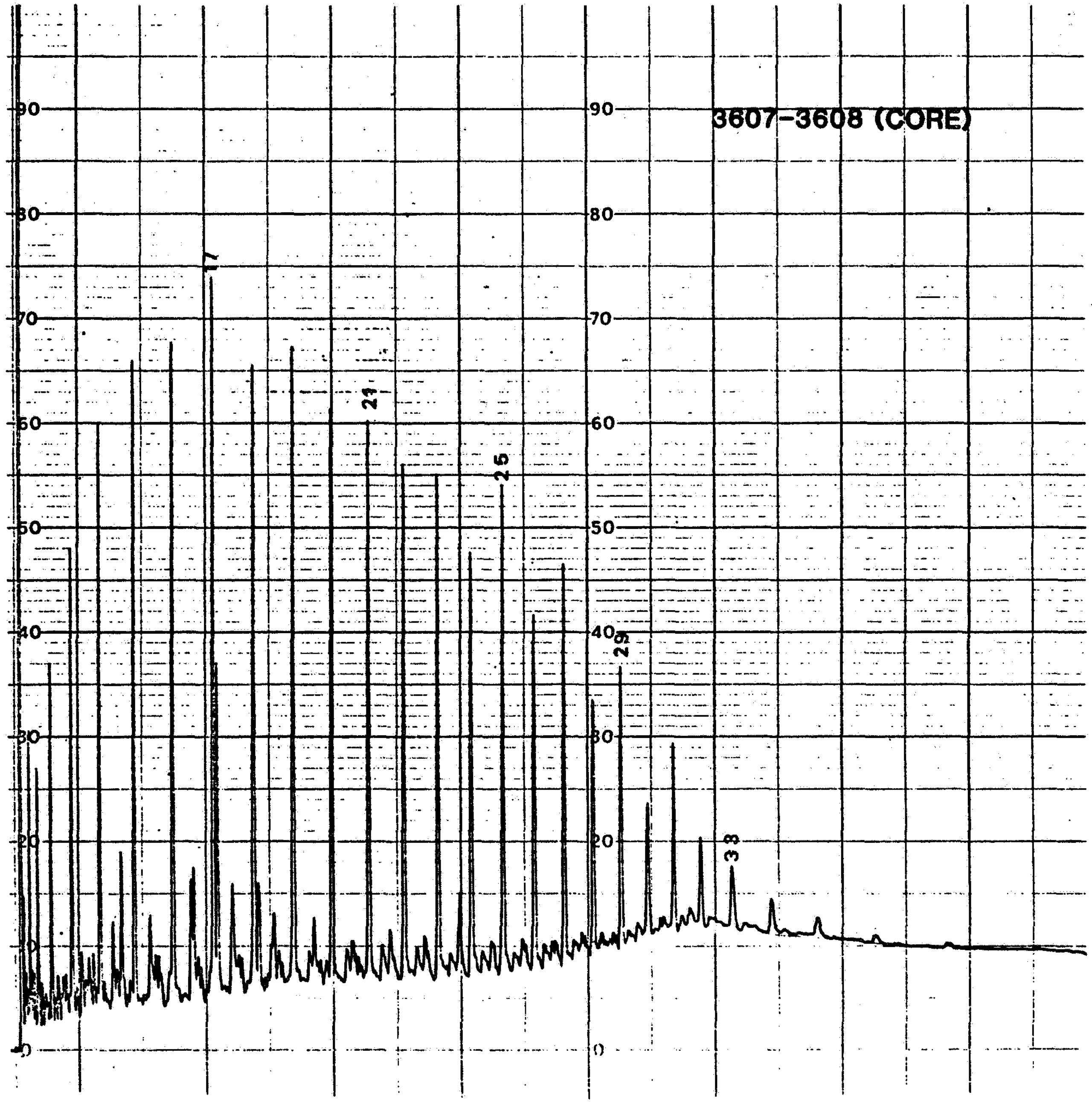


DEPTH: 3000-3100m
90
80
70
60
50
40
30
20
10
0

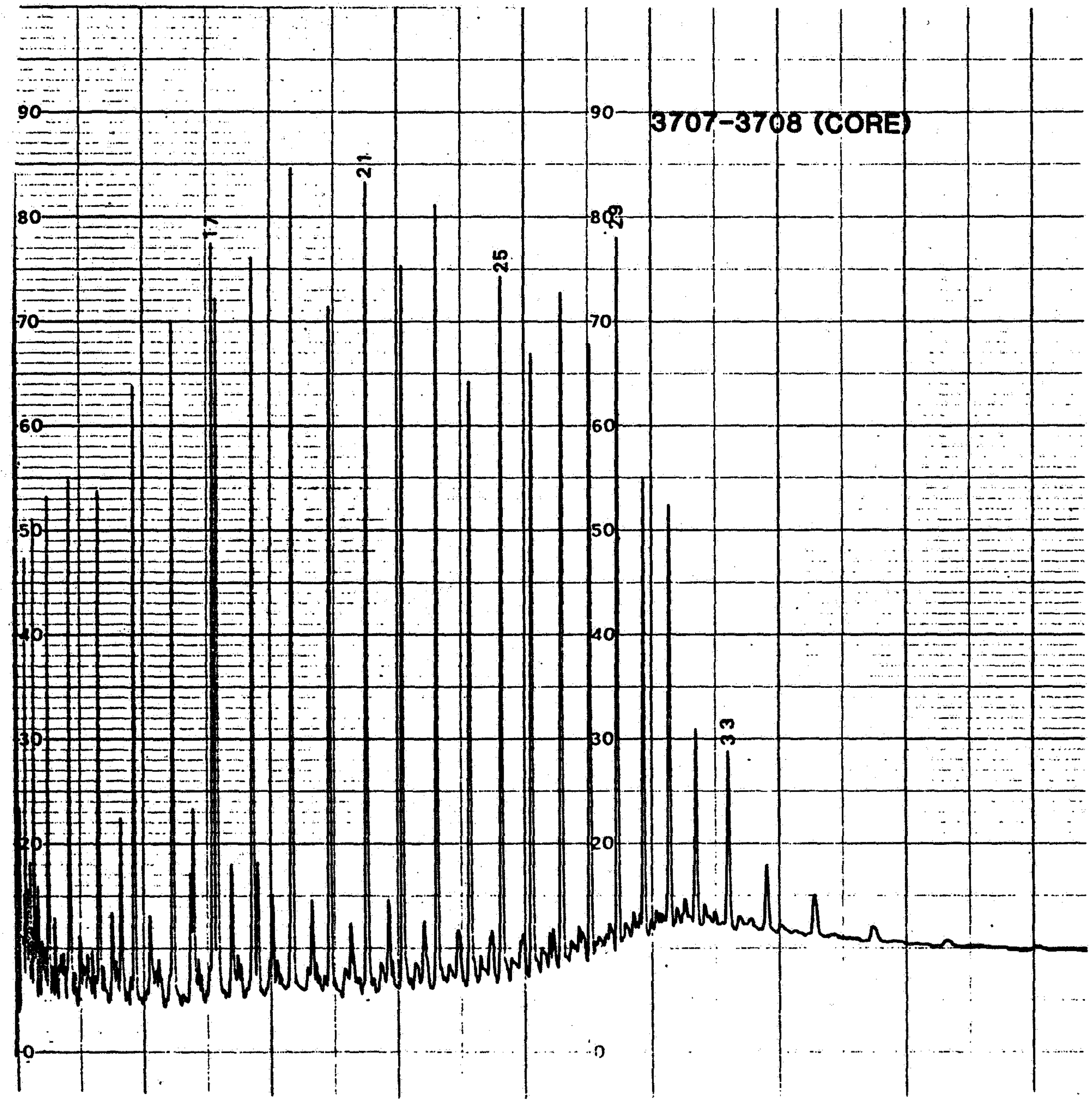

DEPTH: 3100-3200m
90
80
70
60
50
40
30
20
10
0
17
21
25
29
33


DEPTH: 3200-3300m
90
80
70
60
50
40
30
20
10
0
17
21
25
29
33

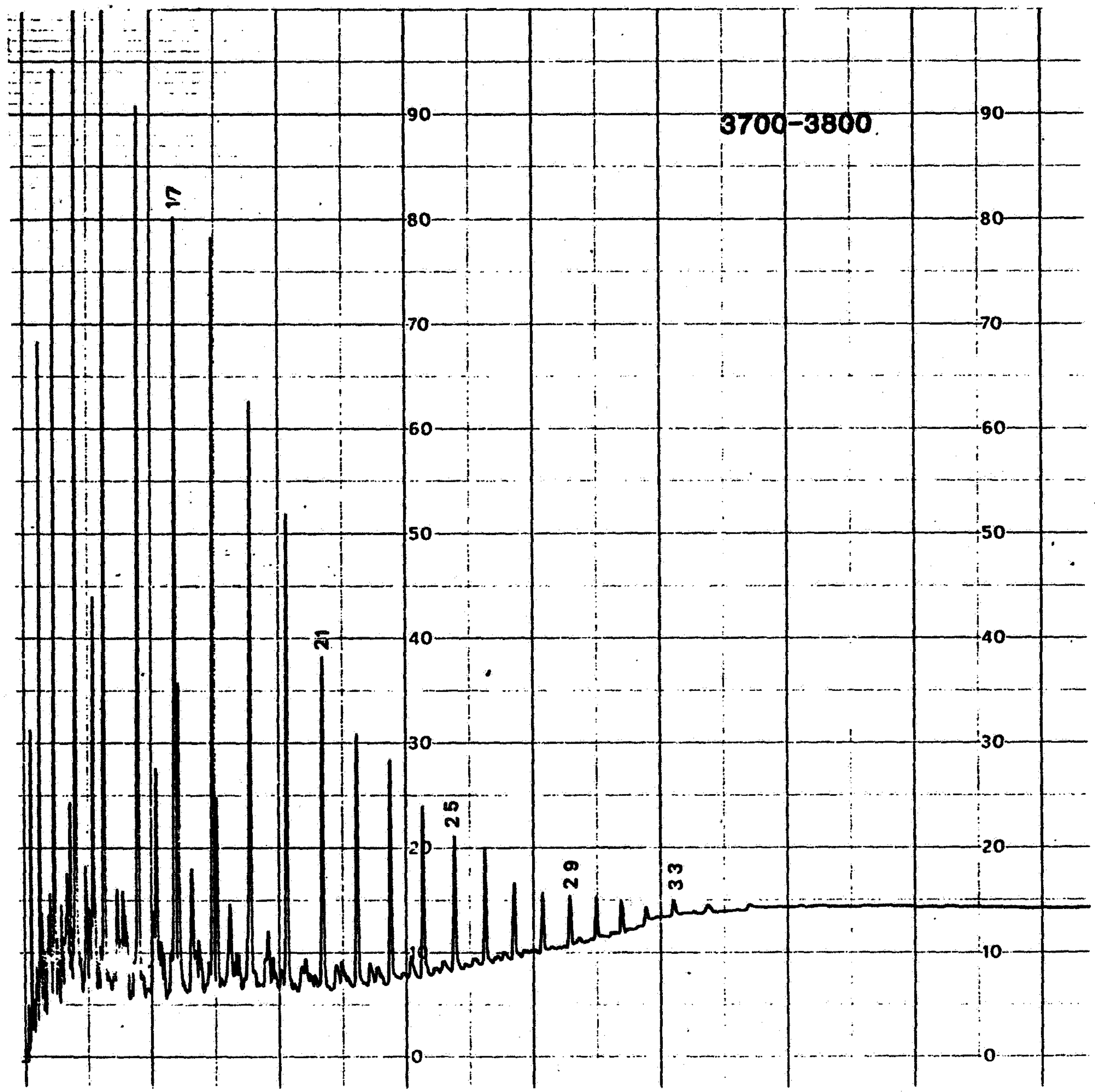

DEPTH: 3400-3500m
17
21
25
29
33
90
80
70
60
50
40
30
20
10
0

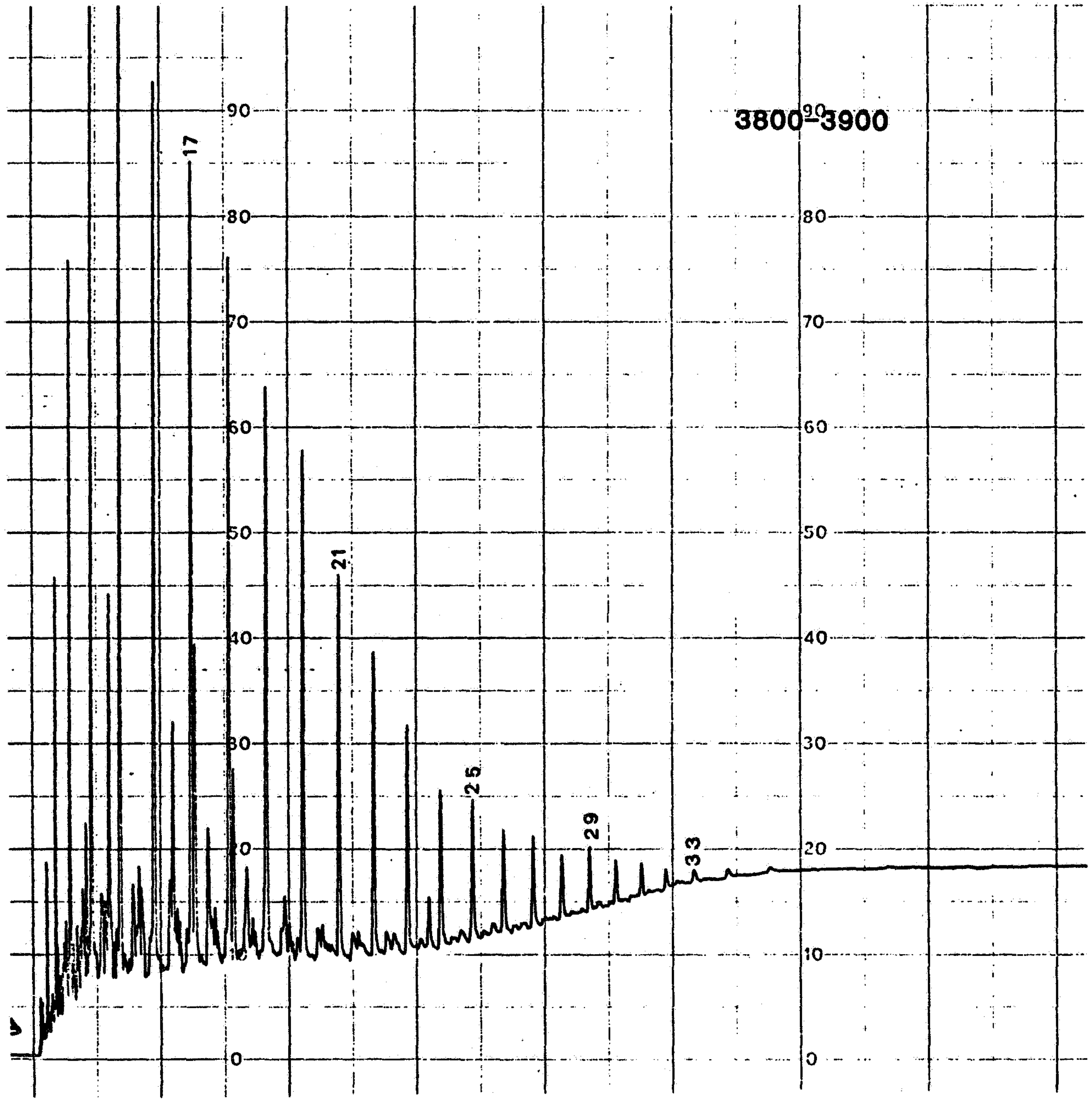


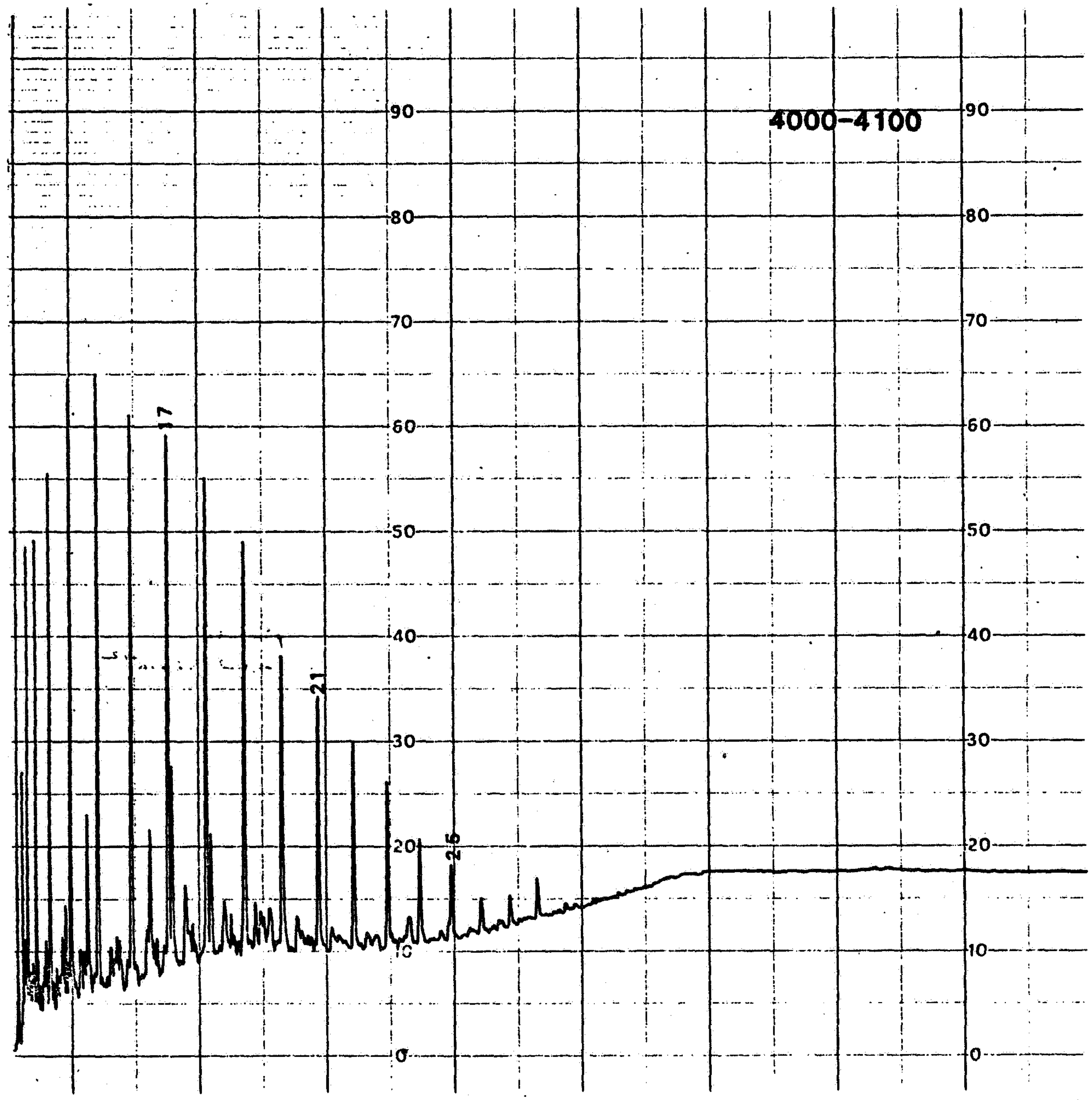
3607-3608 (CORE)
90
80
70
60
50
40
30
20
0
17
21
25
29
33

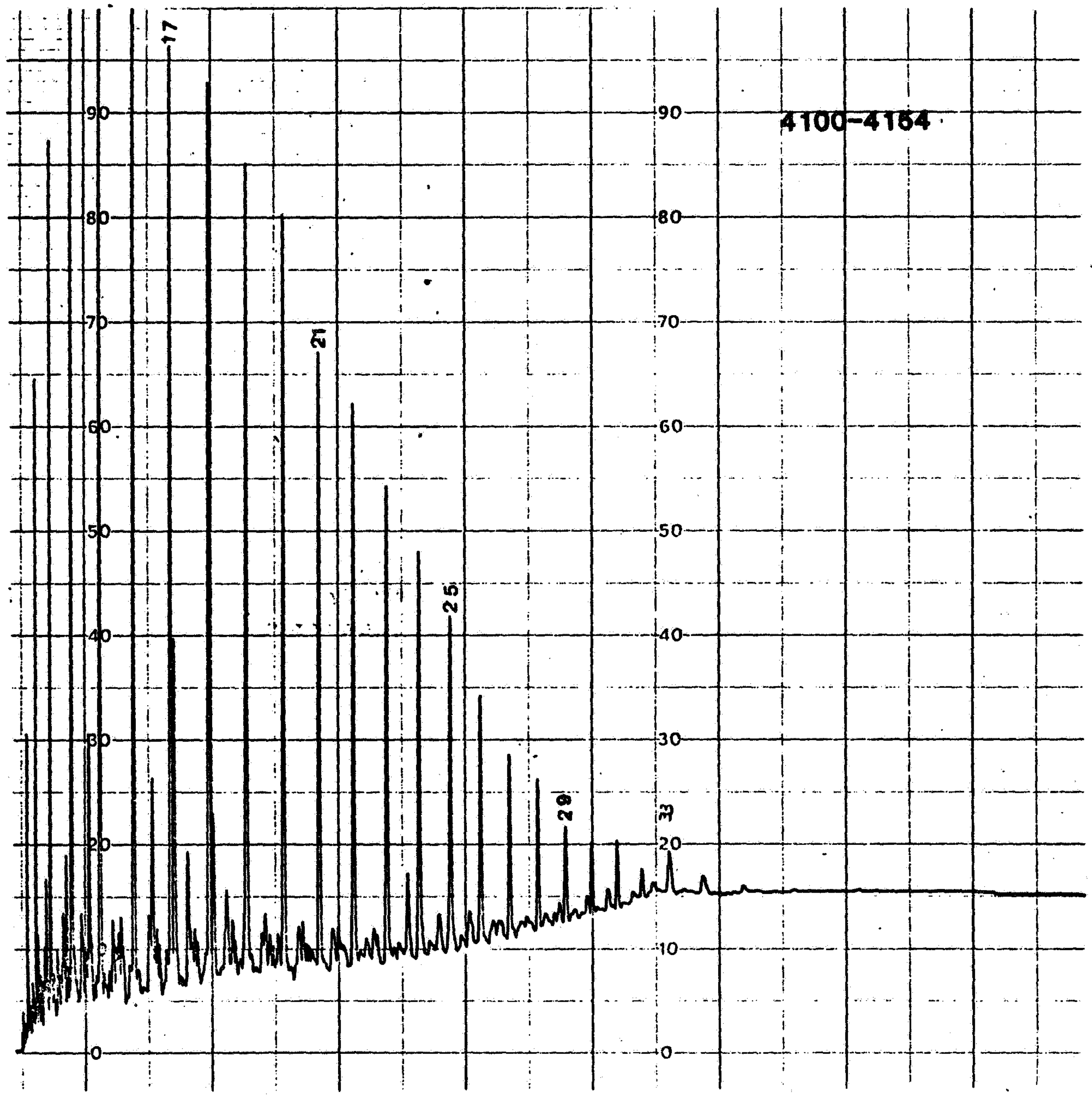


3707-3708 (CORE)
17
21
25
29
33


3700-3800
17
21
25
29
33
90
80
70
60
50
40
30
20
10
0

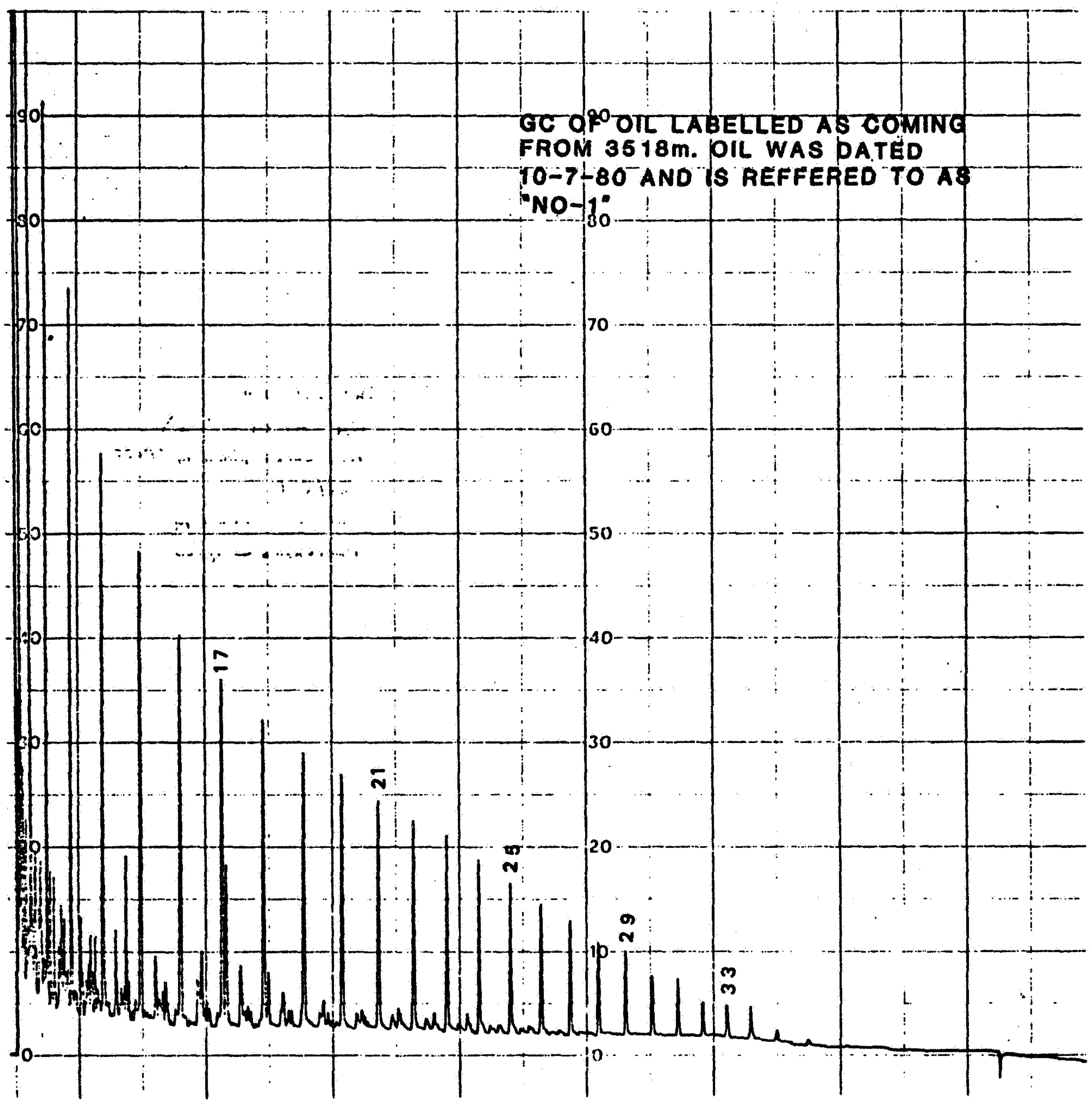

3800-3900
17
21
25
29
33
90
80
70
60
50
40
30
20
10
0


4000-4100
90
80
70
60
50
40
30
20
10
0
17
21
25

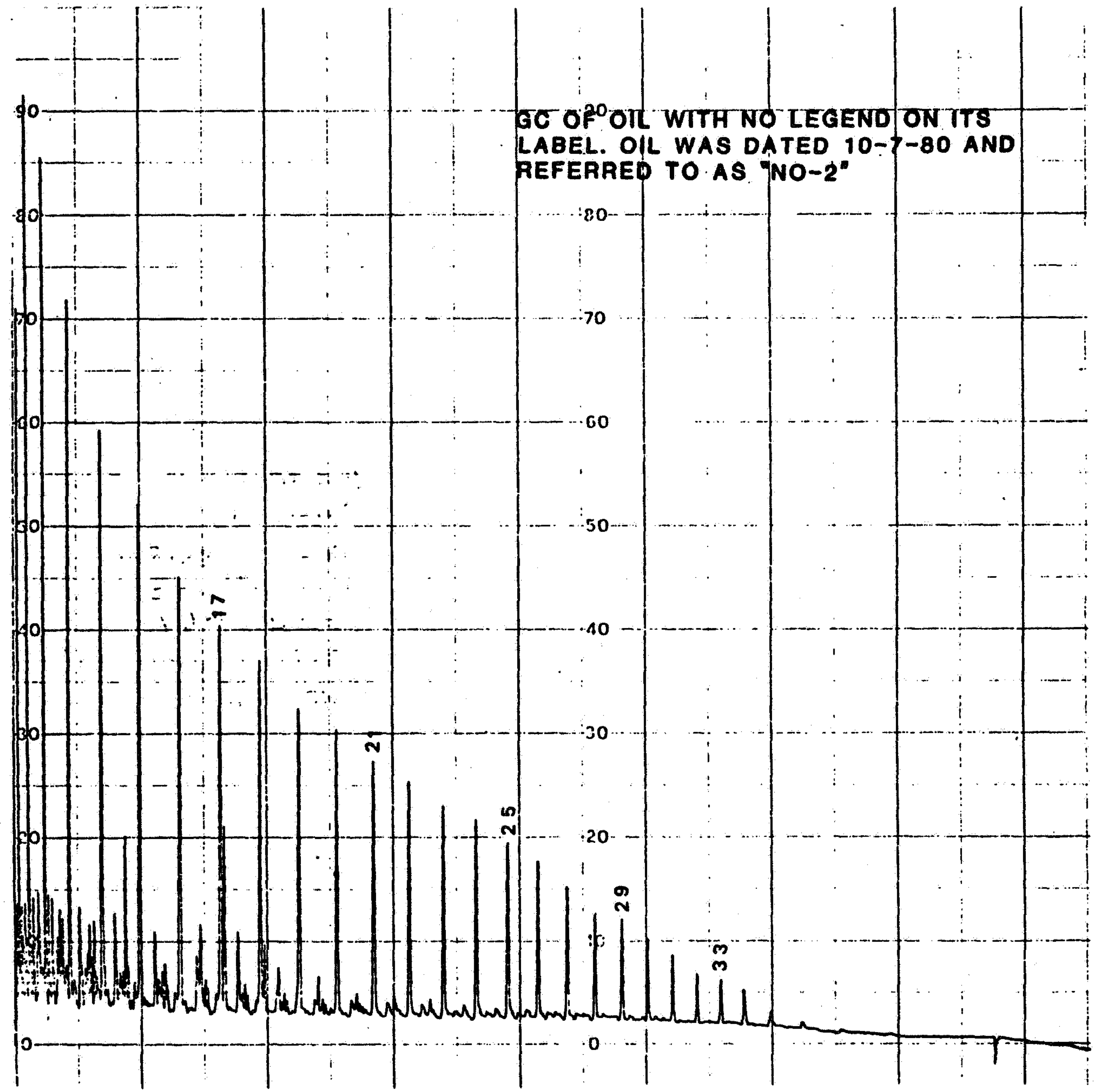

4100-4164
17
21
25
29
33
90
80
70
60
50
40
30
20
10
0

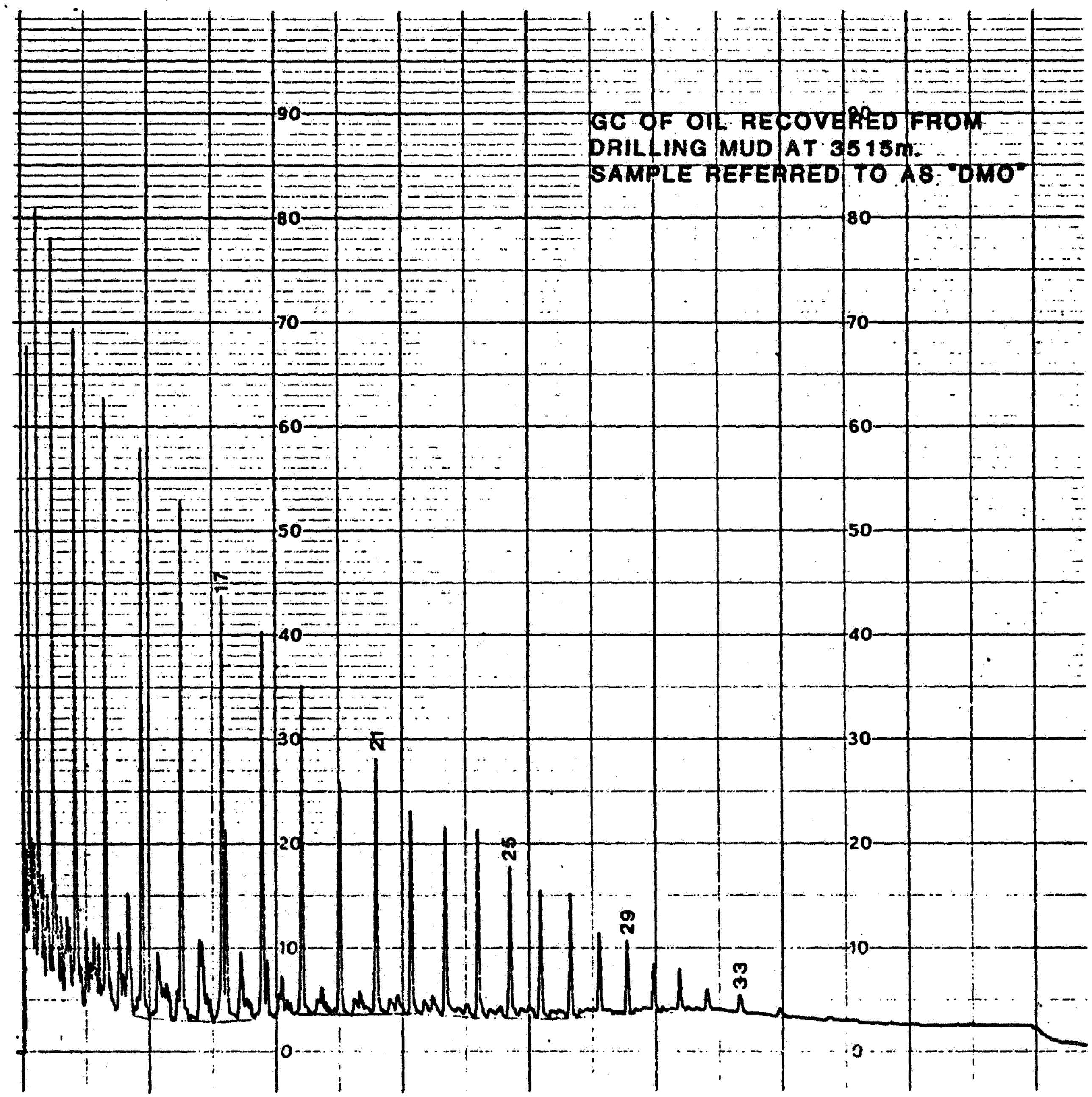
APPENDIX III

GC's of Saturate Hydrocarbon Fraction from Oils and Drilling Mud Recovered in Well 35/8-1



GC OF OIL LABELLED AS COMING FROM 3518m. OIL WAS DATED 10-7-80 AND IS REFFERED TO AS "NO-1"
90
80
70
60
50
40
30
20
10
0
17
21
25
29
33


GC OF OIL WITH NO LEGEND ON ITS LABEL. OIL WAS DATED 10-7-80 AND REFERRED TO AS "NO-2"
90
80
70
60
50
40
30
20
0
17
21
25
29
33


GC OF OIL RECOVERED FROM
DRILLING MUD AT 3515m.
SAMPLE REFERRED TO AS "DMO"
90
80
70
60
50
40
30
20
10
0
17
21
25
29
33