HYDROCARBON SOURCE ANALYSES OF
CUTTINGS FROM 16/1-2, OFFSHORE NORWAY

by

R.E. Metter

← Strat

SUMMARY AND CONCLUSIONS

Canned cuttings from the interval 340-2918 meters (T.D.) were analyzed routinely at EPR for hydrocarbon source characteristics. Five of the samples were sent to GeoChem Laboratores in Houston for heavy hydrocarbon (C_{15+}) extractions.

Charges for this work were billed to our Job No. 8569. Preliminary results were transmitted to Stavanger by phone on September 27, 1976.

The analytical results are listed in Tables 1 thru 4 and they are summarized graphically in Fig.1.

The combined data are interpreted as follows:

Approx. Interval (meters)	Maturity	Quality (Richness)	Indigenous Hydrocarbons Expected if Reservoired
360-1500	Immature	Shales Good	Lean
1500-1850	Immature	Poor to Marginal	Lean
1850-2300	Immature	Fair	Minor Gas Shows
2300-2500	Immature to transitional(?)	Good to Rich	Shows of Oil, Gas
2500-2918	Immature (?)	Poor	Lean

The entire section down to the granitic basement penetrated at the bottom of the well is immature, or barely "transitional" at most, in its stage of organic diagenesis. The shales from the interval 2300-2500 meters contain predominantly algal kerogen, are inherently good to rich oil-prone source rocks, and where more mature we would expect considerable generation of oil with gas from them. Shales from shallower depths, namely about 1890 meters and the interval 2000-2100 meters, also contain potentially oil-prone organic matter, but these shales are less rich.

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 gas analyses are listed in Table I.

Chips of uniform lithologies were picked by hand from the heterogeneous mixtures of chips in 19 of the original samples. These are described in Table 2. 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 3, and they are plotted graphically in Fig. 1. Visual kerogen characteristics were also determined on the "picked" samples (Fig. 1 and Table 2).

Five samples of shales were analyzed by GeoChem Laboratories for heavy (C_{15}+) soluble organic matter, including concentrations of saturate and aromatic hydrocarbons (Table 4). The saturate fractions of these extracts were analyzed by gas chromatography at EPR (Figs. 2-6).

DISCUSSION

Although the shales from the interval 2300-2500 meters gave a fair yield of gas containing more than 90% C_2-C_4, and their gasoline yeilds were up to 73 ppm, we rate the interval as "immature" or perhaps barely in a "transitional" state of maturation. These shales contain a high percentage of algal debris, and when mature we would expect them to yield several hundred parts per million gasolines, two or three times as much gas, and considerably more heavy hydrocarbons than we observed. The kerogen alterations of only "1" and "1+" indicate an immature to barely "transitional" stage consistent with the interpretations cited above.

The same comments as above apply to shale samples from the interval 2000-2100 meters, where again algal kerogen predominates, the gas is over 80% C_2-C_4, but only very modest amounts of gasolines were present. However, this interval is leaner in total organic matter, which may explain the lower total amounts of gas. The sample from 1890 meters also contains some algal debris, and shows comparable patterns.

The heavy hydrocarbon patterns (Table 4 and Figs. 2 thru 6) are consistent with the above interpretations. These C_{15}+ data alone could be interpreted as follows:

Depth	Maturity	Richness	Source Type
1890	Immature	Marginal	Oil, Gas
2070	Immature	Marginal	Oil, Gas
2250	Immature	Fair	Oil, Gas
2340	Immature	Good	Oil
2490	Transitional	Poor	Lean

Estimates of maturity from C_{15}+ data are based on chromatogram patterns (Figs. 2-6), saturate/aromatic ratios, ratios of hydrocarbons to total extracts, and overall patterns By themselves they are not particularly reliable, and should be used in conjunction with the other types of data to arrive at an overall final interpretation of maturity and source type.

The gross geochemical patterns at 16/1-2 are a bit like those at 15/12-2. (See EPR. 39ES. 76) However, at 15/12-2 the rich shale zone starts deeper (at about 2700 meters) and is more mature. It gave up notably greater amounts of gas, gasolines and C_{15}+ hydrocarbons due to its more mature stage of diagenesis.

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)									
										TOTAL GAS						WET GAS			
			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)	C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
67284A	4	360	1182.95	9.17	3.24	1.30	2.22	15.93	1198.88	1.3287	99.	1.	0.	0.	0.	58.20	8.14		
67284D	4	420	1238.31	4.46	1.89	0.77	1.12	8.24	1246.55	0.6610	100.	0.	0.	0.	0.	54.23	9.14		
67284G	4	540	1224.44	4.46	4.44	0.87	1.78	11.55	1235.99	0.9344	100.	0.	0.	0.	0.	39.38	6.15		
67284J	4	630	4190.17	3.52	4.03	1.72	0.50	9.77	4199.93	0.2325	100.	0.	0.	0.	0.	36.41	16.		
67284M	4	720	8562.50	6.11	8.49	1.54	0.55	16.68	8579.18	0.1945	100.	0.	0.	0.	0.	37.51	9.		
67284P	4	810	1436.13	3.25	2.53	0.24	0.17	6.19	1442.32	0.4291	100.	0.	0.	0.	0.	52.41	4.		
67284S	4	900	911.35	8.80	1.90	0.66	1.04	12.40	923.75	1.3423	99.	1.	0.	0.	0.	72.15	5.		
67285B	4	990	1172.11	10.38	1.68	0.51	0.65	13.22	1185.33	1.1153	99.	1.	0.	0.	0.	78.13	4.		
67285E	4	1080	814.80	12.48	3.93	1.29	2.36	20.06	834.86	2.4027	99.	1.	0.	0.	0.	62.20	6.12		
67285F	4	1110	4196.79	47.54	3.42	0.80	0.45	52.20	4248.99	1.2286	99.	1.	0.	0.	0.	90.	7.	2.	1.
67285I	4	1200	7471.80	95.56	6.10	0.85	1.94	104.44	7576.24	1.3785	99.	1.	0.	0.	0.	91.	6.	1.	2.
67285K	4	1260	18621.24	101.07	10.70	3.58	2.64	117.98	18739.22	0.6296	99.	1.	0.	0.	0.	86.	9.	3.	2.
67285M	4	1320	475.86	4.96	2.10	0.44	0.51	8.01	483.87	1.6553	99.	1.	0.	0.	0.	63.26	5.	6.	
67285O	4	1380	16.17	1.03	1.78	0.36	0.56	3.73	19.90	18.7436	81.	5.	9.	2.	3.	28.47	13.	15.	
67285Q	4	1440	685.71	22.41	12.23	2.94	2.50	40.08	725.79	5.5222	95.	3.	2.	0.	0.	56.31	7.	6.	
67285S	4	1500	1773.66	29.98	16.94	9.86	6.44	63.22	1836.88	3.4417	96.	2.	1.	1.	0.	47.27	16.	10.	
67286A	4	1560	12.26	0.42	0.32	0.21	0.28	1.23	13.49	9.1178	91.	3.	2.	2.	2.	34.26	17.	23.	
67286B	4	1590	455.24	9.81	3.94	1.28	1.47	16.50	471.74	3.4976	97.	2.	1.	0.	0.	59.24	8.	9.	
67286C	4	1620	3414.29	55.89	7.24	2.78	2.13	68.04	3482.33	1.9539	98.	2.	0.	0.	0.	82.11	4.	3.	
67286D	4	1650	14.58	0.78	0.33	0.17	0.28	1.56	16.14	9.6653	90.	5.	2.	1.	2.	50.21	11.	18.	
67286E	4	1680	1681.92	33.12	5.28	1.44	1.83	41.67	1723.59	2.4176	98.	2.	0.	0.	0.	80.13	3.	4.	
67286F	4	1710	89.34	4.64	1.52	0.47	0.76	7.39	96.73	7.6398	92.	5.	2.	0.	1.	63.21	6.	10.	
67286G	4	1740	30.48	2.70	1.95	0.52	0.80	5.97	36.45	16.3785	85.	7.	5.	1.	2.	45.33	9.	13.	
67286H	4	1770	11.16	0.53	0.40	0.06	0.10	1.09	12.25	8.8979	92.	4.	3.	0.	1.	48.37	6.	9.	
67286I	4	1800	25.33	6.94	8.45	1.47	2.40	19.26	44.59	43.1935	57.	16.	19.	3.	5.	36.44	8.	12.	
67286J	4	1830	807.32	155.52	116.25	19.63	15.05	306.45	1113.77	27.5146	73.	14.	10.	2.	1.	51.38	6.	5.	
67286K	4	1860	127.83	79.36	93.00	19.48	27.85	219.69	347.52	63.2165	36.	23.	27.	6.	8.	36.42	9.	13.	
67286L	4	1890	9.46	14.69	10.42	2.44	3.67	31.22	40.68	76.7453	23.	36.	26.	6.	9.	47.33	8.	12.	
67286M	4	1920	1681.92	586.88	47.03	7.56	12.98	654.45	2336.37	28.0114	72.	25.	2.	0.	1.	90.	7.	1.	2.
67286N	4	1950	1550.17	406.40	357.70	61.85	117.76	943.71	2493.88	37.8410	63.	16.	14.	2.	5.	43.28	7.	12.	
67286O	4	1980	94.17	141.87	296.42	81.15	176.61	696.05	790.22	88.0830	12.	18.	38.	10.	22.	20.	43.	72.	25.
67286P	4	2010	323.59	598.04	1223.42	350.26	783.11	2954.83	3278.42	90.1297	10.	18.	37.	11.	24.	20.	41.	12.	27.
67286Q	4	2040	9.24	15.40	25.15	5.41	10.53	56.49	65.73	85.9425	14.	23.	39.	8.	16.	27.	44.	10.	19.
67286R	4	2070	674.64	422.40	724.22	168.80	308.37	1623.79	2298.43	70.6478	29.	18.	33.	7.	13.	26.	45.	10.	19.
67286S	4	2100	1109.42	361.85	422.30	104.43	174.86	1063.44	2172.86	48.9419	51.	17.	19.	5.	8.	34.	40.	10.	16.
67286T	4	2130	120.23	90.00	93.15	21.04	34.66	238.85	359.08	66.5172	33.	25.	26.	6.	10.	38.	38.	9.	15.
67287A	4	2160	1716.96	330.40	251.55	44.87	70.21	697.03	2413.99	28.8746	71.	14.	10.	2.	3.	48.	36.	6.	10.
67287B	4	2190	1085.36	403.20	490.92	103.34	202.99	1200.45	2285.81	52.5175	47.	18.	21.	5.	9.	34.	40.	9.	17.
67287C	4	2220	59.20	23.55	31.02	7.07	13.72	75.36	134.56	56.0047	44.	18.	23.	5.	10.	31.	42.	9.	18.
67287D	4	2250	240.64	138.71	20.18	72.07	66.23	297.19	537.83	55.2572	45.	26.	4.	13.	12.	47.	7.	24.	22.
67287E	4	2280	698.00	294.40	367.63	8.91	16.76	687.70	1385.70	49.6283	50.	21.	27.	1.	1.	43.	54.	1.	2.
67287F	4	2310	2971.39	1996.80	1333.63	226.54	203.90	3760.86	6732.25	55.8634	44.	30.	20.	3.	3.	54.	35.	6.	5.
67287G	4	2340	1045.19	677.49	568.72	204.24	192.17	1642.62	2687.81	61.1137	39.	25.	21.	8.	7.	41.	35.	12.	12.
67287H	4	2370	168.19	55.81	80.81	35.64	44.51	216.77	384.96	56.3097	44.	14.	21.	9.	12.	26.	37.	16.	21.
67287I	4	2400	2721.34	2463.74	2489.56	361.02	905.11	6219.43	8940.77	69.5625	30.	28.	28.	4.	10.	40.	39.	6.	15.
67287J	4	2430	607.73	450.56	466.33	70.45	75.99	1063.33	1671.06	63.6320	36.	27.	28.	4.	5.	42.	44.	7.	7.
67287K	4	2460	135.15	193.83	371.32	101.94	232.22	899.31	1034.46	86.9352	13.	19.	36.	10.	22.	22.	41.	11.	24.
67287L	4	2490	206.74	121.76	217.93	55.94	128.15	523.78	730.52	71.6996	28.	17.	29.	8.	18.	23.	42.	11.	24.
67287M	4	2520	168.19	108.90	120.86	19.76	43.57	293.09	461.28	63.5383	37.	24.	26.	4.	9.	37.	41.	7.	15.
67287N	4	2550	226.06	77.73	74.79	11.66	25.12	189.30	415.36	45.5748	54.	19.	18.	3.	6.	41.	40.	6.	13.
67287O	4	2580	116.07	44.50	67.59	12.24	31.38	155.71	271.78	57.2926	42.	16.	25.	5.	12.	29.	43.	8.	20.
67287P	4	2610	101.94	14.13	11.63	5.54	14.57	45.87	147.81	31.0331	68.	10.	8.	4.	10.	31.	25.	12.	32.
67287Q	4	2640	25.57	10.38	24.41	5.62	15.25	55.66	81.23	68.5215	31.	13.	30.	7.	19.	19.	44.	10.	27.
67287R	4	2670	511.16	43.83	45.23	10.44	10.62	110.12	621.28	17.7246	82.	7.	7.	2.	2.	40.	41.	9.	10.
67287S	4	2700	29.72	4.42	3.45	0.46	1.01	9.34	39.06	23.9119	76.	11.	9.	1.	3.	47.	37.	5.	11.
67287T	4	2760	215.66	103.25	150.14	55.25	93.52	402.16	617.82	65.0923	35.	17.	24.	9.	15.	26.	37.	14.	23.
67288A	4	2790	22.36	9.17	20.25	17.60	19.19	66.21	88.57	74.7544	25.	10.	23.	20.	22.	14.	30.	27.	29.
67288B	4	2820	215.85	26.94	39.08	18.65	37.67	122.34	338.19	36.1749	63.	8.	12.	6.	11.	22.	32.	15.	31.
67288C	4	2850	26.99	1.22	1.75	0.81	0.85	4.63	31.62	14.6426	84.	4.	6.	3.	3.	26.	39.	17.	18.
67288D	4	2880	7.75	0.39	0.68	0.29	0.82	2.18	9.93	21.9537	78.	4.	7.	3.	8.	18.	31.	13.	38.
67288E	4	2910	16.52	1.06	1.30	0.53	1.39	4.28	20.80	20.5769	79.	5.	6.	3.	7.	25.	30.	12.	33.
67288F	4	2918	23.65	2.83	2.43	1.05	3.80	10.11	33.76	29.9466	71.	8.	7.	3.	11.	28.	24.	10.	38.

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)									
										TOTAL GAS						WET GAS			
			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)	C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
67284A	4	360	588.67	4.00	1.63	1.17	1.79	8.59	597.26	1.4382	99.	1.	0.	0.	0.	46.	19.	14.	21.
67284D	4	420	1520.03	4.50	2.41	1.65	1.77	10.33	1530.36	0.6750	100.	0.	0.	0.	0.	44.	23.	16.	17.
67284G	4	540	872.50	6.90	3.71	1.72	2.10	14.43	886.93	1.6269	99.	1.	0.	0.	0.	47.	26.	12.	15.
67284J	4	630	2346.28	10.20	4.27	2.48	1.77	18.72	2365.00	0.7915	100.	0.	0.	0.	0.	55.	23.	13.	9.
67284M	4	720	3540.44	21.72	6.30	3.79	2.25	34.06	3574.50	0.9528	99.	1.	0.	0.	0.	64.	18.	11.	7.
67284P	4	810	2522.88	28.20	4.18	1.85	1.33	35.56	2558.44	1.3899	99.	1.	0.	0.	0.	79.	12.	5.	4.
67284S	4	900	1866.93	13.05	5.74	1.86	3.52	24.17	1891.10	1.2781	99.	1.	0.	0.	0.	53.	24.	8.	15.
67285B	4	990	812.58	7.95	2.02	0.49	0.72	11.18	823.76	1.3572	99.	1.	0.	0.	0.	72.	18.	4.	6.
67285E	4	1080	632.82	7.65	2.93	1.05	1.44	13.07	645.89	2.0235	99.	1.	0.	0.	0.	59.	22.	8.	11.
67285F	4	1110	2712.10	36.00	4.44	0.49	2.02	42.95	2755.05	1.5589	99.	1.	0.	0.	0.	84.	10.	1.	5.
67285I	4	1200	2270.59	40.50	4.14	1.09	1.86	47.59	2318.18	2.0529	98.	2.	0.	0.	0.	85.	9.	2.	4.
67285K	4	1260	2678.46	38.40	3.00	0.51	0.86	42.77	2721.23	1.5717	99.	1.	0.	0.	0.	90.	7.	1.	2.
67285M	4	1320	960.80	10.92	11.02	2.98	3.24	28.16	988.96	2.8474	98.	1.	1.	0.	0.	39.	38.	11.	12.
67285O	4	1380	423.63	7.35	15.84	3.11	6.97	33.27	456.90	7.2816	92.	2.	3.	1.	2.	22.	48.	9.	21.
67285Q	4	1440	1461.17	16.50	19.41	7.77	7.74	51.42	1512.59	3.3994	96.	1.	1.	1.	1.	32.	38.	15.	15.
67285S	4	1500	1366.56	19.80	14.90	12.82	10.77	58.29	1424.85	4.0909	96.	1.	1.	1.	1.	34.	26.	22.	18.
67286A	4	1560	273.31	3.84	1.89	2.23	2.23	10.19	283.50	3.5943	96.	1.	1.	1.	1.	37.	19.	22.	22.
67286B	4	1590	515.09	5.10	2.37	0.87	1.00	9.34	524.43	1.7809	99.	1.	0.	0.	0.	55.	25.	9.	11.
67286C	4	1620	639.13	11.70	3.34	2.04	1.11	18.19	657.32	2.7672	97.	2.	1.	0.	0.	65.	18.	11.	6.
67286D	4	1650	457.27	7.50	2.25	1.46	1.77	12.98	470.25	2.7602	98.	2.	0.	0.	0.	58.	17.	11.	14.
67286E	4	1680	154.53	3.30	1.79	1.36	1.55	8.30	162.53	4.9221	95.	2.	1.	1.	1.	42.	22.	17.	19.
67286F	4	1710	181.33	3.36	1.38	0.39	0.55	5.68	187.01	3.0373	97.	2.	1.	0.	0.	59.	24.	7.	10.
67286G	4	1740	267.00	8.85	6.54	1.58	2.21	19.18	286.18	6.7019	93.	3.	2.	1.	1.	46.	34.	8.	12.
67286H	4	1770	315.36	20.31	24.84	4.63	8.15	57.93	373.29	15.5186	85.	5.	7.	1.	2.	35.	43.	8.	14.
67286I	4	1800	735.84	9.60	81.35	20.63	41.11	152.69	888.53	17.1845	83.	1.	9.	2.	5.	6.	53.	14.	27.
67286J	4	1830	231.26	36.60	65.83	16.05	15.49	133.97	365.23	36.6869	64.	10.	18.	4.	4.	27.	49.	12.	12.
67286K	4	1860	639.13	278.88	715.39	195.80	389.40	1579.47	2218.60	71.1922	29.	13.	31.	9.	18.	18.	45.	12.	25.
67286L	4	1890	1114.27	737.28	1754.70	418.34	856.68	3767.00	4881.27	77.1725	23.	15.	35.	9.	18.	20.	46.	11.	23.
67286M	4	1920	620.21	213.12	317.95	68.38	150.10	749.55	1369.76	54.7212	45.	16.	23.	5.	11.	28.	43.	9.	20.
67286N	4	1950	562.39	116.40	206.17	55.71	134.17	512.45	1074.84	47.6768	53.	11.	19.	5.	12.	23.	40.	11.	26.
67286O	4	1980	728.48	654.72	1722.90	565.66	1549.10	4492.38	5220.86	86.0467	14.	13.	32.	11.	30.	15.	38.	13.	34.
67286P	4	2010	310.10	466.56	1391.04	540.79	1444.32	3842.71	4152.81	92.5328	7.	11.	33.	13.	36.	12.	36.	14.	38.
67286Q	4	2040	294.34	306.24	201.20	224.09	559.32	1290.85	1585.19	81.4319	19.	19.	13.	14.	35.	24.	16.	17.	43.
67286R	4	2070	328.50	108.96	288.14	80.81	215.94	693.85	1022.35	67.8681	32.	11.	28.	8.	21.	16.	41.	12.	31.
67286S	4	2100	1093.25	316.80	536.54	156.02	354.00	1363.36	2456.61	55.4976	45.	13.	22.	6.	14.	23.	40.	11.	26.
67286T	4	2130	935.57	153.60	253.37	82.05	424.80	913.82	1849.39	49.4119	51.	8.	14.	4.	23.	17.	28.	9.	46.
67287A	4	2160	1517.93	355.20	476.93	125.25	284.97	1242.35	2760.28	45.0081	55.	13.	17.	5.	10.	29.	38.	10.	23.
67287B	4	2190	567.65	223.20	710.42	242.42	628.70	1804.74	2372.39	76.0726	24.	9.	30.	10.	27.	12.	40.	13.	35.
67287C	4	2220	1040.69	237.60	564.36	164.72	419.14	1385.82	2426.51	57.1116	43.	10.	23.	7.	17.	17.	41.	12.	30.
67287D	4	2250	954.49	332.16	697.51	402.17	492.06	1923.90	2878.39	66.8394	33.	12.	24.	14.	17.	17.	36.	21.	26.
67287E	4	2280	851.47	301.92	702.47	243.98	620.92	1869.29	2720.76	68.7047	31.	11.	26.	9.	23.	16.	38.	13.	33.
67287F	4	2310	4120.70	2035.20	5429.03	907.54	2401.53	10773.29	14893.99	72.3331	28.	14.	36.	6.	16.	19.	51.	8.	22.
67287G	4	2340	1562.08	2849.28	7670.59	2262.62	6649.53	19432.01	20994.09	92.5564	7.	14.	36.	11.	22.	15.	39.	12.	34.
67287H	4	2370	1993.07	3916.80	7650.72	1737.37	5168.40	18473.28	20466.35	90.2617	10.	19.	38.	8.	25.	21.	42.	9.	26.
67287I	4	2400	1892.16	4992.00	8942.40	1305.36	4177.20	19416.95	21309.11	91.1204	9.	23.	42.	6.	20.	26.	45.	7.	22.
67287J	4	2430	601.15	612.00	2682.72	680.65	2506.32	6481.68	7082.84	91.5125	8.	9.	38.	10.	35.	9.	41.	11.	39.
67287K	4	2460	433.62	240.00	1490.40	532.71	845.35	3108.46	3542.08	87.7585	12.	7.	42.	15.	24.	8.	46.	17.	27.
67287L	4	2490	570.80	67.20	268.27	81.58	276.83	693.88	1264.68	54.8660	46.	5.	21.	6.	22.	10.	39.	12.	39.
67287M	4	2520	569.75	68.16	120.47	10.68	24.34	223.65	793.40	28.1888	72.	9.	15.	1.	3.	30.	54.	5.	11.
67287N	4	2550	588.67	87.60	151.52	19.81	76.11	335.04	923.71	36.2711	65.	9.	16.	2.	8.	26.	45.	6.	23.
67287O	4	2580	462.00	11.10	29.03	6.68	23.45	70.26	532.26	13.2032	88.	2.	5.	1.	4.	16.	41.	10.	33.
67287P	4	2610	576.06	7.20	7.61	0.19	9.96	24.96	601.02	4.1529	96.	1.	1.	0.	2.	29.	30.	1.	40.
67287Q	4	2640	651.74	11.10	24.22	0.19	8.63	44.14	695.88	6.3430	94.	2.	3.	0.	1.	25.	55.	0.	20.
67287R	4	2670	982.87	23.19	28.57	0.19	9.15	61.10	1043.97	5.8526	94.	2.	3.	0.	1.	38.	47.	0.	15.
67287S	4	2700	567.65	13.42	26.64	9.13	17.88	67.07	634.72	10.5668	90.	2.	4.	1.	3.	20.	39.	14.	27.
67287T	4	2760	665.41	75.60	189.28	85.63	192.93	543.44	1208.85	44.9551	55.	6.	16.	7.	16.	14.	35.	16.	35.
67288A	4	2790	511.41	18.09	19.87	11.31	12.17	61.44	572.85	10.7252	91.	3.	3.	2.	2.	29.	33.	18.	20.
67288B	4	2820	546.62	25.50	28.01	14.92	29.78	98.21	644.83	15.2373	85.	4.	4.	2.	5.	26.	29.	15.	30.
67288C	4	2850	735.84	17.70	11.83	0.97	1.11	31.61	767.45	4.1168	96.	2.	2.	0.	0.	56.	37.	3.	4.
67288D	4	2880	368.45	7.17	3.10	0.83	1.66	12.76	381.21	3.3471	97.	2.	1.	0.	0.	56.	24.	7.	13.
67288E	4	2910	274.89	28.80	11.64	2.96	13.72	57.12	332.01	17.2042	82.	9.	4.	1.	4.	51.	20.	5.	24.
67288F	4	2918	210.24	5.55	2.78	1.46	2.77	12.56	222.80	5.6373	95.	2.	1.	1.	1.	44.	22.	12.	22.

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)									
										TOTAL GAS						WET GAS			
			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)	C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	C_2	C_3	iC_4	nC_4
67284A	4	360	1771.62	13.17	4.87	2.47	4.61	24.52	1796.14	1.3651	99.	1.	0.	0.	0.	54.	20.	10.	16.
67284D	4	420	2758.34	8.96	4.30	2.42	2.89	18.57	2776.91	0.6687	100.	0.	0.	0.	0.	48.	23.	13.	16.
67284G	4	540	2096.94	11.36	8.15	2.59	3.88	25.98	2122.92	1.2238	99.	1.	0.	0.	0.	44.	31.	10.	15.
67284J	4	630	6536.45	13.72	8.30	4.20	2.27	28.49	6564.93	0.4339	100.	0.	0.	0.	0.	48.	29.	15.	8.
67284M	4	720	12102.94	27.83	14.79	5.33	2.80	50.74	12153.68	0.4175	100.	0.	0.	0.	0.	54.	29.	11.	6.
67284P	4	810	3959.01	31.45	6.71	2.09	1.50	41.75	4000.76	1.0435	99.	1.	0.	0.	0.	75.	16.	5.	4.
67284S	4	900	2778.28	21.85	7.64	2.52	4.56	36.57	2814.85	1.2991	99.	1.	0.	0.	0.	60.	21.	7.	12.
67285B	4	990	1984.69	18.33	3.70	1.30	1.37	24.40	2009.09	1.2144	99.	1.	0.	0.	0.	75.	15.	4.	6.
67285E	4	1080	1447.62	20.13	6.86	2.34	3.80	33.13	1480.75	2.2373	99.	1.	0.	0.	0.	61.	21.	7.	11.
67285F	4	1110	6908.89	83.54	7.86	1.29	2.47	95.15	7004.04	1.3585	99.	1.	0.	0.	0.	88.	8.	1.	3.
67285I	4	1200	9742.39	136.06	10.24	1.94	3.80	152.03	9894.41	1.5365	99.	1.	0.	0.	0.	90.	7.	1.	2.
67285K	4	1260	21299.70	139.47	13.70	4.09	3.50	160.75	21460.45	0.7491	99.	1.	0.	0.	0.	86.	9.	3.	2.
67285M	4	1320	1436.66	15.88	13.12	3.42	3.75	36.17	1472.83	2.4558	98.	1.	1.	0.	0.	45.	36.	9.	10.
67285O	4	1380	439.80	8.38	17.62	3.47	7.53	37.00	476.80	7.7600	91.	2.	4.	1.	2.	23.	48.	9.	20.
67285Q	4	1440	2146.88	38.91	31.64	10.71	10.24	91.50	2238.38	4.0878	97.	2.	1.	0.	0.	42.	35.	12.	11.
67285S	4	1500	3140.22	49.78	31.84	22.68	17.21	121.51	3261.73	3.7253	95.	2.	1.	1.	1.	41.	26.	19.	14.
67286A	4	1560	285.57	4.26	2.21	2.44	2.51	11.42	296.99	3.8451	96.	1.	1.	1.	1.	38.	19.	21.	22.
67286B	4	1590	970.33	14.91	6.31	2.15	2.47	25.84	996.17	2.5938	98.	1.	1.	0.	0.	58.	24.	8.	10.
67286C	4	1620	4053.42	67.59	10.58	4.82	3.24	86.23	4139.65	2.0830	98.	2.	0.	0.	0.	78.	12.	6.	4.
67286D	4	1650	471.85	8.28	2.58	1.63	2.05	14.54	486.39	2.9893	97.	2.	1.	0.	0.	57.	18.	11.	14.
67286E	4	1680	1836.45	36.42	7.07	2.81	3.38	49.67	1886.12	2.6334	98.	2.	0.	0.	0.	73.	14.	6.	7.
67286F	4	1710	270.67	8.00	2.90	0.86	1.31	13.07	283.74	4.6063	96.	3.	1.	0.	0.	61.	22.	7.	10.
67286G	4	1740	297.48	11.55	8.49	2.10	3.01	25.15	322.63	7.7951	91.	4.	3.	1.	1.	46.	34.	8.	12.
67286H	4	1770	326.52	20.84	25.24	4.69	8.25	59.02	385.54	15.3083	85.	5.	7.	1.	2.	35.	43.	8.	14.
67286I	4	1800	761.17	16.54	89.80	22.10	43.51	171.95	933.12	18.4274	81.	2.	10.	2.	5.	10.	52.	13.	25.
67286J	4	1830	1038.58	192.12	182.08	35.68	30.54	440.42	1479.00	29.7782	71.	13.	12.	2.	2.	44.	41.	8.	7.
67286K	4	1860	766.96	358.24	808.39	215.28	417.25	1799.16	2566.12	70.1121	30.	14.	32.	8.	16.	20.	45.	12.	23.
67286L	4	1890	1123.73	751.97	1765.12	420.78	860.35	3798.22	4921.95	77.1690	23.	15.	36.	9.	17.	20.	40.	11.	23.
67286M	4	1920	2302.13	800.00	364.98	75.94	163.08	1404.00	3706.13	37.8831	62.	22.	10.	2.	4.	57.	26.	5.	12.
67286N	4	1950	2112.56	522.80	563.87	117.56	251.93	1456.16	3568.72	40.8034	59.	15.	16.	3.	7.	36.	39.	8.	17.
67286O	4	1980	821.65	796.59	2019.32	646.81	1725.71	5188.43	6011.08	86.3144	14.	13.	34.	11.	29.	15.	40.	12.	33.
67286P	4	2010	633.69	1064.60	2614.46	891.05	2227.43	6797.54	7431.23	91.4726	9.	14.	35.	12.	30.	16.	38.	13.	33.
67286Q	4	2040	303.58	321.64	226.35	229.50	569.85	1347.34	1650.92	81.6114	18.	19.	14.	14.	35.	24.	17.	17.	42.
67286R	4	2070	1303.14	531.36	1012.36	249.61	524.31	2317.64	3320.78	69.7920	39.	16.	30.	8.	16.	23.	43.	11.	23.
67286S	4	2100	2201.67	678.65	958.84	260.45	528.86	2426.80	4629.47	52.4207	48.	15.	21.	6.	11.	28.	39.	11.	22.
67286T	4	2130	1054.80	243.60	346.52	103.09	459.46	1152.67	2208.47	52.1931	48.	11.	16.	5.	21.	21.	30.	9.	40.
67287A	4	2160	3234.89	685.60	728.48	170.12	355.18	1939.38	5174.27	37.4812	63.	13.	14.	3.	7.	35.	38.	9.	18.
67287B	4	2190	1654.01	626.40	1201.34	345.76	831.69	3005.19	4658.20	64.5140	35.	13.	26.	7.	18.	21.	39.	12.	28.
67287C	4	2220	1099.89	261.15	595.38	171.79	432.86	1461.18	2561.07	57.0535	43.	10.	23.	7.	17.	18.	40.	12.	30.
67287D	4	2250	1195.13	470.87	717.69	474.24	558.29	2221.09	3416.22	65.0160	35.	14.	21.	14.	16.	21.	33.	21.	25.
67287E	4	2280	1548.47	596.32	1070.10	252.89	637.68	2556.99	4106.46	62.2675	38.	15.	26.	6.	16.	23.	42.	10.	25.
67287F	4	2310	7092.09	4032.00	6762.66	1134.08	2605.43	14534.16	21626.25	67.2161	33.	19.	31.	5.	12.	28.	46.	8.	18.
67287G	4	2340	2607.27	3526.77	8239.31	2466.86	6841.70	21074.63	23681.90	88.9964	11.	15.	35.	10.	29.	17.	39.	12.	32.
67287H	4	2370	2161.26	3972.61	7731.53	1773.01	5212.91	18690.05	20851.31	89.6349	10.	19.	37.	9.	25.	21.	42.	9.	26.
67287I	4	2400	4612.50	7455.74	11431.96	1666.38	5082.31	25636.38	30249.88	84.7487	15.	25.	38.	6.	17.	29.	44.	7.	20.
67287J	4	2430	1208.88	1062.56	3149.05	751.10	2582.31	7545.01	8753.89	86.1903	14.	12.	36.	9.	29.	14.	42.	10.	34.
67287K	4	2460	568.77	433.83	1861.72	634.65	1077.57	4007.77	4576.54	87.5723	12.	9.	41.	14.	24.	11.	46.	16.	27.
67287L	4	2490	778.54	188.96	486.20	137.52	404.98	1217.66	1995.20	61.0294	39.	9.	24.	7.	20.	16.	40.	11.	33.
67287M	4	2520	737.94	177.06	241.33	30.44	67.91	516.74	1254.66	41.1849	60.	14.	19.	2.	5.	34.	47.	6.	13.
67287N	4	2550	814.73	165.33	226.31	31.47	101.23	524.34	1339.07	39.1570	61.	12.	17.	2.	8.	32.	43.	6.	19.
67287O	4	2580	578.07	55.60	96.62	18.92	54.83	225.97	804.04	28.1142	72.	7.	12.	2.	7.	25.	43.	8.	24.
67287P	4	2610	678.00	21.33	19.24	5.73	24.53	70.83	748.83	9.4587	90.	3.	3.	1.	3.	30.	27.	8.	35.
67287Q	4	2640	677.31	21.48	48.63	5.81	23.88	99.80	777.11	12.8424	87.	3.	6.	1.	3.	22.	48.	6.	24.
67287R	4	2670	1494.03	67.02	73.80	10.63	19.77	171.22	1665.25	10.2819	90.	4.	4.	1.	1.	39.	43.	6.	12.
67287S	4	2700	597.37	17.84	30.09	9.59	18.89	76.41	673.78	11.3404	89.	3.	4.	1.	3.	23.	39.	13.	25.
67287T	4	2760	880.07	178.85	339.42	140.88	286.45	945.60	1826.67	51.7663	48.	10.	19.	8.	16.	19.	36.	15.	30.
67288A	4	2790	533.77	27.26	40.12	28.91	31.36	127.65	661.42	19.2993	81.	4.	6.	4.	5.	21.	31.	23.	24.
67288B	4	2820	762.47	52.44	67.09	33.57	67.45	220.55	983.02	22.4359	78.	5.	7.	3.	7.	24.	30.	15.	31.
67288C	4	2850	762.83	18.92	13.58	1.78	1.96	36.24	799.07	4.5352	96.	2.	2.	0.	0.	53.	37.	5.	5.
67288D	4	2880	376.20	7.56	3.78	1.12	2.48	14.94	391.14	3.8195	96.	2.	1.	0.	1.	51.	25.	7.	17.
67288E	4	2910	291.41	29.86	12.94	3.49	15.11	61.40	352.81	17.4.30	83.	8.	4.	1.	4.	48.	21.	6.	25.
67288F	4	2918	233.89	8.38	5.21	2.51	6.57	22.67	256.56	8.8361	91.	3.	2.	1.	3.	37.	22.	11.	29.

TABLE 2 DESCRIPTION OF " PICKED" SAMPLES AND OF VISUAL KEROGEN

(Kerogen by J.L. Morgan)

Depth (Meters)	EPR No.	Gross Lithology	GSA Color Code (dry)	Total Organic Carbon (%)	Kerogen Alteration	Types of Visual Kerogen (% of Total on Slide)					
						Algal	Amorphous	Herbaceous	Woody	Coaly	Other*
900	67284-S	Silty marl or calc. mudstone lt. olive gray	5Y 6/1	1.8	1+	40	-	trace	20	10	20N,tr M
1110	67285- F	Silty clay, olive gray to med. olive gray, some sl. calc.	5Y 4/1-5/1	3.7	1+	20	-	10	40	trace	20N
1320	67285-M	Claystone, lt. olive gray, sl. silty, sl. calc.	5Y 6/1	1.6	1+	10	-	30	40	10	10N,tr M
1500	67285-S	Shale, olive gray, sl. micaceaus	5Y 4/1	1.6	1+	-	-	10	50	10	20N, 10M
1620	67286-C	Shale, med. lt. olive gray	5Y 5/1-6/1	.5	1+	-	-	30	30	20	20N
1830	67286-J	Shale, med. gray	N5	.3	2-	-	-	30	40	20	10N
1890	67286-L	Shale, med. dk. gray, tr. pyrite	N4	.8	2-	20	20	20	20	20	-
1950	67286-N	Shale, med. greenish gray to med. gray	5GY5/1-N5	.4	2-	10	trace	20	20	20	20M
2010	67286-P	Shale, greenish gray to med. gray, plus trace of red beds and lt. gray shale	5G 5/1-N5	.9	1	40	10	30	trace	20	-
2070	67286-R	Shale, med. dk. gray to greenish gray	N4-5G 6/1	.5	2-	30	10	10	20	30	-
2190	67287-B	Shale, med. dk. gray	N4	.5	2-	trace	-	10	30	40	10M
2250	67287-D	Shale, as above, large thin flakes	N4	.6	1	30	-	10	10	40	10M

Table 2 (continued)

Depth (Meters)	EPR No.	Gross Lithology	GSA Color Code (dry)	Total Organic Carbon (%)	Kerogen Alteration	Types of Visual Kerogen (% of Total on Slide)					
						Algal	Amorphous	Herbaceous	Woody	Coaly	Other*
2310	67287-F	Sandstone and mudstone, med dk. gray to med. greenish gray, minor shale	N4-5GY5/1	1.4	1	60	-	trace	trace	30	trN
2340	67287-G	Mixture, as above, plus trace of chalk		2.2	1	60	-	-	10	30	trM
2400	67287-I	Med. lt. gray siltstone with med. dk. gray laminations	N6 N4	3.2	1+	50	-	10	30	trace	-
2490	67287-L	Shale, med. dk. gray to med. gray	N4-N5	.5	1+	20	20	trace	20	20	20M
2670	67287-R	Red beds - mainly siltstone and sandstone	10R3/2-4/2	.01	2-	-	-	30	30	30	trM
2760	67287-T	Dolomite, lt. olive gray to white, various textures	5Y6/1-N9	.3	1+	-	-	-	20	-	80 Al?
2820	67288-B	Mixture of limestones and dolomites, med. to very lt. gray; plus quartz grains	N6-N8	.2	2-	-	-	-	trace	20	70 Al?
2910	67288-E	Granite, mod. grayish red (feldspar, quartz, minor black mica, trace calcite)	10R 5/4	-	-	-	-	-	-	-	-

*N - Non-filamentous Algal
M - Microplankton
Al? - Possible Algal
tr - trace

Table 3 Organic Matter and Light Gasolines (C_4-C_7)

(Analyses by A.K. Everett, H.M. Fry)

Depth (Meters)	EPR No.	Total Organic Carbon (%)	Total Organic Matter (%)	Total C_4-C_7 (ppm)	Correlation Ratios (See Table 3-A)			
					C_1/C_2	A/D_2	C_1/D_2	CH/MCP
900	67284-S	1.84	2.25	0.	-	-	-	-
1110	67285-F	3.70	4.52	0.	-	-	-	-
1320	67285-M	1.61	1.96	0.	-	-	-	-
1500	67285-S	1.60	1.95	0.	-	-	-	-
1620	67286-C	.51	.63	0.	-	-	-	-
1830	67286-J	.32	.39	0.	-	-	-	-
1890	67286-L	.75	.91	2.4	1.65	15.9	15.2	1.38
1950	67286-N	.35	.43	1.1	2.54	9.08	8.06	1.37
2010	67286-P	.88	1.07	6.7	3.72	4.03	14.6	2.81
2070	67286-R	.48	.58	7.1	2.23	4.45	8.51	1.15
2190	67287-B	.53	.64	2.9	1.28	11.1	13.2	.79
2250	67287-D	.62	.76	4.6	1.34	8.65	14.0	2.07
2310	67287-F	1.44	1.76	17.9	.64	2.17	5.06	1.16
2340	67287-G	2.15	2.63	43.3	3.10	3.24	12.2	4.03
2400	67287-I	3.20	3.90	72.5	1.41	.61	3.07	1.58
2490	67287-L	.53	.65	6.9	1.65	6.79	12.0	1.10
2670	67287-R	.01	.02	1.3	2.78	4.16	23.8	3.26
2760	67287-T	.31	.38	1.1	2.90	2.70	11.3	1.18
2820	67288-B	.17	.20	0.	-	-	-	-

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.

Table 4

Summary of C15+ Soxhlet Extraction, Deasphaltening and Liquid Chromatography *

A. Weights of Extracts and Chromatographic Fractions

GeoChem Sample Number	Identification	Weight of Rock Extd. (grams)	Total Extract (grams)	Precipitated Asphaltenes (grams)	N-C5 Soluble (grams)	Sulfur (grams)	Paraffins-Naphthenes (grams)	Aromatics (grams)	Eluted NSO'S (grams)	Noneluted NSO'S (grams)
777-001	67286 L 1830 m	100.0	0.0394	0.0200	0.0194	N.D.	0.0019	0.0017	0.0076	0.0082
777-002	67286 R 2070	100.0	0.0383	0.0156	0.0227	N.D.	0.0021	0.0092	0.0074	0.0040
777-003	67287 D 2250	100.0	0.0384	0.0198	0.0186	N.D.	0.0024	0.0084	0.0063	0.0015
777-004	67287 G 2340	94.0	0.1441	0.0393	0.1048	N.D.	0.0105	0.0466	0.0351	0.0126
777-005	67287 L 2490	89.0	0.0240	0.0164	0.0076	N.D.	N.D.	N.D.	N.D.	N.D.

Table 4 (Continued)

B. Concentration of Extracted Materials in Rock

			Hydrocarbons				Nonhydrocarbons			
GeoChem Sample Number	Identification	Total Extract (ppm)	Paraffin-Naphthene (ppm)	Aromatic (ppm)	Total (ppm)	Sulfur (ppm)	Precipitd Asphaltene (ppm)	Eluted NSO'S (ppm)	Noneluted NSO'S (ppm)	Total (ppm)
777-001	67286 L	394	19	17	36	-	200	76	82	358
777-002	67286 R	383	21	92	113	-	156	74	40	270
777-003	67287 D	384	24	84	108	-	198	63	15	276
777-004	67287 G	1533	112	496	607	-	418	373	134	926
777-005	67287 L	270	-	-	-	-	184	-	-	-

Table 4 (Continued)

C. Composition of Extracts

		Hydrocarbons				Nonhydrocarbons					
GeoChem Sample Number	Identification	Paraffin-Naphthene %	Aromatic %	PN/Arom	Sulfur %	Eluted NSO'S %	Noneluted NSO'S %	Precipitd Asphaltene %	Asph/NSO	HC'S %	HC/Non HC
777-001	67286 L 1830 m	4.8	4.3	1.12	-	19.3	20.8	50.8	1.27	9.1	0.10
777-002	67286 R 2070	5.5	24.0	0.23	-	19.3	10.4	40.7	1.37	29.5	0.42
777-003	67287 D 2250	6.3	21.9	0.29	-	16.4	3.9	51.6	2.54	28.1	0.39
777-004	67287 G 2340	7.3	32.3	0.23	-	24.4	8.7	27.3	0.82	39.6	0.66
777-005	67287 L 2490	-	-	-	-	-	-	68.3	-	-	-

*Analyses by GeoChem Laboratories

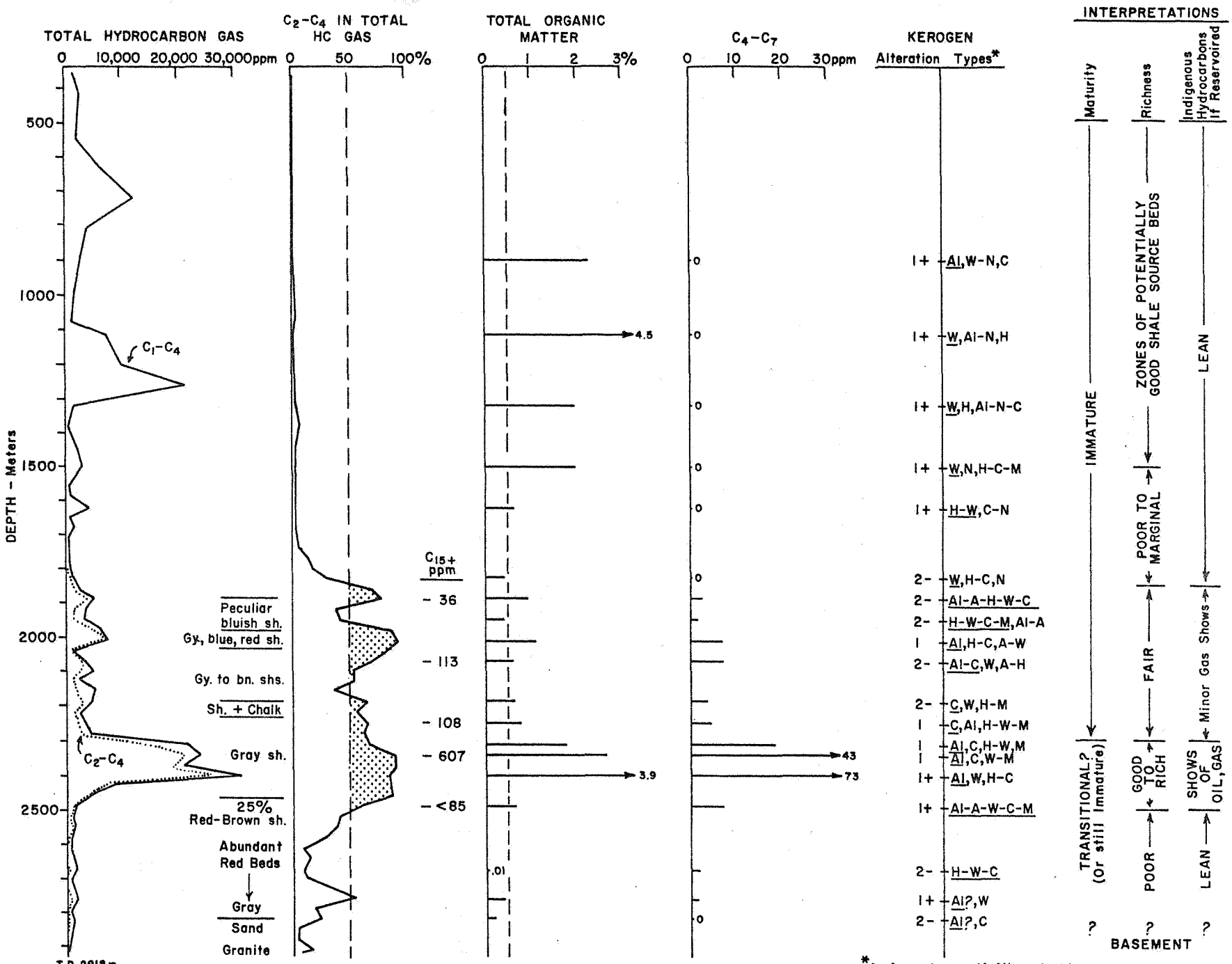

FIG. 1 - GEOCHEMICAL PROFILES, 16/1-2.

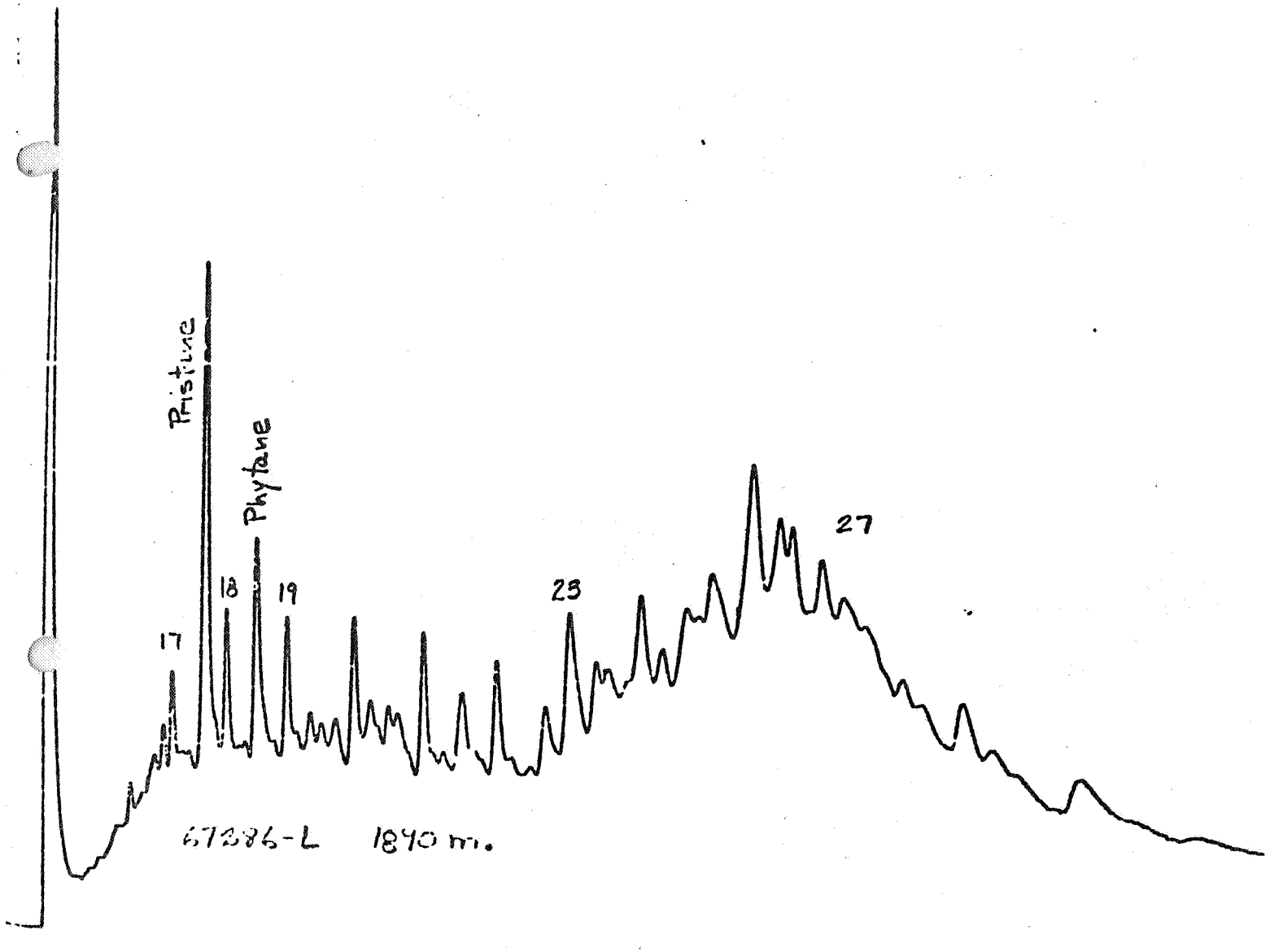

Fig. 7 C_{15}+ Saturates

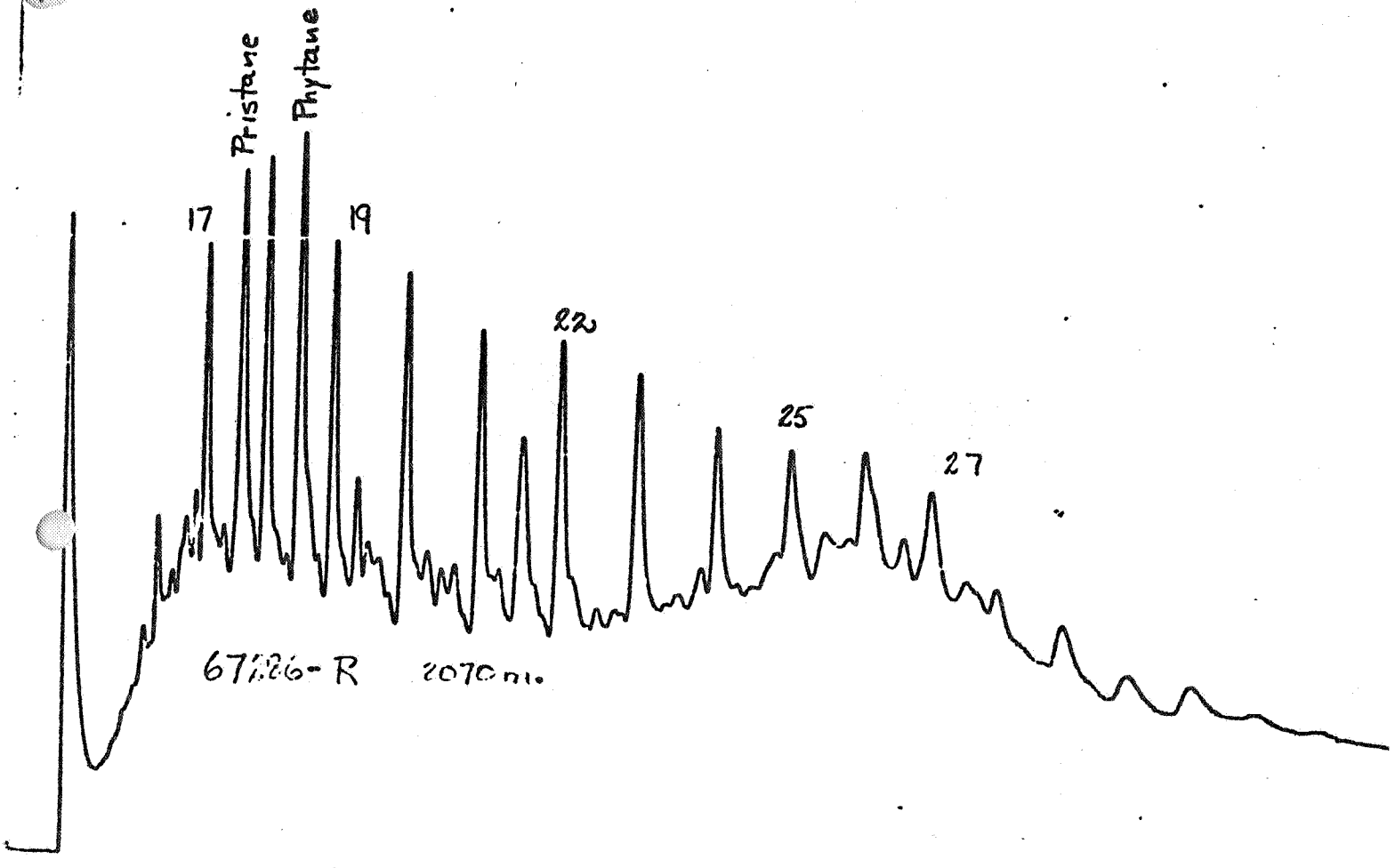

Fig. 3 C_{15}+ Saturates

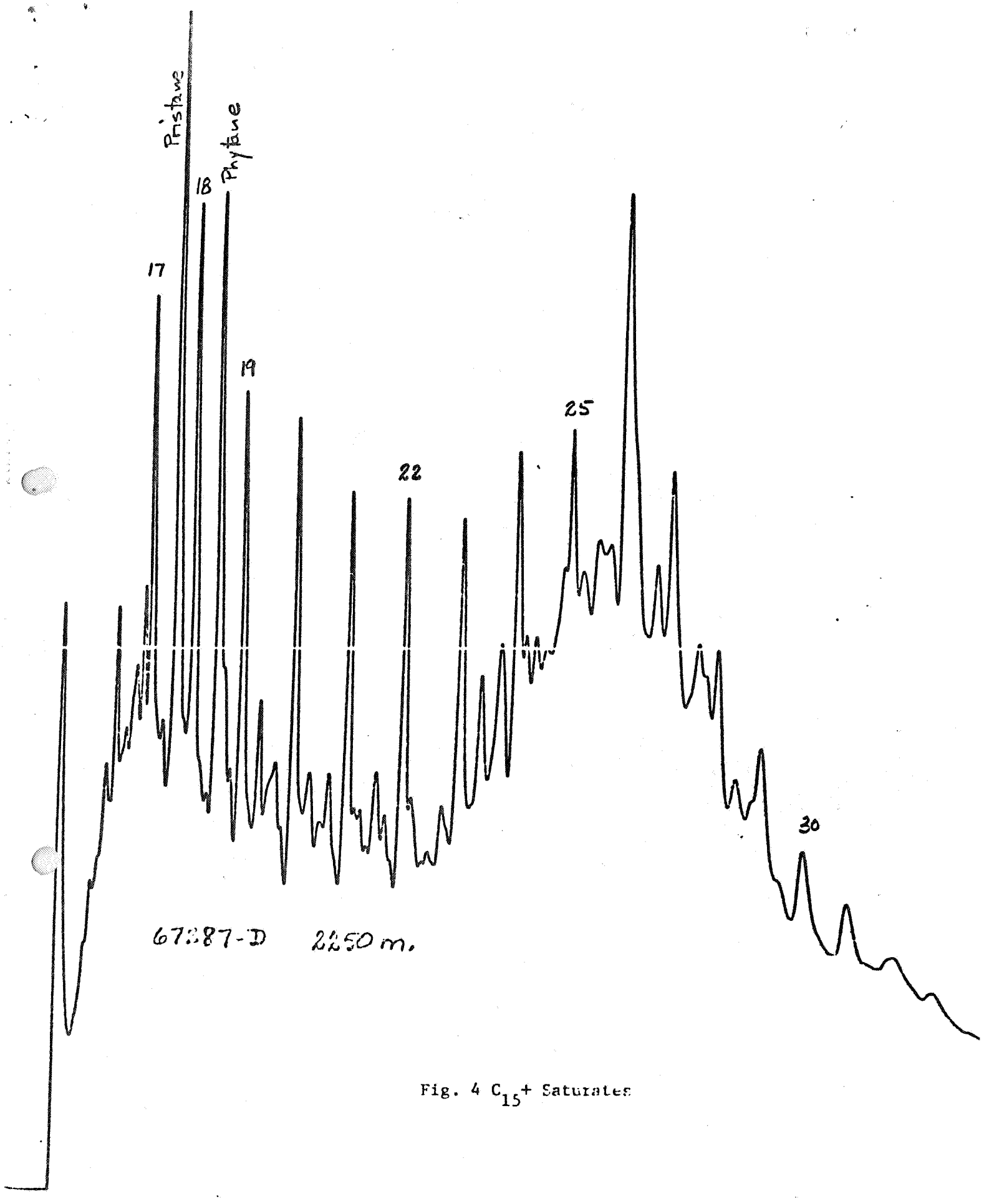

Fig. 4 C_{15}+ Saturates

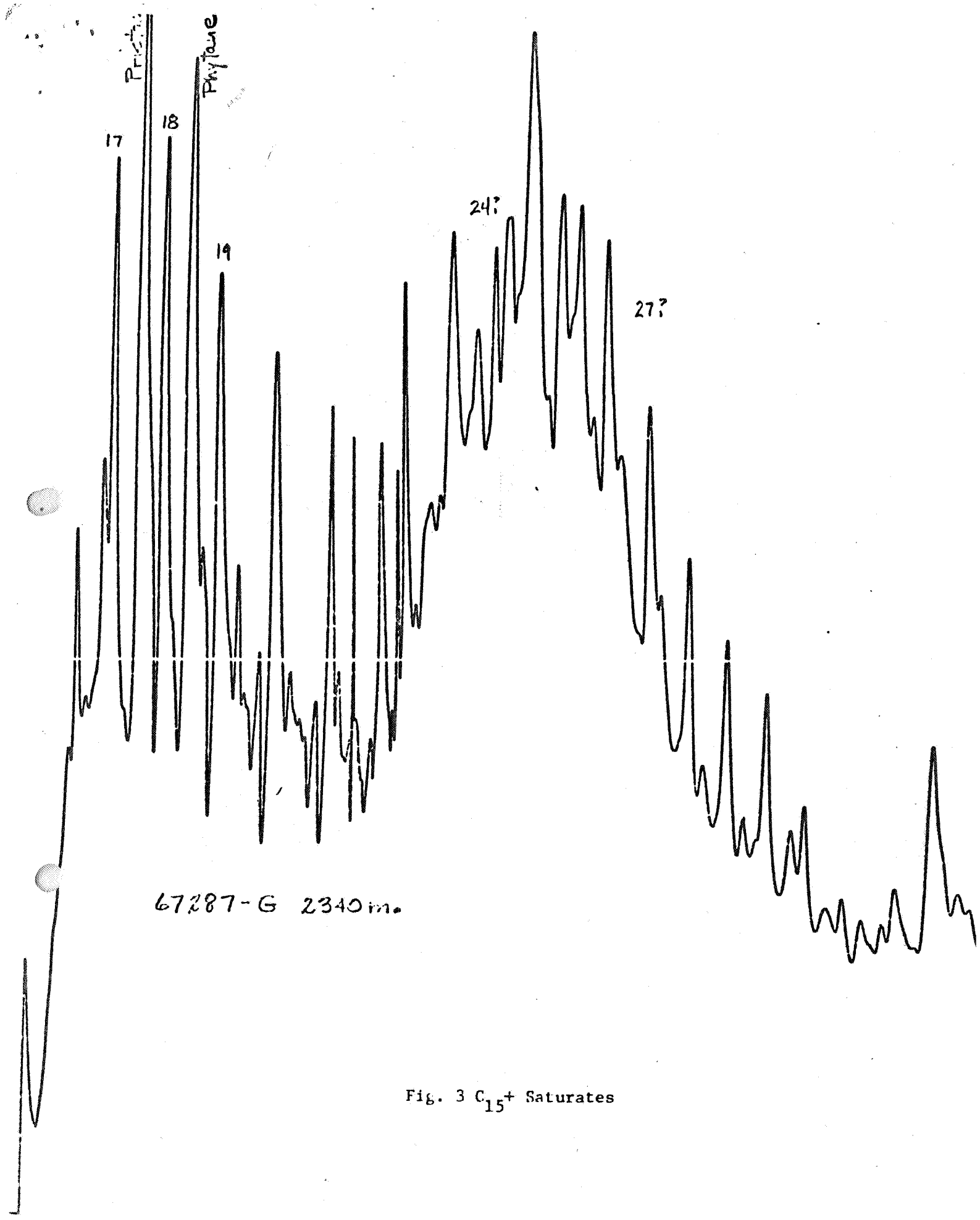

Fig. 3 C_{15}+ Saturates

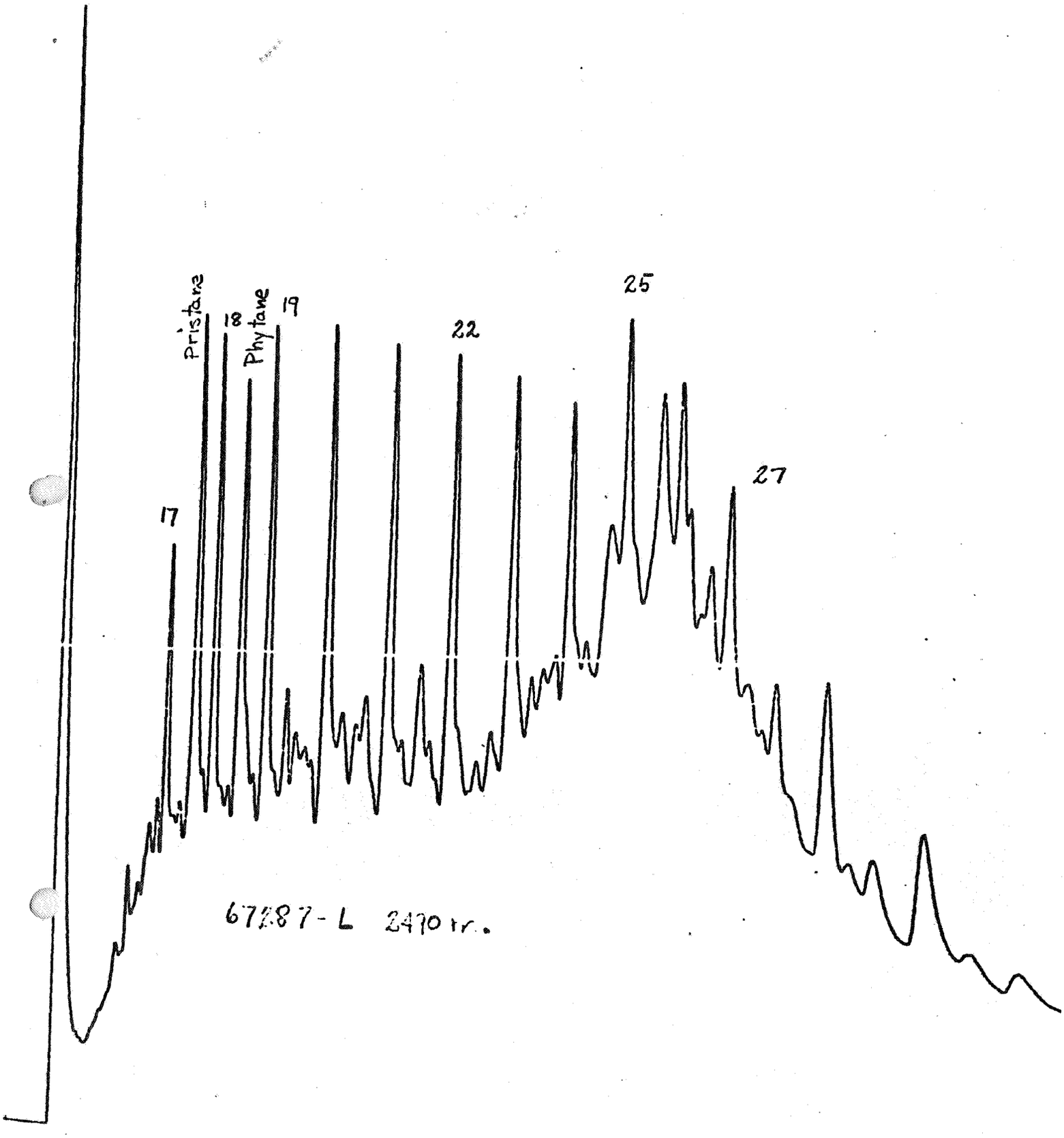

Fig. 6 C_{15}+ Saturates