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Technical Service Report

Exxon Production Research Company

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SOURCE ANALYSES OF CANNED CUTTINGS FROM 15/6-4, OFFSHORE NORWAY

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Reservoir Evaluation Division

November, 1976

FOR COMPANY USE ONLY

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Charges for this work were authorized by Esso Europe, were billed to Esso Exploration and Production Norway, Inc., and are not covered by production research agreements with Exxon Production Research Company.

SOURCE ANALYSES OF CANNED CUTTINGS

FROM 15/6-4, OFFSHORE NORWAY

R.E. Metter

SUMMARY AND CONCLUSIONS

Canned cuttings from the interval 180-3500 meters were analyzed routinely for hydrocarbon source characteristics.

Charges for this service work were billed to our Nob No. 8570. Preliminary results were sent to Esso Norway on October 8, 1976.

The analytical results are interpreted as follows:

Approx. Interval (meters)	Maturity	Richness	Indigenous Hydrocarbons Expected if Reservoired
180-1170	Immature	Various	Lean
1170-1650	Immature	Shales rich	Lean
1650-2190	Immature	Poor	Lean
2190-2690	Algal transitional; the rest immature	Fair to Good	Minor gas, liquids
2690-3170	Mature?	Poor	Lean
3170-3290	Mature ?	Rich	Oil
3290-3500	Mature ?	Poor to Fair	Minor oil, gas

The analytical data are listed in detail in Tables 1 thru 4, and they are summarized graphically in Fig. 1

There are two intervals of interest. The rich, dark shales from about 3170 meters to 3290 meters are rich in oil-prone organic matter. The high total gas yields, the high percentages of C_2-C_4 gases in total hydrocarbon gas, and the appreciable yields of gasolines all suggest a mature oil source. However, the "1+" kerogen alterations suggest that these beds are not yet fully mature, and we have seen similar shales elsewhere yield many times as much gasoline as was observed in the 15/6-4 samples. The latter observations suggest that a "transitional" maturity rating may be more appropriate for this interval, and we would expect still greater oil generation at full maturity.

The interval from 2190 to 2690 meters contains potential source materials of hydrocarbon gases and liquids. High percentages of C_2-C_4 and appreciable gasoline yields were obtained from the samples from this interval. The C_2-C_4 and the gasolines probably came mainly from the algal and some of the herbaceous material, which was rated above as "transitional" in maturity. The woody, coaly and some of the herbaceous kerogen would still be immature. This interval, at a little more mature stage, could be a "fair to good" source of hydrocarbon gases and liquids.

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 standard mixtures 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 1.

Chips of uniform lithologies were picked by hand from the heterogeneous mixtures of chips in 24 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 (Table 2).

Five gross cuttings samples were analyzed for heavy (C_{15}+) soluble organic matter (Table 4). Gas chromatograms were run on the saturate fractions of the soluble organic extracts (Figs. 2-6).

DISCUSSION

Some of the shales down to 1650 meters could be prolific gas sources if they were mature, but in their present state of maturation at 15/6-4 we would not expect them to have generated much reservoired gas.

The 2190-2690 meter interval gave C_{15}+ yields more suggestive of a gas and condensate source section than of a medium-gravity oil source. The chromatograms in Figs. 2 thru 4 and the analyses in Table 4 both suggest this. The high C_2-C_4 percentages and the good gasoline yields could indicate either an oil or a condensate source.

The sample from 3170 meters contained laminae and thin lenses of silt and sand, and its high C_{15}+ yield is attributed to migrated hydrocarbons concentrated in these "microreservoirs.

The 3170'-3290 meter zone is outstanding in this profile, and is undoubtedly a rich potential oil source. Timing of migration and trap formation would be the most important prospect evaluation problem where this interval is fully mature.

TABLE 1A

C_1-C_4 HYDROCARBON ANALYSES - AIR SPACE A[illegible]P OF CANS

SAMPLE NUMBER	R	DEPTH	GAS CONCENTRATION (VOLUME GAS PER MILLION VOLUMES CUTTINGS)							GAS COMPOSITION (PERCENT)											NOTES
			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	
67303A	4	180	87.16	3.87	3.83	1.61	4.95	14.26	101.42	14.0603	86.	4.	4.	2.	5.	27.	27.	11.	35.	
67303D	4	270	88.64	3.46	1.56	0.35	1.27	6.64	95.66	7.1466	93.	4.	2.	0.	1.	53.	23.	5.	19.	
67303G	4	360	2160.50	10.96	2.71	0.39	0.95	15.01	2175.51	0.6899	99.	1.	0.	0.	0.	73.	18.	3.	6.	*B*
67303J	4	430	13920.66	82.09	19.73	4.47	6.14	112.42	14033.08	0.8011	99.	1.	0.	0.	0.	73.	18.	4.	5.	
67303M	4	540	914.54	4.72	3.05	0.61	1.99	10.37	924.91	1.1212	99.	1.	0.	0.	0.	46.	29.	6.	19.	
67303P	4	630	6220.04	4.51	11.65	3.90	7.05	27.10	6247.14	0.4338	100.	0.	0.	0.	0.	17.	43.	14.	26.	
67303S	4	720	4935.78	25.40	4.35	1.49	1.86	33.11	4968.89	0.6663	99.	1.	0.	0.	0.	77.	13.	5.	5.	
67304B	4	810	14927.01	42.78	10.09	3.92	4.46	61.25	14988.26	0.4087	100.	0.	0.	0.	0.	71.	16.	6.	7.	
67304E	4	900	1002.14	3.68	1.66	0.22	0.73	6.30	1008.44	0.6247	100.	0.	0.	0.	0.	58.	26.	4.	12.	
67304H	4	990	1264.99	7.56	2.46	0.34	1.07	11.39	1276.38	0.8923	99.	1.	0.	0.	0.	66.	22.	3.	9.	
67304K	4	1080	2034.52	10.97	1.69	0.46	0.53	13.65	2048.17	0.6762	99.	1.	0.	0.	0.	79.	14.	3.	4.	
67304N	4	1170	229.86	1.76	1.10	0.25	0.63	3.74	233.60	1.6010	99.	1.	0.	0.	0.	47.	27.	9.	17.	*B*
67304Q	4	1260	15025.13	14.34	14.47	3.57	3.20	36.07	15061.20	0.2395	100.	0.	0.	0.	0.	40.	41.	10.	9.	
67304T	4	1350	11793.05	56.58	10.09	2.54	2.36	73.59	11866.65	0.6201	100.	0.	0.	0.	0.	80.	14.	3.	3.	
67305C	4	1440	19.62	1.86	1.49	0.62	1.09	5.09	24.71	20.5989	79.	8.	6.	3.	4.	36.	29.	12.	21.	
67305F	4	1530	5853.14	107.52	34.97	6.91	12.63	164.02	6017.16	2.7260	97.	2.	1.	0.	0.	66.	21.	5.	6.	
67305G	4	1560	4997.70	96.88	35.77	9.66	13.96	156.29	5153.98	3.0323	97.	2.	1.	0.	0.	62.	23.	6.	9.	
67305J	4	1650	15078.40	249.22	69.95	14.67	17.36	351.39	15429.79	2.2774	98.	2.	0.	0.	0.	71.	20.	4.	5.	
67305L	4	1710	6671.61	164.35	53.12	12.06	18.69	248.23	6919.84	3.5872	97.	2.	1.	0.	0.	66.	21.	5.	6.	
67305N	4	1770	396.17	25.32	17.53	8.70	6.73	58.26	454.41	12.8253	87.	6.	4.	2.	1.	43.	30.	15.	12.	
67305P	4	1830	2606.97	98.77	31.32	5.76	7.96	141.81	2748.78	5.1590	95.	4.	1.	0.	0.	68.	22.	4.	6.	
67305R	4	1890	1151.18	65.71	18.17	2.23	2.60	88.71	1239.89	7.1546	94.	5.	1.	0.	0.	74.	20.	3.	3.	
67305T	4	1950	427.99	42.56	18.72	2.88	4.50	68.66	496.65	13.8592	85.	9.	4.	1.	1.	62.	27.	4.	7.	
67306B	4	2010	1914.86	66.29	26.77	3.53	4.49	97.08	2011.94	4.8252	96.	3.	1.	0.	0.	70.	21.	4.	5.	
67306D	4	2070	1770.33	292.92	356.66	26.94	54.46	731.00	2501.33	29.2244	71.	12.	14.	1.	2.	40.	49.	4.	7.	
67306F	4	2130	492.80	176.24	312.65	59.92	76.45	621.26	1114.06	55.7654	45.	15.	28.	5.	7.	27.	50.	10.	13.	
67306H	4	2190	1593.11	1351.68	3825.00	1664.49	2265.60	9107.36	10700.47	85.1117	15.	13.	35.	16.	21.	15.	42.	18.	25.	
67306J	4	2250	90.58	12.40	30.47	62.59	56.64	160.10	250.68	63.8663	36.	5.	12.	24.	23.	8.	19.	38.	35.	
67306L	4	2310	1634.82	2386.94	4052.89	1089.04	1610.84	9140.71	10775.53	84.8284	15.	22.	38.	10.	15.	26.	44.	12.	18.	
67306N	4	2370	168.19	257.28	633.48	183.61	261.42	1335.77	1503.96	88.8188	11.	17.	43.	12.	17.	19.	47.	14.	20.	
67306P	4	2430	366.17	295.69	1485.10	535.40	813.10	3129.49	3495.66	89.5250	10.	8.	44.	15.	23.	9.	48.	17.	26.	
67306R	4	2490	91.10	166.40	397.44	101.11	147.26	812.21	903.31	89.9148	10.	18.	45.	11.	16.	20.	50.	12.	18.	
67306T	4	2550	2423.56	1673.92	5079.28	1541.57	2344.90	10639.68	13063.16	82.9786	17.	14.	39.	12.	18.	17.	47.	14.	22.	
67307A	4	2580	571.85	679.53	1350.00	327.21	400.15	2828.95	3400.80	83.1848	17.	20.	39.	10.	14.	24.	48.	12.	16.	
67307B	4	2600	366.96	591.13	1397.00	342.37	501.18	2631.74	3198.70	88.5276	11.	18.	44.	11.	16.	21.	49.	12.	18.	
67307C	4	2630	389.11	529.68	1344.80	324.73	484.59	2683.80	3072.97	87.3376	13.	17.	43.	11.	16.	20.	50.	12.	18.	
67307D	4	2660	388.65	858.88	862.22	232.80	362.57	2316.53	2705.18	85.6331	14.	32.	32.	9.	13.	37.	37.	10.	16.	
67307E	4	2690	126.81	76.02	161.50	47.12	72.19	358.83	485.64	73.6660	26.	16.	33.	10.	15.	22.	45.	13.	20.	
67307F	4	2720	60.74	38.83	362.11	70.45	112.81	584.20	644.94	90.5826	9.	6.	57.	11.	17.	7.	62.	12.	19.	
67307G	4	2750	51.35	20.67	64.31	30.82	45.10	160.30	211.65	75.7382	24.	9.	40.	15.	12.	13.	52.	19.	16.	
67307H	4	2780	57.70	76.38	272.16	72.81	54.68	476.05	533.75	89.1896	11.	14.	51.	14.	10.	16.	58.	15.	11.	
67307I	4	2810	21.10	12.55	58.71	35.55	64.69	171.50	192.60	89.0446	11.	7.	30.	18.	34.	7.	34.	21.	38.	
67307J	4	2840	95.03	127.62	619.34	303.70	545.81	1596.67	1691.70	94.3826	6.	8.	36.	18.	32.	8.	39.	19.	34.	
67307K	4	2870	42.04	38.65	161.69	75.93	144.56	419.23	461.27	90.8860	9.	8.	36.	16.	31.	9.	39.	18.	34.	
67307L	4	2900	26.57	5.14	10.82	2.62	4.01	22.59	49.16	45.9520	55.	10.	22.	5.	8.	23.	47.	12.	18.	
67307M	4	2930	31.78	18.60	58.56	22.40	40.57	140.13	171.91	81.5136	18.	11.	34.	13.	24.	13.	42.	16.	29.	
67307N	4	2960	1031.58	420.67	1165.82	668.93	1241.88	3503.30	4534.88	77.2523	23.	9.	26.	15.	27.	12.	33.	19.	36.	
67307O	4	2990	28.07	16.21	19.14	14.41	12.32	62.08	90.15	68.8636	31.	18.	21.	16.	14.	26.	31.	23.	20.	
67307P	4	3020	1857.00	625.78	1130.50	419.93	488.07	2664.28	4521.28	63.3511	37.	14.	25.	9.	15.	22.	39.	15.	24.	
67307Q	4	3050	17.73	13.20	25.07	31.12	101.78	171.16	188.89	90.6136	9.	7.	13.	16.	55.	8.	15.	18.	59.	
67307R	4	3080	137.61	51.84	28.03	45.22	78.78	203.87	341.48	59.7018	41.	15.	8.	13.	23.	25.	14.	22.	39.	
67307S	4	3110	52.41	29.67	74.19	44.48	101.32	249.66	302.27	82.6012	17.	10.	25.	15.	33.	12.	30.	18.	40.	
67307T	4	3140	5.89	2.64	4.32	5.16	4.04	16.16	22.05	73.2880	27.	12.	20.	23.	18.	16.	27.	32.	25.	
67308A	4	3170	1197.73	1652.36	2410.36	602.76	1052.13	5725.61	6923.34	82.7001	17.	24.	35.	9.	15.	29.	42.	11.	18.	
67308B	4	3200	21406.23	8069.00	7749.43	1072.92	1997.85	17904.79	39311.02	45.5465	54.	21.	17.	3.	5.	45.	36.	6.	11.	
67308C	4	3230	2325.62	2529.60	2602.49	524.91	860.09	6517.14	8842.76	73.7003	26.	29.	29.	6.	10.	39.	40.	8.	13.	
67308D	4	3260	6727.67	3620.80	1958.05	257.70	391.76	6236.36	12964.03	48.1051	52.	28.	15.	2.	3.	59.	31.	4.	6.	
67308E	4	3290	122595.56	45381.76	36048.60	7638.14	10941.81	94610.44	217606.00	43.2021	56.	21.	14.	4.	5.	48.	32.	8.	12.	
67308F	4	3320	254.84	154.18	129.32	44.03	45.05	372.58	627.42	59.3828	40.	25.	21.	7.	7.	41.	35.	12.	12.	
67308G	4	3350	5537.39	3366.31	2771.84	542.91	1074.71	7747.81	13285.20	58.3191	42.	25.	21.	4.	8.	42.	36.	8.	14.	
67308H	4	3380	2822.26	1880.06	1228.58	188.47	354.00	3651.40	6473.66	56.4040	44.	29.	19.	3.	5.	51.	34.	5.	10.	
67308I	4	3410	3877.04	2072.50	2616.99	460.30	845.24	6994.52	10871.56	64.3378	36.	28.	24.	4.	8.	44.	37.	7.	12.	
67308J	4	3440	6842.09	8428.05	7606.62	1443.53	2459.79	19935.96	26778.07	74.2749	31.	29.	26.	5.	9.	43.	38.	7.	12.	
67308K	4	3470	3.73	6.91	7.95	1.46	2.75	19.07	22.80	83.6403	16.	30.	36.	6.	12.	36.	42.	8.	14.	
67308L	4	3500	3592.10	3675.06	2963.20	492.54	902.87	7973.66	11565.76	68.9419	31.	32.	25.	4.	8.	47.	36.	6.	11.	

B = CUTTINGS NOT ANALYZED *C* = AIR SPACE GAS NOT RUN *BC* = NO ANALYSES RUN

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)								NOTES
			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	
673028A	4	180	594.18	6.90	0.93	0.49	1.22	9.54	608.72	1.5672	99.	1.	0.	0.	0.	72.16.	5.13.			
673038	4	270	567.65	4.42	1.48	0.70	1.16	7.73	575.38	1.3434	99.	1.	0.	0.	0.	57.19.	9.15.			
673048	4	360	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	*B*
673058J	4	450	756.66	8.10	1.88	0.49	1.38	11.83	768.69	1.5389	99.	1.	0.	0.	0.	68.16.	4.12.			
673058M	4	540	1829.09	7.05	1.79	0.56	1.05	10.47	1839.56	0.5691	100.	0.	0.	0.	0.	67.17.	6.10.			
673058P	4	630	977.62	8.70	2.02	0.97	1.66	13.35	990.97	1.3471	99.	1.	0.	0.	0.	66.15.	7.12.			
673059S	4	720	672.77	9.45	1.55	0.76	1.13	12.91	685.68	1.8827	99.	1.	0.	0.	0.	73.12.	6. 9.			
673059B	4	810	1486.50	4.64	2.13	1.15	1.77	9.89	1498.39	0.6600	100.	0.	0.	0.	0.	46.22.12.18.				
673059F	4	900	607.56	3.60	1.74	0.76	1.14	6.71	614.30	1.0922	100.	0.	0.	0.	0.	44.27.12.17.				
673059H	4	990	756.66	9.52	3.57	1.89	1.55	16.53	773.39	2.1373	99.	1.	0.	0.	0.	58.22.11. 9.				
673059K	4	1080	1196.37	9.48	2.65	0.68	1.44	14.25	1212.62	1.1751	99.	1.	0.	0.	0.	66.19. 5.10.				
673059N	4	1170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	*B*
673059Q	4	1260	1014.41	8.85	3.67	0.68	0.88	14.08	1028.49	1.3690	99.	1.	0.	0.	0.	63.26.	5. 6.			
673059T	4	1350	1509.52	24.60	5.20	1.17	2.41	32.84	1542.36	2.1292	98.	2.	0.	0.	0.	73.16.	4. 7.			
673059C	4	1440	467.78	7.80	7.92	4.93	10.62	31.27	499.05	6.2658	93.	2.	2.	1.	2.	25.25.16.34.				
673059E	4	1530	756.86	16.56	19.60	10.20	20.53	66.29	823.15	8.0532	93.	2.	2.	1.	2.	25.29.15.31.				
673059G	4	1620	1042.79	25.35	32.91	17.48	34.96	110.70	1153.49	9.5969	90.	2.	3.	2.	3.	23.30.16.31.				
673059J	4	1650	1744.96	65.40	73.40	24.66	47.97	211.63	1956.62	10.8161	90.	3.	4.	1.	2.	31.34.12.23.				
673059L	4	1710	775.79	76.60	36.43	11.65	23.01	141.89	917.68	15.4618	85.	8.	3.	1.	3.	55.21. 8.16.				
673059N	4	1770	735.64	14.55	14.90	7.09	8.41	44.95	780.79	5.7569	94.	2.	2.	1.	1.	32.33.16.19.				
673059P	4	1830	777.69	19.05	19.25	4.47	8.30	51.07	828.96	6.1607	94.	2.	2.	1.	1.	37.38. 9.16.				
673059R	4	1890	1049.10	21.63	16.77	2.75	5.06	46.21	1095.31	4.2189	96.	2.	2.	0.	0.	47.36. 6.11.				
673059T	4	1950	633.67	10.53	12.73	3.11	6.33	32.70	666.57	4.9056	95.	2.	2.	0.	1.	32.39.10.19.				
673059B	4	2010	1040.69	25.80	18.26	4.64	7.54	56.24	1096.93	5.1270	95.	2.	2.	0.	1.	47.32. 8.13.				
673059D	4	2070	863.61	111.60	737.25	226.26	332.05	1406.56	2289.57	61.4333	38.	5.32.10.15.				8.52.16.24.				
673059F	4	2130	744.25	55.80	712.41	275.37	501.26	1544.84	2289.09	67.4871	33.	2.31.12.22.				4.46.18.32.				
673059H	4	2190	959.74	456.00	2595.26	1466.98	3058.56	7576.81	8536.55	88.7573	11.	5.30.17.37.				6.34.19.41.				
673059J	4	2250	1040.64	1436.06	6743.68	3865.00	8354.40	22421.16	23461.80	95.5643	4.	6.37.17.36.				6.40.17.37.				
673059L	4	2310	996.64	1593.60	7352.64	2645.53	5777.28	17369.04	18367.68	94.5630	5.	9.41.14.31.				9.43.15.33.				
673059N	4	2370	851.47	341.60	2635.03	1255.63	2848.99	7130.64	7982.32	89.3330	11.	5.33.16.35.				5.37.16.40.				
673059P	4	2430	693.74	108.96	1652.35	1013.21	2299.56	5075.09	5768.89	87.9735	12.	2.29.18.39.				2.33.20.45.				
673059R	4	2490	1014.41	302.40	1589.76	576.09	1302.72	3772.97	4787.38	78.8107	21.	6.34.12.27.				8.42.15.35.				
673059T	4	2550	810.47	116.40	924.05	490.44	1114.39	2639.28	3449.75	76.5064	23.	3.27.14.33.				4.35.19.42.				
673079A	4	2580	807.32	416.64	2364.64	845.38	1869.12	5515.77	6323.09	87.2322	13.	7.37.13.36.				8.43.15.34.				
673079B	4	2610	683.28	297.60	2106.43	795.65	1781.33	4981.01	5664.29	87.9370	12.	5.36.14.31.				6.42.16.36.				
673079C	4	2640	725.33	230.40	1734.82	723.54	1585.92	4274.68	5000.01	85.4934	15.	5.34.14.32.				5.41.17.37.				
673079D	4	2660	798.91	40.80	382.54	261.07	659.86	1344.27	2143.18	62.7231	37.	2.16.12.31.				3.26.19.50.				
673079F	4	2690	988.13	81.60	444.64	206.13	486.52	1219.89	2208.02	55.2461	45.	4.20. 9.22.				7.36.17.40.				
673079H	4	2720	991.28	14.10	122.96	105.67	247.81	490.53	1481.81	33.1034	67.	1. 8. 7.17.				3.25.22.50.				
673079G	4	2750	819.94	14.91	60.82	44.66	106.20	232.61	1052.55	22.0996	79.	1. 6. 4.10.				6.29.19.46.				
673079H	4	2780	720.07	59.70	645.84	372.96	800.04	1878.54	2598.61	72.2902	28.	2.25.14.31.				3.34.20.43.				
673071	4	2810	801.61	27.00	54.46	53.67	118.59	253.12	1054.13	24.0122	76.	3. 5. 5.11.				11.22.21.46.				
673073	4	2840	828.34	18.63	215.86	285.31	677.56	1197.36	2025.70	59.1064	41.	1.11.14.33.				2.16.24.56.				
673075K	4	2870	989.18	45.16	312.98	200.47	412.06	970.69	1959.87	49.5283	51.	2.16.10.21.				5.32.21.42.				
673077L	4	2900	977.62	25.44	122.96	107.23	230.61	486.44	1464.06	33.2254	67.	2. 8. 7.16.				5.25.22.48.				
673079M	4	2930	1204.67	132.00	558.42	355.56	686.76	1730.74	2935.41	58.9607	42.	4.19.12.23.				8.32.21.39.				
673079N	4	2960	948.64	79.80	307.02	340.02	700.92	1427.76	2426.40	58.8427	41.	3.13.14.29.				6.22.24.48.				
673079Q	4	2990	1456.66	278.40	193.75	441.34	849.66	1763.09	3213.75	54.8608	45.	9. 6.14.26.				16.11.25.48.				
673079P	4	3020	1524.24	394.64	935.98	498.52	881.55	2783.89	4308.13	64.6194	35.	9.22.12.22.				14.14.18.34.				
673079G	4	3050	895.62	134.40	559.40	687.49	906.24	2287.53	3183.15	71.8637	28.	4.18.22.28.				6.24.30.40.				
673079K	4	3080	1261.48	166.20	574.27	340.99	704.46	1673.92	3135.36	53.7673	42.	6.18.12.22.				11.31.21.37.				
673079S	4	3110	1356.05	302.40	1275.76	845.10	1648.29	4121.56	5477.55	75.2435	25.	6.23.16.30.				7.31.22.40.				
673071	4	3140	1555.78	366.84	1867.47	1745.45	3460.70	7430.75	8986.54	82.6876	17.	4.21.19.39.				5.25.23.47.				
673066A	4	3170	4583.23	12479.99	24243.82	5532.24	13862.61	56118.65	60701.88	92.4496	8.	21.39. 9.23.				22.43.10.25.				
673066B	4	3200	18085.62	16761.58	30086.19	6191.13	16142.38	69181.25	87261.86	79.2800	21.	19.35. 7.18.				24.44. 9.23.				
673066C	4	3230	6509.62	13478.38	20666.88	4475.52	10336.66	48957.55	55458.17	86.2783	12.	24.37. 8.19.				26.42. 9.21.				
673066D	4	3260	10932.47	16511.98	15847.56	2469.51	5579.04	40478.10	51410.57	78.7350	21.	32.31. 5.11.				41.39. 6.14.				
673066E	4	3290	4325.68	4329.60	4262.54	933.95	2131.08	11657.10	15982.64	72.9355	27.	27.27. 6.13.				37.37. 8.18.				
673066F	4	3320	2606.57	2056.80	2931.12	746.25	1033.71	7369.87	10276.44	71.7162	28.	20.29. 7.16.				28.40.10.22.				
673066G	4	3350	4215.08	4272.00	5643.64	1345.76	3044.40	14305.79	18515.84	77.2625	23.	23.31. 7.16.				30.40. 9.21.				
673066H	4	3380	5340.00	6624.00	7352.64	1297.59	3139.98	18414.20	23754.29	77.5195	22.	28.32. 5.13.				36.40. 7.17.				
673061	4	3410	2253.81	2976.00	4051.02	1235.43	3327.66	13590.04	15823.64	85.8633	14.	19.38. 8.21.				22.45. 9.24.				
673066J	4	3440	3321.79	3964.00	6100.43	1120.43	2548.85	13813.54	17135.33	80.6143	19.	23.36. 7.15.				29.45. 8.18.				
673066K	4	3470	512.46	478.80	757.62	149.57	364.09	1770.08	2282.54	77.5487	22.	21.33. 7.17.				27.43. 8.22.				
673066L	4	3500	1706.20	2376.00	4237.76	472.42	2403.66	9469.77	11197.97	84.7454	15.	21.39. 4.21.				25.45. 5.25.				

B = CUTTINGS NOT ANALYZED *C* = AIR SPACE GAS NOT RUN *BC* = NO ANALYSES RUN

TABLE 1C

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)										NOTES
			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 C_2-C_4	C_1	C_2	C_3	iC_4	nC_4	WET GAS C_2	C_3	iC_4	nC_4	
67303A	4	110	687.54	16.77	4.76	2.10	6.17	23.80	710.14	3.3514	96.	2.	1.	0.	1.	45.	20.	9.	26.	
67303E	4	270	656.49	8.08	2.01	1.05	2.43	14.57	671.06	2.1711	99.	1.	0.	0.	0.	55.	21.	7.	17.	
67303G	4	340	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	*B*
67303J	4	430	14677.52	90.19	21.59	4.96	7.52	124.25	14801.77	0.8394	99.	1.	0.	0.	0.	73.	17.	4.	6.	
67303K	4	540	2743.63	11.77	4.84	1.19	3.04	20.84	2764.47	0.7538	100.	0.	0.	0.	0.	56.	23.	6.	15.	
67303P	4	630	7197.66	13.21	12.67	4.67	8.71	40.45	7238.11	0.5589	100.	0.	0.	0.	0.	33.	33.	12.	22.	
67303S	4	720	5605.55	34.43	5.90	2.27	2.93	46.02	5654.56	0.8136	99.	1.	0.	0.	0.	76.	13.	5.	6.	
67304F	4	810	16415.53	47.82	12.22	5.06	6.23	71.14	16486.67	0.4315	100.	0.	0.	0.	0.	67.	17.	7.	9.	
67304E	4	900	1609.72	6.66	2.45	1.01	1.67	13.01	1622.74	0.6017	100.	0.	0.	0.	0.	51.	27.	8.	14.	
67304H	4	990	2021.65	17.02	6.05	2.23	2.62	27.92	2049.77	1.3621	99.	1.	0.	0.	0.	61.	22.	6.	9.	
67304K	4	1080	3232.64	21.45	4.54	1.14	1.97	28.10	3260.75	0.8617	99.	1.	0.	0.	0.	73.	16.	4.	7.	
67304N	4	1170	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.	0.	0.	0.	0.	0.	0.	0.	0.	*B*
67304Q	4	1260	16039.54	23.19	16.64	4.25	4.08	50.15	16089.69	0.3117	100.	0.	0.	0.	0.	47.	37.	6.	6.	
67304T	4	1350	13302.57	82.58	15.35	3.71	4.79	106.43	13408.99	0.7937	99.	1.	0.	0.	0.	78.	14.	3.	5.	
67305C	4	1440	487.40	9.69	9.41	5.55	11.71	36.36	523.76	6.9420	93.	2.	2.	1.	2.	27.	26.	15.	32.	
67305E	4	1550	6609.94	124.08	53.97	19.11	33.16	230.31	6840.25	3.3670	97.	2.	1.	0.	0.	55.	23.	8.	14.	
67305G	4	1560	6040.49	122.23	66.68	27.16	48.92	266.98	6307.47	4.2328	96.	2.	1.	0.	1.	46.	26.	10.	18.	
67305J	4	1650	16823.39	314.62	143.35	39.73	65.32	563.02	17386.41	3.2383	97.	2.	1.	0.	0.	56.	25.	7.	12.	
67305L	4	1710	7447.40	241.15	83.55	23.72	41.70	390.12	7837.52	4.9776	95.	3.	1.	0.	1.	62.	21.	6.	11.	
67305N	4	1770	1131.97	39.67	32.43	15.79	15.14	103.23	1235.20	8.3573	92.	3.	3.	1.	1.	39.	31.	15.	15.	
67305P	4	1830	3384.86	115.82	50.57	10.23	16.26	192.88	3577.74	5.3911	96.	3.	1.	0.	0.	61.	26.	5.	8.	
67305R	4	1890	2200.28	87.34	34.94	4.98	7.66	134.92	2335.20	5.7776	95.	4.	1.	0.	0.	64.	26.	4.	6.	
67305T	4	1950	1061.86	53.09	31.65	5.99	10.83	101.56	1163.42	8.7294	90.	5.	3.	1.	1.	52.	31.	6.	11.	
67306B	4	2010	2955.55	94.09	39.03	8.17	12.03	153.32	3108.87	4.9317	96.	3.	1.	0.	0.	62.	25.	5.	6.	
67306D	4	2070	2653.34	403.92	1093.93	253.20	386.51	2137.56	4790.90	44.6171	56.	8.	23.	5.	6.	19.	51.	12.	18.	
67306F	4	2130	1237.05	220.04	1025.66	335.29	579.71	2166.10	3403.15	63.6498	36.	7.	30.	10.	17.	10.	46.	15.	27.	
67306H	4	2190	2553.85	1807.68	6420.88	3131.47	5324.10	16684.17	19237.03	86.7295	13.	9.	33.	16.	28.	11.	38.	19.	32.	
67306J	4	2250	1131.27	1450.48	6774.15	3945.59	8411.04	22581.25	23712.53	95.2292	5.	6.	37.	17.	35.	6.	40.	17.	37.	
67306L	4	2310	2633.46	3980.54	11466.52	3734.57	7388.12	26509.75	29143.21	90.9637	4.	14.	39.	13.	25.	15.	43.	14.	28.	
67306N	4	2370	1019.66	648.48	3266.49	1439.24	2110.41	8466.61	9486.27	89.2512	11.	7.	34.	15.	33.	8.	38.	17.	37.	
67306P	4	2430	1059.96	404.85	3138.45	1546.61	3112.68	8204.56	9264.54	88.5589	11.	4.	34.	17.	34.	5.	36.	19.	38.	
67306R	4	2490	1106.51	466.80	1987.20	679.26	1449.96	4585.18	5690.69	80.5733	19.	8.	35.	12.	25.	10.	43.	15.	32.	
67306T	4	2550	3034.97	1984.32	6063.32	2132.01	3459.29	13478.94	16512.91	81.6267	18.	12.	36.	12.	21.	15.	44.	15.	26.	
67307A	4	2580	1385.17	1090.17	3740.70	1172.54	2335.27	8344.72	9723.89	85.8167	14.	11.	38.	12.	24.	13.	45.	14.	28.	
67307B	4	2600	1049.24	888.73	3503.49	1138.02	2282.51	7812.75	8862.99	88.1502	12.	10.	40.	13.	26.	11.	45.	15.	29.	
67307C	4	2630	1114.44	760.66	3079.68	1046.27	2070.51	6958.54	8072.98	86.1954	14.	9.	38.	13.	26.	11.	44.	15.	30.	
67307D	4	2660	1187.56	899.68	1244.76	493.93	1022.43	3660.80	4848.36	75.5060	24.	19.	26.	10.	21.	25.	34.	13.	28.	
67307E	4	2690	1114.94	159.62	664.14	252.25	500.71	1576.72	2693.66	58.6087	41.	6.	23.	9.	21.	10.	38.	16.	36.	
67307F	4	2720	1053.02	52.93	465.07	170.12	360.61	1074.73	2126.75	50.5339	49.	2.	23.	8.	17.	5.	45.	16.	34.	
67307G	4	2750	871.29	34.98	151.13	75.50	131.30	392.91	1264.20	31.0797	69.	3.	12.	6.	10.	9.	39.	19.	33.	
67307H	4	2780	778.77	136.08	918.02	445.77	854.72	2354.59	3132.38	75.1698	25.	4.	29.	14.	27.	6.	39.	19.	36.	
67307I	4	2810	822.11	39.55	113.17	86.62	183.28	424.62	1246.73	34.0587	66.	3.	9.	7.	15.	9.	27.	21.	43.	
67307J	4	2840	923.37	140.45	835.20	589.01	1223.37	2794.03	3717.40	75.1608	25.	4.	22.	16.	33.	5.	30.	21.	44.	
67307K	4	2870	1031.22	82.03	474.87	276.40	556.62	1389.92	2421.14	57.4076	43.	3.	20.	11.	23.	6.	34.	20.	40.	
67307L	4	2900	1004.19	30.58	133.78	109.85	234.82	509.03	1513.22	33.6388	66.	2.	9.	7.	16.	6.	26.	22.	46.	
67307M	4	2920	1236.45	150.66	614.98	377.90	727.33	1870.87	3107.32	60.2065	40.	5.	20.	12.	23.	8.	33.	20.	39.	
67307N	4	2960	2031.22	506.47	1472.64	1008.95	1942.60	4931.05	6961.26	70.6355	29.	7.	21.	14.	28.	10.	30.	20.	40.	
67307O	4	2990	1478.73	294.61	212.89	455.75	861.92	1825.17	3303.90	55.2429	45.	9.	6.	14.	26.	16.	12.	25.	47.	
67307P	4	3020	3181.24	1025.02	2004.48	916.45	1639.62	5648.16	8829.41	63.9699	36.	12.	23.	10.	19.	18.	37.	16.	29.	
67307Q	4	3050	914.35	147.60	564.47	718.62	1028.00	2458.69	3372.04	72.9140	27.	4.	17.	21.	30.	6.	24.	29.	41.	
67307R	4	3080	1399.05	251.04	807.25	436.22	783.24	2077.74	3476.84	59.7608	40.	7.	17.	13.	23.	12.	29.	21.	38.	
67307S	4	3110	1409.46	332.27	1349.97	439.58	1749.54	4371.36	5779.82	75.6314	24.	6.	23.	16.	30.	8.	31.	21.	40.	
67307T	4	3140	1562.67	359.28	1872.29	1750.61	3464.74	7446.91	9008.58	82.6646	17.	4.	21.	19.	38.	5.	25.	24.	46.	
67308A	4	3170	5780.95	14132.35	26662.16	6135.00	14914.74	61844.26	67625.19	91.4515	9.	21.	39.	9.	22.	23.	43.	10.	24.	
67308B	4	3200	39486.84	24851.18	36830.62	7264.05	18140.23	87086.00	126572.88	68.8030	31.	20.	29.	6.	14.	29.	42.	8.	21.	
67308C	4	3230	8826.22	16069.04	23209.35	5000.43	11196.89	55474.70	64300.93	86.2735	14.	25.	36.	8.	17.	29.	42.	9.	20.	
67308D	4	3260	17661.14	20140.77	17855.62	2747.27	5970.80	46714.46	64374.60	72.5666	27.	31.	28.	4.	9.	43.	38.	6.	13.	
67308E	4	3290	127921.19	49711.38	34311.40	8572.09	13072.89	105667.56	233588.81	45.2366	54.	21.	15.	4.	6.	48.	32.	8.	12.	
67308F	4	3320	3162.41	2210.98	3600.44	792.28	1078.76	7742.45	10903.86	71.0065	29.	20.	28.	7.	15.	29.	39.	10.	22.	
67308G	4	3350	9747.43	7580.31	8415.52	1936.67	4119.11	22053.60	31801.04	69.3487	31.	24.	26.	6.	13.	34.	38.	9.	19.	
67308H	4	3380	8162.35	8564.06	6581.52	1466.66	3453.98	22065.61	30227.96	72.9973	27.	28.	28.	5.	12.	39.	38.	7.	16.	
67308I	4	3410	6110.84	6048.00	8688.01	1695.73	4172.64	20584.56	26695.41	77.1090	23.	23.	32.	6.	16.	29.	43.	8.	20.	
67308J	4	3440	12163.86	12410.65	13760.93	2563.96	5008.59	33749.52	45913.40	73.5069	26.	27.	30.	6.	11.	37.	40.	8.	15.	
67308K	4	3470	516.19	485.71	765.57	151.03	366.64	1769.15	2305.34	77.6089	22.	21.	33.	7.	17.	27.	43.	8.	22.	
67308L	4	3500	5302.30	6051.66	7140.90	964.96	2306.53	17463.43	22763.73	76.7160	23.	27.	31.	4.	15.	35.	40.	6.	19.	

B = CUTTINGS NOT ANALYZED   *C* = AIR SPACE GAS NOT RUN   *BC* = NO ANALYSES RUN

Table 2 Description of "Picked" Cuttings and Visual Kerogen Characteristics
(Kerogen by J.L. Morgan)

Depth (meters)	EPR No.	Gross Lithology	GSA Color Code (dry)	TOCC Total Organic Matter (%)	LOMT Kerogen Alteration	OMT (Types of Kerogen (% of Total on Slide) Algal	Amorphous	Herbaceous	Woody	Coaly	Other*
1170	67304-N	Med. olive gray silty shale and lt. olive gray siltstone, sl. calc.	5Y5/1-6/1	2.25	1	30	-	10	40	tr	10M
1350	67304-T	Shale, med. olive gray, silty, trace of mica.	5Y 5/1	3.39	1+	20	-	10	50	tr	20N
1500	67305-E	Shale, brownish gray, silty	5YR4/1	3.68	1+	10	-	30	50	tr	10N
1650	67305-J	Claystone, olive gray, sl. silty.	5Y4/1	4.47	1+	20	-	10	30	tr	30N
1830	67305-P	Shale, med. gray to greenish gray.	N5-5GY6/1	.35	1+	-	-	60	20	20	-
1950	67305-T	Shale, olive gray to greenish gray trace pyrite.	5Y4/1-5GY6/1	.47	1+	-	-	40	30	20	trA1?
2070	67306-D	Shale, med. greenish gray.	5GY5/1	.72	1+	-	-	40	20	10	30A1?
2190	67306-H	Shale, as above, plus traces of chalk and pyrite	5GY5/1	.25	1+	-	-	40	30	10	20A1?
2310	67306-L	Shale, med. gray to med. dk. gray, finely disseminated pyrite.	N5-N4	1.39	1+	30	-	50	20	tr	-
2430	67306-P	Shale, med. dk. gray, trace fine gr. white calc. sandstone.	N4	1.07	1+	20	-	40	20	20	-
2550	67306-T	Shale, med. dk. gray to med. gry, large thin prisms.	N4-N5	1.89	1+	30	-	40	20	10	-
2630	67307-C	Shale, as above, large flakes	N4-N5	1.57	1+	-	-	50	20	10	20 A1?
2690	67307-E	Shale, as above, some finely micaceous, sl. calc.	N4-N5	.86	2-	-	-	30	30	30	10A1?
2780	67307-H	Chalk, pinkish white	5YR9/1	.07	2+	-	-	-	60	30	trA1?

Table 2 Continued -------

Depth (meters)	EPR No.	Gross Lithology	GSA Color Code (dry)	Total Organic Matter (%)	Kerogen Alteration	Types of Kerogen (% of Total on Slide) Algal	Amorphous	Herbaceous	Woody	Coaly	Other*
2840	67307-J	Shale, med. dk. gray to med. gray-large, very thin flakes mod. calc. or dol.	N4-N5	.30	1+	-	-	40	30	20	trAl?
2900	67307-L	Shale, as above, dol. and calc.	N4-N5	.24	2+	-	-	-	40	50	trM
2990	67307-O	Shale, as above, plus limestone, chalk	N4-N5	.13	3-	-	-	-	50	50	-
3080	67307-R	Mixture of calc. shale, limestone, chalk; med. gray to lt. gray; chips sand-sized	N5-N7	.14	3-	-	-	-	50	50	-
3170	67308-A	Shale, med. gray with lt. gray sandy laminae, calc.; large thin prisms	N5; N7	.27	3-	20	20	tr	20	30	trM
3230	67308-C	Shale, dk, brownish gray, thin flakes, looks rich	5YR 3/1	3.74	1+	30	20	10	20	20	-
3260	67308-D	Shale, dk. gray to dk. olive gray, thin flakes	N3-5Y3/1	4.14	1+	30	-	10	30	30	-
3350	67308-G	Shale, med. gray, calc.	N5	.24	3-	-	-	-	50	50	trM
3440	67308-J	Mixture of lt. olive gray sandstone, med. dk. gry shale, and grayish brown shale, trace pyrite	N4,5YR7/4	1.08	1+	20	20	10	20	30	-
3500	67308-L	As above, variety of shales	-	.88	1+	20	20	10	20	30	-

* M- Microplankton
Al? - Possibly Algal
N - Nonfilamentous Algal

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

(Analyses by H.M. Fry)

Depth (meters)	EPR No.	Organic Carbon (%)	(C_4-C_7) Hydrocarbons (ppm)	Correlation Ratios C_1/C_2	A/D_2	C_1D_2	CH/MCP
1170	67304-N	1.84	0.9	1.41	6.84	13.5	.96
1350	67304-T	2.78	0.0	-	-	-	-
1500	67305-E	3.02	0.4	.85	6.93	8.79	.55
1650	67305-J	3.66	0.0	-	-	-	-
1830	67305-P	.29	0.0	-	-	-	-
1950	67305-T	.39	0.0	-	-	-	-
2070	67306-D	.59	0.2	1.09	3.06	3.01	.64
2190	67306-H	.20	11.2	3.03	6.85	11.8	1.98
2310	67306-L	1.14	33.6	2.86	10.8	47.0	1.91
2430	67306-P	.88	33.3	3.26	11.0	53.2	2.03
2550	67306-T	1.55	50.6	1.93	4.62	16.1	1.30
2630	67307-C	1.28	27.5	.95	.95	2.92	1.31
2690	67307-E	.71	24.8	2.25	5.26	10.8	1.47
2780	67307-H	.06	.7	2.84	3.82	9.27	1.73
2840	67307-J	.25	5.1	4.29	10.2	18.6	2.06
2900	67307-L	.20	1.2	3.70	5.58	10.2	1.60
2990	67307-O	.11	1.6	3.03	10.1	7.74	1.59
3080	67307-R	.11	.9	5.42	4.81	4.08	1.40
3170	67308-A	.22	7.4	1.82	3.97	5.72	.95
3230	67308-C	3.07	228.	1.44	18.0	9.18	.09
3260	67308-D	3.39	125.	1.89	9.63	21.3	1.46
3350	67308-G	.20	11.8	2.24	8.12	14.7	1.34
3440	67308-J	.88	12.2	2.21	8.67	14.8	1.35
3500	67308-L	.72	11.6	2.02	8.68	13.5	1.23

Table 4 Heavy (C_{15}+) Soluble Organic Matter

(Analysis by GeoChem)

Depth (meters)	2190	2310	2630	3170	3230
EPR No.	67306-H	67306-L	67307-C	67308-A	67308-C
Total Organic Matter (%)	.82	1.00	.78	.56	3.82
Soluble Organic Matter (ppm)	245	489	405	1286	2045
Composition of Soluble OM (%)					
Saturates*	6.7	5.5	--**	29.3	15.5
Aromatics	7.7	2.6	-	21.2	29.5
NSO's	27.4	8.2	-	18.3	22.4
Noneluted NSO's	32.2	33.7	-	12.4	3.2
Asphaltenes	26.0	50.0	71.5	18.8	29.4
Hydrocarbons					
ppm of rock	35	40	probably <40	649	920
% of T.O.M.	.43	.40	probably < .5	11.6	2.41
Sats./Arom.	.9	2.1	---	1.4	.5
Source Interpretation	Marginal Gas Source	Fair Gas Source	Marginal Gas Source	Stain (Migrated Oil	Rich Oil Source

* Gas chromatograms in Figs. 2 thru 6.

** Pentane - soluble fraction too small for further analysis.

Lithologies of C_{15}+ samples (all were mixtures)

67306-H Med. greenish gray to dark greenish gray shale (5GY5/1-4/1) plus minor "red" beds (5YR4/1)

67306-L Greenish gray to med. greenish gray shales (5G6/1-5/1) plus med. lt. gray shale (N6) and brownish gray (5YR4/1) "red beds" as above.

67307-C Med. gray to med. dk. gray shales (N5-N4) and med. greenish gray shale(5G5/1)

67308-A Calc. and dol. shales; lt. gray (N7), med. gray (N5) to med. dk. gray; plus red beds (10R4/2 and 5R4/2)

67308-C Shale, dk. gray (N3) to brownish gray (5YR4/1), looks "rich"

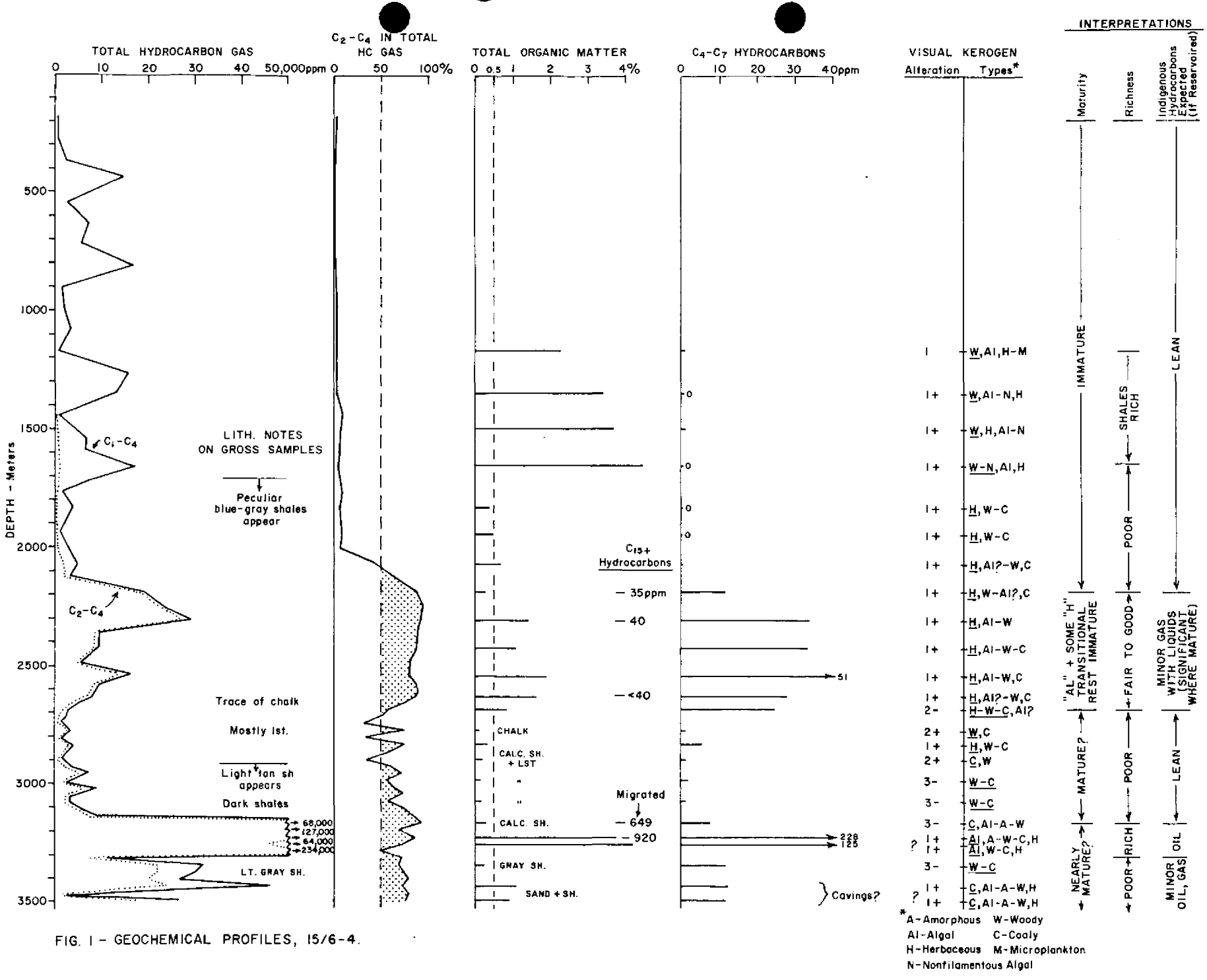

FIG. 1 - GEOCHEMICAL PROFILES, 15/6-4.

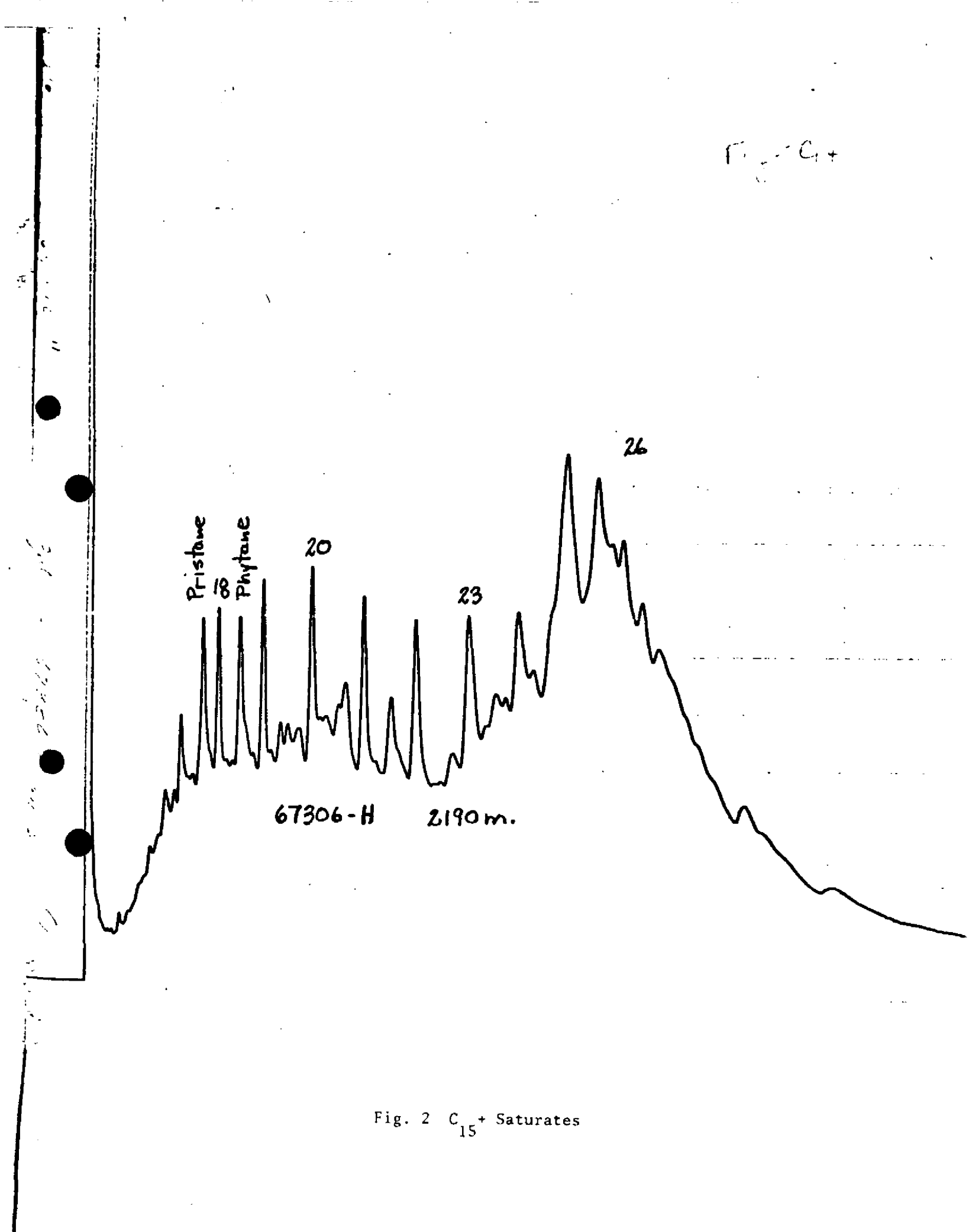

Fig. 2 C_{15}+ Saturates

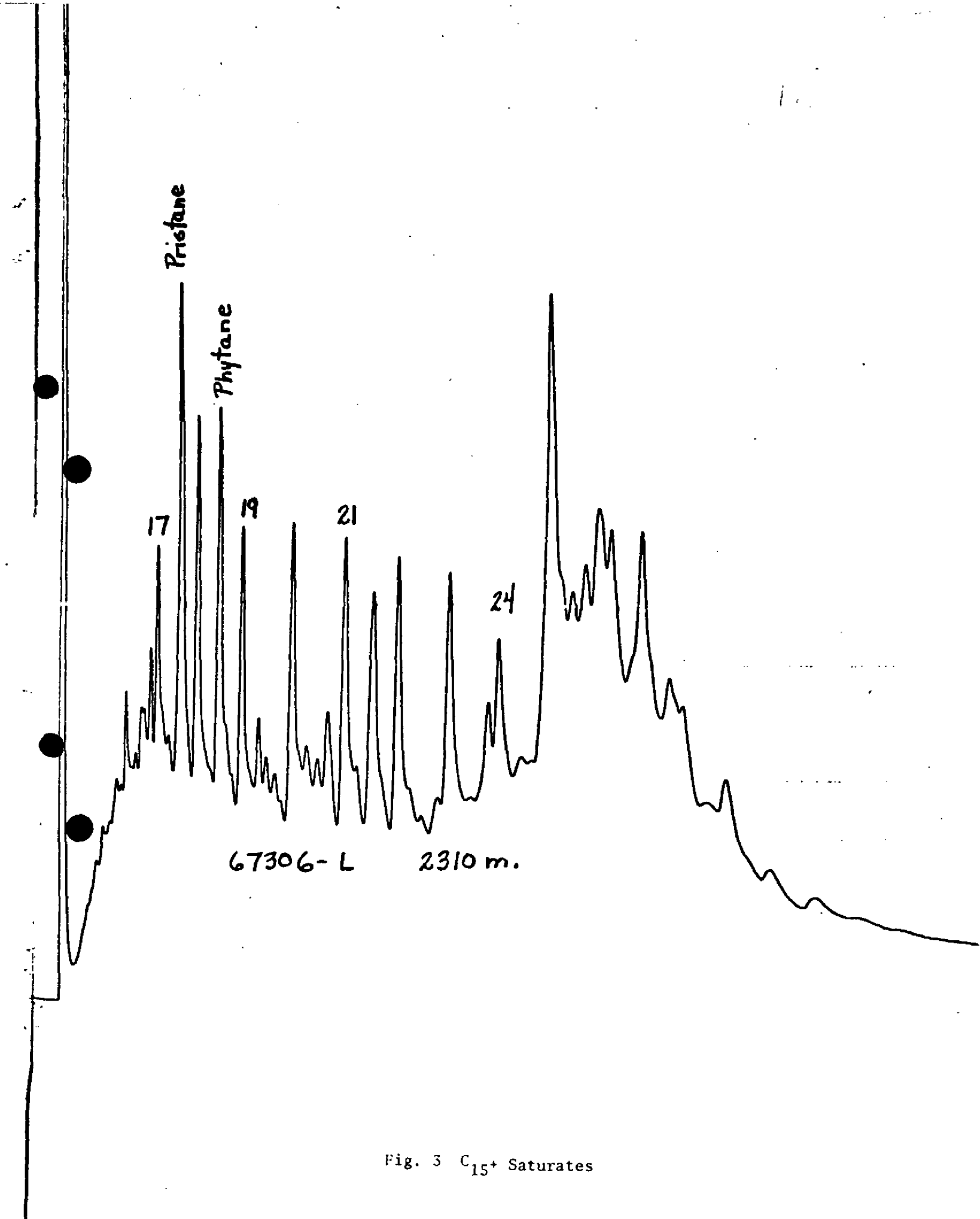

Fig. 3 C_{15+} Saturates

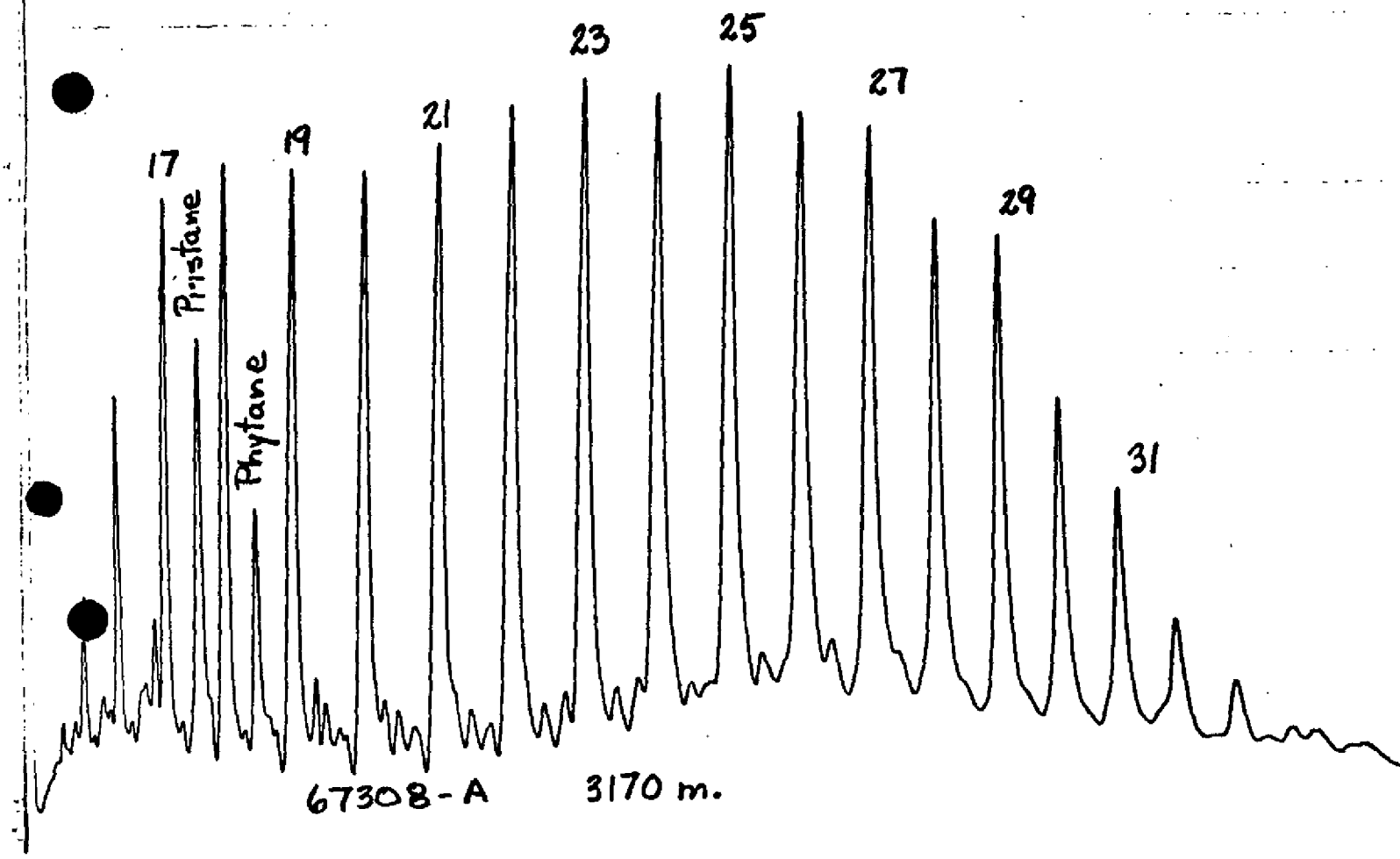

Fig. 4 C_{15}^{+} Saturates

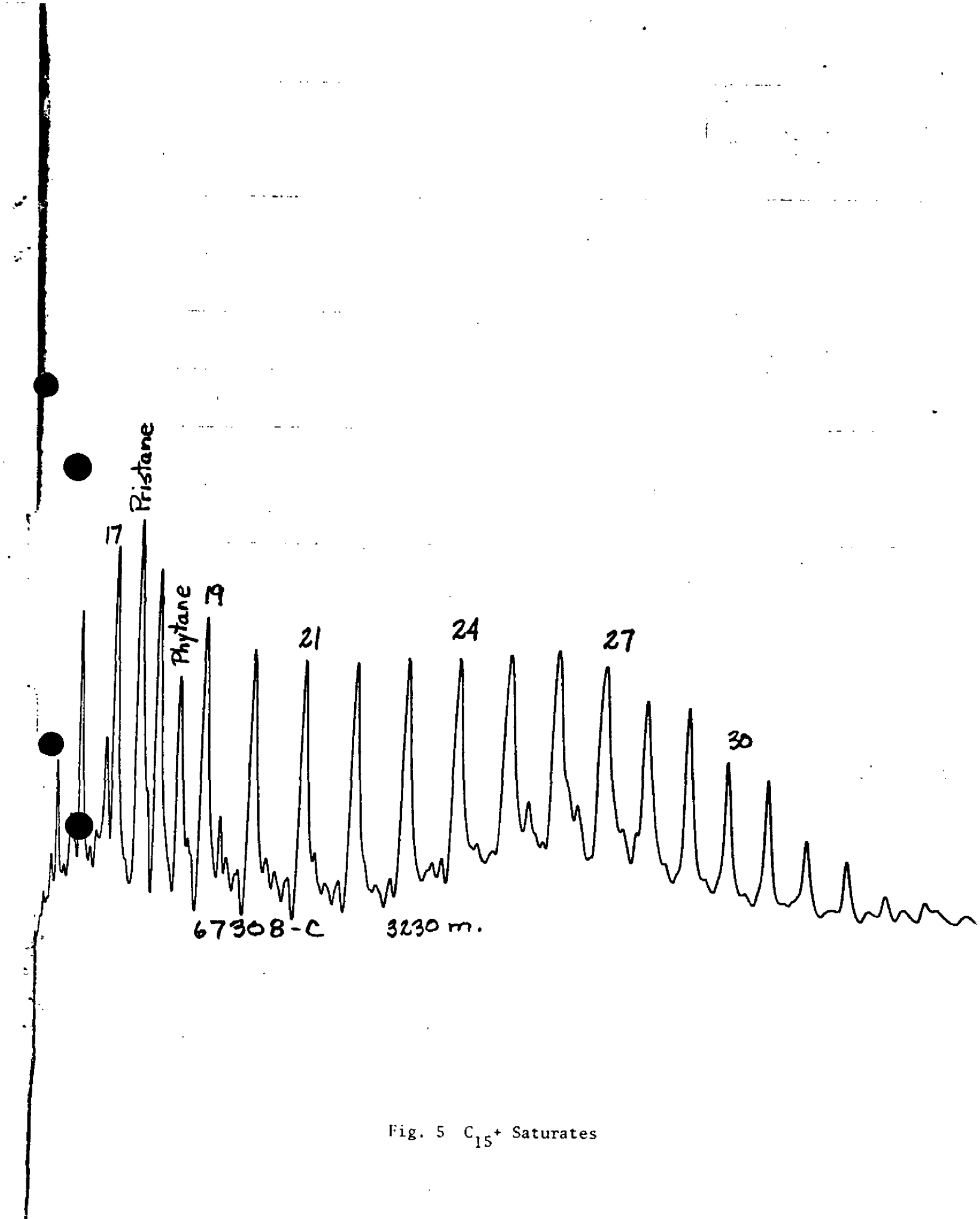

Fig. 5 C_{15}^{+} Saturates

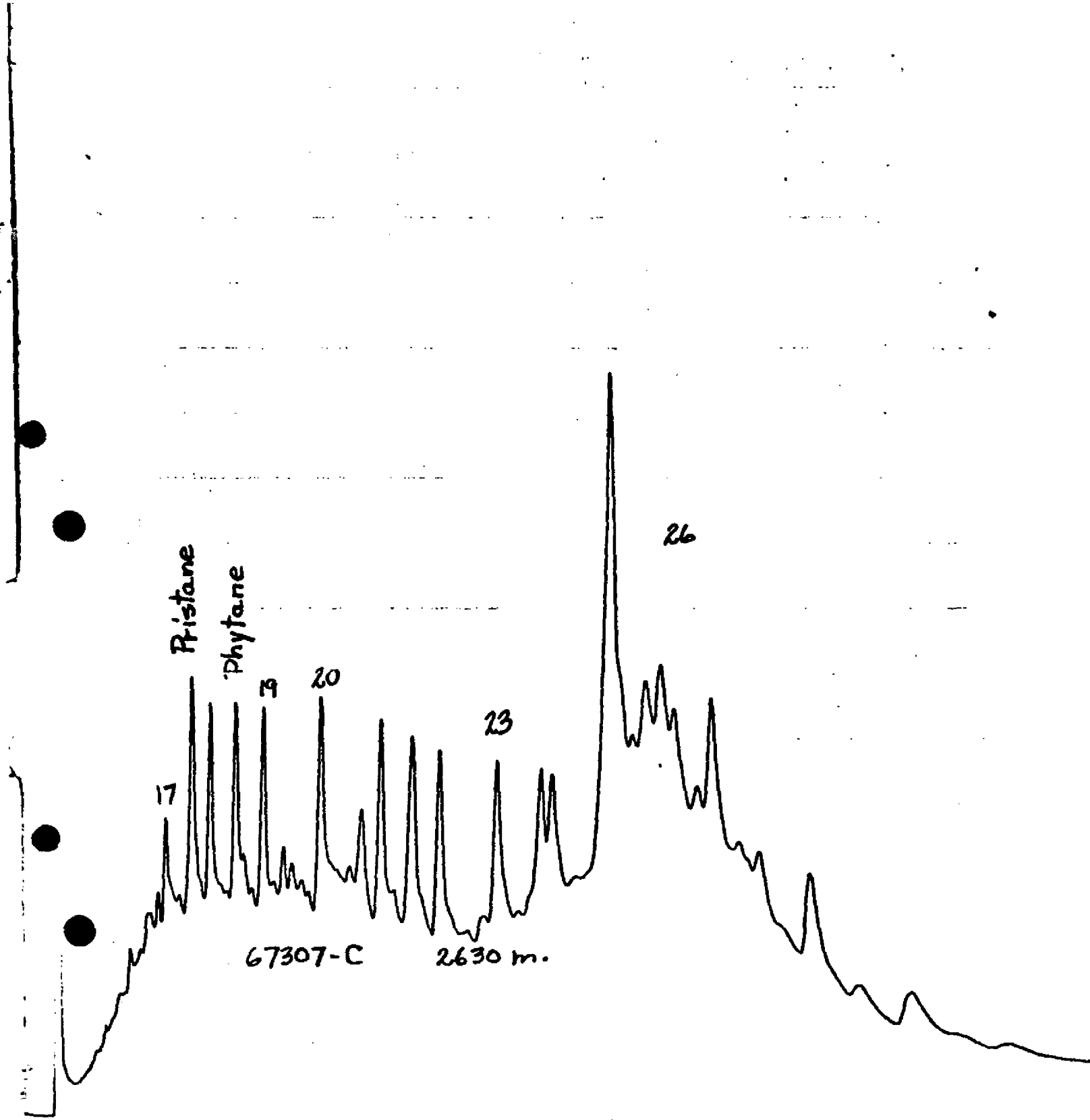

Fig. 6 C_{15}^{+} Saturates