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GEOCHEMICAL ANALYSIS OF POTASH MINE SEEP OILS, COLLAPSED BRECCIA PIPE OIL SHOWS AND SELECTED CRUDE OILS, EDDY COUNTY, NEW MEXICO

by

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and

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ABSTRACT

Oil shows, in the form of oil stains and bleeding oil, in core samples from two breccia pipes, Hills A and C, Eddy County, New Mexico, and seepage oils in a potash mine near Hill C breccia pipe are geochemically similar. The geochemical similarities strongly suggest that they belong to the same family of oils and were derived from similar sources.

The oils are relatively high in sulfur (0.89 to 1.23 percent), rich in hydrocarbons (average 82 percent), relatively high in saturated hydrocarbon/aromatic hydrocarbon ratios (average 2.9), and based on analysis of seep oils alone, have a low API gravity (average 19.4°). The oils are for the most part severely biodegraded as attested by the loss of n-paraffin molecules.

Geochemical comparison of seven crude oils collected in the vicinity of the breccia pipes indicates that the Yates oils are the likely source of the above family of oils. Six barrels of crude oil that were dumped into a potash exploration borehole near Hill C breccia pipe, to release stuck casing, are considered an unlikely source of the breccia pipe and mine seep oils. Volumetric and hydrodynamic constraints make it highly improbable that such a small volume of "dumped" oil could migrate over distances ranging from about 600 feet to 2.5 miles to the sites of the oil shows.

INTRODUCTION

Numerous geologic, geophysical, and hydrologic studies are being carried out in the Carlsbad area of Eddy County, southeastern New Mexico, by the U.S. Geological Survey on behalf of the Department of Energy. The area is being considered for an underground storage facility for radioactive waste. One of these studies concerns breccia pipes, nearly cylindrical collapsed-type features, filled with fractured rock, silt, sand, and mud. Two of these breccia pipe features (Fig. 1), Hills A and C, about 2.5 miles apart, and about 20 miles northeast of Carlsbad, have been drilled and cored in an attempt to reconstruct the geologic history of their formation. Rocks were found to have been displaced downward in Hill A as much as about 1,100 ft and in Hill C as much as 350 ft.

Traces of oil in the form of oil stains and bleeding oil were observed in core samples retrieved from drill holes WIPP-31 (Hill A breccia pipe) and WIPP-16 (Hill C breccia pipe) at depths of 1,629 and 1,281 ft, respectively. The WIPP-16 core sample is from a displaced block of the Rustler Formation; the other core sample is from a displaced block of either the Rustler or the Salado Formation, both of which are Late Permian in age (Fig. 2). Both of the samples are a few hundred feet below their normal stratigraphic horizons. The breccia pipes occur over the buried Capitan reef just north of the Delaware Basin (Fig. 1).

Substantially greater amounts of oil were also discovered in an active oil seep, about 140 ft east of the boundary of Hill C breccia pipe, along a fault zone in salt and potash deposits of the Salado Formation in the Mississippi Chemical Corporation (MCC) potash mine (Fig. 3). At the time when the oil seep was first encountered in 1975, at least five gallons of oil were recovered. Bleeding and dripping oil along the fault plane has continued to date but at a much reduced rate. The oil seep, at a depth of 1,164 ft beneath the surface, is also located about 600 ft north of a plugged and abandoned potash exploration borehole (U.S. B & C 184; Fig. 3) drilled about 1950. This latter borehole is singled out because about six barrels of crude oil were dumped into the hole to facilitate release of stuck casing. One of the problems that evolved and one that needs to be resolved is whether this "dumped oil" migrated north and northwestward and acted as the source of the mine seep oil and breccia pipe oil shows.

Representative samples of oil-stained breccia pipe cores (Nos. 11, 12) and mine seep oils (Nos. 10, 10A, and MC, Table 1) were collected for geochemical analysis to determine the nature of the oils, their relation to one another, and their possible sources.

In addition, seven crude oil samples (Nos. 1-9, Table 2), (six Permian and one Pennsylvanian in age) were collected from nearby oil fields. They were submitted for analysis to determine, by means of oil-to-oil correlation, their likelihood as a possible source for the breccia pipe and mine seep oils. One drill cuttings sample (No. 218, Table 2), of the Bone Spring Limestone of Early Permian age was also included to determine whether the Bone Spring might be the ultimate source of the breccia pipe and seep oils. Other studies (J. A. Williams, 1977; oral commun., 1981) have shown that the Bone Spring Limestone is the likely source of many of the Permian oils in the Delaware Basin and Northwest Shelf.

ACKNOWLEDGMENTS

We thank James Walls, vice-president and general manager of Mississippi Chemical Corporation, Eddy County, New Mexico, for his generous assistance and cooperation and for allowing us access to the oil source in the mine. We thank C. W. McCroskey, chief chemist of the Corporation, for supplying us with a sample of the oil taken when the oil was first encountered in 1975. Thanks are also due to James Brasfield, USGS, Artesia, N. Mex., who was responsible for collecting crude oil samples from producing wells.

ANALYTICAL PROCEDURES

Deasphaltening and silica gel chromatography were used to characterize the gross chemical composition of the crude and extracted oils. Heptane was initially used to precipitate out the heavy asphaltene fraction. The successive silica-gel column elutants--heptane, benzene, and benzene-methanol (1:1)--gave rise to the saturated hydrocarbon, aromatic hydrocarbon, and resins fractions, respectively. The fraction of "amount lost" is attributed predominantly to lower molecular weight hydrocarbons ($<C_{12}$) lost by evaporation during the removal of the elutant solvents and to a much lesser degree to heavier hydrocarbons retained on the silica gel column. In general, higher "amount lost" values are correlative with higher API gravities and indicate relatively greater amounts of lower molecular weight hydrocarbons in the oils.

Gas chromatographic analysis, a method for characterizing molecular distributions of volatile organic chemical compounds, was limited to only the saturated hydrocarbon fraction. These molecular distributions can be used as "fingerprints" for identifying and correlating crude oils and crude oil/source rock combinations. Analyses were made on a Varian 2800 gas chromatograph using a 1.8 m x 2 mm I.D. glass column packed with 3% SE-30 on 100/120 Mesh Gas Chrom Q. Column temperature was 80°C at injection (injector temperature at 300°C) and was programmed to rise 12°C/min for 10 minutes, then 10°C/min for 10 minutes to a final temperature of 300°C, which was then held for another six minutes.

RESULTS AND DISCUSSION

Mine Seep Oils

Geochemical analyses, including gas chromatography and carbon isotope ratios for the three mine seep oil samples, collected in three different spot locations underground all within 100 ft of each other (Fig. 3) and at different times from the MCC potash mine, are essentially identical, indicating that they were derived from a common source (Table 3, Figs. 4, 5, 6). The oils are heavy (average API gravity, 19.4°, relatively rich in sulfur (average 1.1 percent), rich in total hydrocarbon content (average 88 percent), and moderately high in the ratio of saturated hydrocarbons to aromatic hydrocarbons (sat/arom ratio) (average 2.8). The hydrocarbon richness and relatively high sat/arom ratios strongly suggest that the source of the seep oils was from a mature oil or mature source rock. Immature oils or extracts, on the other hand, would be characterized by a much higher percentage of nonhydrocarbons, i.e., resins and asphaltenes (>50 percent), and by a lower sat/arom ratio (generally <1.0). Leakage or secondary migration from an underlying oil accumulation is considered the most viable explanation for the seep oil, although expulsion and primary migration from an underlying source rock, or migration of "dumped oil" from the nearby potash exploration borehole are alternative hypotheses that must be considered.

Gas chromatographic analysis indicates that the seep oils were subjected to biodegradation (Fig. 4,5). Biodegradation or bacterial alteration is indicated by the absence of normal-paraffin hydrocarbon molecules, which are selectively consumed by bacteria in the presence of oxygenated waters (Winters and Williams, 1969; Milner and others, 1977). If the n-paraffins were present, they would be readily recognized as distinct peaks or spikes distributed in a regularly spaced pattern above the hump that consists of branched and cyclic hydrocarbons (naphthenes). Removal of these n-paraffins is strongly suggested when comparison is made of saturated hydrocarbon distributions of samples 10, 10A, and MC with those of mature-looking crude oil samples from the lower Bell Canyon and older rocks, where regularly spaced n-paraffin peaks are present and apparently very slightly or not at all affected by biodegradation (Figs. 4-7 and 12-16).

Breccia Pipe "Oils"

The chemical composition of the two breccia pipe "oil shows", hereafter simply referred to as "oils", are also, in general, similar to one another (Table 3 and Figs. 4, 8, 9), indicating that they were probably derived from a common source or from similar sources. Some variability in molecular distributions, however, is present, but this is attributed mainly to differing degrees of biodegradation. That biodegradation is a viable cause for the observed differences in the oils is supported by similar hydrocarbon molecular variations attributed to microbiological alterations in other petroliferous areas. As an example, Figure 18 shows dramatic compositional variations in the hydrocarbon distribution patterns of reservoired oil within the Bell Creek field, Powder River Basin, Montana (Winters and Williams, 1969). These variations are attributed to microbiological degradation. Another example of apparent microbiological alteration is illustrated in Figure 19 (Winters and Williams, 1969). Comparison of two oils, believed derived from the same source in an area of North Africa, shows that one of the oils has undergone extensive loss of n-paraffins while the other oil is still intact.

In this study, gas chromatographic analysis clearly shows that the WIPP-16 breccia pipe oil has undergone more intense biodegradation (with all the n-paraffins removed) than the WIPP-31 oil where only partial removal of the n-paraffins has occurred (Figs. 8, 9). This explains, in part, the relatively lower amount of saturated hydrocarbon content in the WIPP-16 oil (46.8 percent) as against the higher amount (65.2 percent) in the WIPP-31 oil (Table 3).

It is interesting to note that the removal of n-paraffins from the WIPP-16 oil not only results in a lower saturated hydrocarbon content but also gives rise to a gross chemical composition that is very similar to that of the Bone Spring rock extract (Table 3), but this apparent correlation is purely fortuitous and not supported by other evidence. The Bone Springs extract has a full complement of n-paraffins. The coincidentally similar gross compositions actually argue against genetic association, because migration effects, due in large part to adsorption-desorption phenomena, especially for long distance vertical migration through varying lithologies, almost invariably show that the composition of crude oil, with respect to a solvent extract of the presumed source rock, is enriched in saturated hydrocarbons and depleted in high molecular weight compounds (resins and asphaltenes) (Tissot and Welte, 1978, p. 290). Conversely, source rock extracts are depleted in saturated hydrocarbons and enriched in resins and asphaltenes. Such is not the case for the WIPP-16 oil and Bone Spring rock extract.

In addition to similarities of molecular distributions, the breccia pipe oils are also similar to the mine seep oils in having a relatively high sulfur content (average 1.1 percent), relatively high total hydrocarbon content (average 74.2 percent), and a moderately high sat/arom ratio (average 3.1).

In summary, comparison of the breccia pipe oils with the mine seep oils in terms of gross chemical parameters (Table 3) and in molecular distributions (Figs. 5-9) strongly suggests that they belong to the same family of oils and hence are derived from similar sources.

Possible Oil Source: Crude Oils

In considering a possible source for the above family of oils, geochemical comparisons were made with seven representative crude oils (Nos. 1-9) collected from nearby oil fields. Assuming that the above oil shows were derived from leakage of underlying oil accumulations, it appears that the most likely source for the above oils is from the oils reservoired in the Yates Formation or from the same source rocks that produced the Yates oils. The Yates oils are stratigraphically the closest to the above family of oils (Figs. 2 and 4), have similar overall chemical composition (Table 3), somewhat comparable gas chromatographic fingerprints (Figs. 4-11), and nearly identical API gravities as the mine seep oils (Table 3). One graphic representation indicating the close relationship of the Yates oils to the oil shows is demonstrated in Figure 20 where the API gravities are plotted against the sat/arom ratios, one of the key bulk chemical parameters. In addition, of the seven crude oils analyzed in this study, the two Yates oils are the only ones that show any appreciable amount of microbiological degradation, again suggesting some genetic affinity to the oil shows. We theorize that prior to oil leakage from the reservoir, the Yates oils had already undergone a certain degree of biodegradation (Figs. 10, 11) probably within the reservoir at the oil-water contact. Subsequent to leakage, the oils were further biodegraded either during migration or at the depositional sites as the oils came in contact with meteoric waters charged with oxygen and bacteria.

It is interesting to point out that the two Yates oils collected from the same stratigraphic unit but from two different localities also show significant differences in compositions that are attributable to differences in microbiological alterations. These differences are comparable to those seen for the two breccia pipe oils determined in this study and for those observed in the Bell Creek oils (Fig. 18) and in the North African oils (Fig. 19) determined in outside studies. The Yates crude oil (No. [illegible] Fig. 10) which shows signs of a greater degree of biodegradation (lesser amounts of n-paraffins) also has a relatively lower amount of saturated hydrocarbons (54.6 percent) when compared to the No. 1 oil (64.2 percent, Fig. 11). These compositional variations might also account for some of the variations observed in the breccia pipe and mine seep oils, assuming, of course, that the Yates oils are indeed the source oils.

<u>Carbon Isotope Analyses</u>

Carbon isotope analyses measure the abundance ratios of two stable isotopes ^{13}C and ^{12}C in natural carbonaceous materials relative to the $^{13}C/^{12}C$ ratio of the traditional standard, the Peedee Belemnite (PDB), a Cretaceous belemnite from the Peedee Formation of South Carolina. The difference between isotope ratios of the sample and the standard is normally expressed in terms of a "delta" value, $\delta^{13}C$ (in units of parts per thousand, $^{o}/oo$) which is defined as follows:

$$\delta^{13}C\ {}^{o}/_{oo} = \left(\frac{{}^{13}C/{}^{12}C_{\text{sample}} - {}^{13}C/{}^{12}C_{\text{PDB}}}{{}^{13}C/{}^{12}C_{\text{PDB}}} \right) \times 1000$$

The $^{13}C/^{12}C$ ratio is dependent on the original source of the carbon in the sample and on the isotopic fractionation which has taken place in the formation of the sample. Carbon isotope ratios, therefore, are unique measurements and can be used as a tool in characterizing and correlating geologic materials. For example, oils derived from the same source or similar sources should have similar isotope ratios. Conversely, oils derived from decidedly different source materials, should show, for the most part, significant deviations in isotope ratios.

In determining the source of the mine seep and breccia pipe oils, isotope analyses of the saturated hydrocarbon and aromatic hydrocarbon fractions showed that the average $\delta^{13}C$ values (per mil) for the Yates oils (-28.2 and -28.2, respectively) are comparable to those of the mine seep oils (average, -28.2, -28.4) and breccia pipe oils (average, -28.3, -28.2) (Table 3). Although the data indicate that the Yates oils are similar to and hence a possible source of the seep and breccia oils, the data are unfortunately not conclusive. The reason for this is that the carbon isotope ratios for the other Permian oils (Table 3) also have similar values, all within a few tenths of a part per mil. Consequently, from the standpoint of carbon isotope analyses alone, the immediate source of the seep and breccia oils cannot be pinpointed. On the other hand, the Pennsylvanian crude oil has significantly different $\delta^{13}C$ values (-27.2, -26.7) and hence is judged not to be a source of the mine seep and breccia pipe oils.

Possible Oil Source: Exploration Borehole "Dumped" Oil

In the following discussion, consideration is also given to the "dumped oil" in the exploration borehole as a possible source of the mine seep and breccia pipe oils. This, of course, can only be entertained if the dumped oil were a Yates oil which previously has been identified as the likely source. If any other stratigraphically deeper oil were used, each of which has been shown to be compositionally mismatched with the mine seep oils, it would seem that the borehole oil would have to be automatically disqualified as a possible source.

Assuming, however, that the borehole oil was a Yates oil, the chances of its being the source of the mine seep and breccia pipe oils are still rated highly improbable for several reasons.

Before delving into the reasons, certain facts must be established or reiterated.

1) In about 1950, six barrels of crude oil were injected (probably under pressure) into the potash exploration borehole (U.S. B & C 184; TD, 1,233 ft) to help release the stuck steel casing (TD, approx. 800 ft) which extended beneath some of the porous beds of the Rustler Formation and into about 110 ft of the generally impervious dissolution zone at the top of the Salado Formation. It is assumed that a bridge plug was set intact immediately below the bottom of the casing to prevent the oil from merely filling part of the open hole, thus rendering the oil's purpose ineffective. Whatever the reasons, the efforts to dislodge and retrieve the casing were unsuccessful.

Although the specific details are not known, it seems reasonable to assume that a) some, if not most, of the oil remained within the casing, b) some of the oil that was forced upward from the bottom of the casing through the annulus was in contact (for the first 110 ft) only with the impervious dissolution beds at the top of the Salado Formation thus being restricted from any long distance migration, and c) the remainder of the oil, if any at all, that was forced upward beyond the first 110 ft, penetrated and saturated all porous rock units of the lower part of the Rustler Formation.

2) Owing to the fact that no water was observed along the fault plane where the seep oil was encountered in the mine, the oil (if indeed it did migrate this far) had to migrate through a porous and permeable rock unit more or less as a continuous oil phase without the aid of flowing ground water. Also, if ground water had been the medium of transport and was actively flowing for an appreciable time in the immediate geologic past, then there should have been some evidence of dissolution of the soluble halite and potash deposits at or near the fault plane where the oil seepage occurs. However, no such evidence has been demonstrated. Furthermore, according to Brokaw and others (1972), the prevailing direction of water movement in transmissive zones above the Salado Formation is to the south and southwest - nearly opposite to what would be required if water were to transport the oil north and northwest from the borehole to the mine seep and breccia pipe areas.

With the above facts in mind, it seems highly unlikely for a portion of six barrels of oil to have escaped from the immediate environs of the borehole and to have migrated in a continuous oil phase, (or for that matter in solution or as globules in flowing ground water against the prevailing hydrodynamic gradient) over a distance of 2.5 miles and to have exsolved or "settled out" of solution at more or less comparable depths of 1164 ft (mine seep), 1281 ft (Hill C breccia pipe) and 1629 ft (Hill A breccia pipe) without any traces of oil discovered in the overlying rocks. Furthermore, if we were to take every drop of oil that was forced down the borehole, concentrate it and let it migrate in continuous oil phase radially (i.e. equally in all directions away from the borehole) through only a one-foot porous and permeable zone, then for a rock unit with 10 percent porosity, calculations (see Appendix) show that the oil can migrate only about 10.5 ft away from the borehole. For a transmissive one-foot bed with 5 percent porosity the oil could migrate only a distance of about 15 feet.

In summary, the above considerations strongly suggest that the borehole oil is not the source of the WIPP-31 and WIPP-16 breccia pipe oils nor of the mine seep oils which are located about 2.5 miles, 1,400 ft, and 600 ft, respectively, north and northwest of the borehole.

SUMMARY AND CONCLUSIONS

Geochemical analyses have shown that the mine seep and breccia pipe oils of Eddy County, New Mexico have similar compositions based on gross chemical characteristics, hydrocarbon molecular distributions, and stable carbon isotope ratios. Such similarities indicate that they are genetically related, (i.e. belonging to the same family of oils), and probably derived from a common source or similar sources. The compositional variations that are apparent are largely due to differences in degree of microbiological degradation.

From geologic considerations, the oil "dumped" into the potash exploration borehole (drilled about 1950 in the vicinity of one of the collapsed breccia pipes) is ruled out as a source of 1) the mine seep oils discovered along a fault in the MCC potash mine, about 600 ft from the borehole and 2) the breccia pipe oils at Hills A and C approximately 2.5 miles and 1,400 ft respectively, from the borehole.

Geochemical analysis and oil-to-oil correlation of seven crude oil samples collected from oil fields in the vicinity of the breccia pipes, indicate that the Yates oils are the likely source of the breccia pipe and mine seep oils.

The breccia pipe and mine seep oils were probably emplaced at their present sites during or sometime after the brecciation, fracturing, and faulting of rocks in response to the dissolution of the Capitan Limestone, a reef facies, and subsequent caving of the overlying rocks. Partial leakage from disrupted Yates oil reservoirs probably accounts for the above oil shows.

The presence of significant amounts of seepage oil (in excess of 5 gallons) in the MCC mine might be a reflection of leakage from commercial accumulations of oil in the Yates Formation in the vicinity of the mine. Such oil shows should warrant further petroleum exploration. Necessary precautions could be taken to insure that such exploration did not interfere with the potash mining.

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Table 1. - Location of mine seep and breccia pipe oil samples, Eddy County, New Mexico.

Sample No.	Location
Mine Seep Oils	
10	MCC mine, 16-L drift, about 140 ft from boundary of breccia pipe (Hill C), collected 1980.
10A	MCC mine, 15-L drift, about 140 ft from boundary of breccia pipe (Hill C), collected 1980.
MC	MCC mine, 16-L drift, about 140 ft from boundary of breccia pipe (Hill C), collected 1975.
Breccia Pipe Oils	
11	Drillhole Wipp-31, Hill A, Sec. 35, T.20S., R.30E.
12	Drillhole Wipp-16, Hill C, Sec. 5, T.21S, R.30E.

Table 2. -- Well name, field name (if any), location, and name and age of formation from which crude oil and drill cuttings samples were taken. [Crude oil samples collected in 1980 by James Brasfield, USGS, Artesia, N. Mex., and R. P. Snyder, USGS, Denver, Colo.; cuttings sample provided by Jack Williams, Amoco Production Company, Tulsa, Okla.].

Sample No.	Description
Crude Oils	
1	Gulf Fed. Lease, Hudson and Hudson; Dos Hermanos field; Sec. 33, T.20S., R.30E., Eddy Co., N.M.; Yates Fm.; Permian.
2	Meadco Properties Ltd., Hudson Fed. #2; wildcat; Sec. 4, T.21S, R.29E, Eddy Co., N.M.; Cherry Canyon or basal Bell Canyon Fm.; Permian.
3	Perry R. Bass, Fed. Cobb #1; field unknown; Sec. 23, T.20S, R.31E., Eddy Co., N.M.; lower Brushy Canyon Fm.; Permian.
4	Perry R. Bass - Big Eddy #7; undesignated field; Sec. 19, T.20S, R.31E., Eddy Co., N.M.; Pennsylvanian.
5	Perry R. Bass - Big Eddy #58; Indian Flats Delaware field; Sec. 35, T.21S., R28E., Eddy Co., N.M.; lower Bell Canyon Fm.; Permian.
7	Barber Oil Co., #3 Colgazier "O"; Dos Hermanos field; Sec. 20, T.20S, R.30E., Eddy Co., N.M.; Yates Fm.; Permian.
9	Yates Pet. Co., #1 Fed. GN; Indian Flats field; Sec. 27, T.21S., R.28E., Eddy Co., N.M.; lower Bell Canyon Fm.; Permian.
Cuttings	
218	Bass - N. Custer Mountain; Sec. 28, T.23S., R.35E., Lea Co., N.M.; Bone Spring Ls.; Permian.

le 3. Geochemical analyses of potash mine seep oils, collapsed breccia pipe oils, and selected crude oils, Eddy County, New ico.

TYPE OF SAMPLE	DEPTH (Ft)	FORMATION OR LOCALITY	API GRAVITY	S %	SILICA GEL CHROMATOGRAPHIC FRACTIONS AS PERCENT OF TOTAL SAMPLE: SAT HC %	AROM HC %	RESINS %	ASPHAL-TENES %	AMOUNT LOST %	SAT/AROM RATIO	$\delta^{13}C$ o/oo (PDB): SAT HC	AROM HC
Mine seep oil	1164	MCC mine	18.9	1.14	64.8	22.1	6.8	1.4	4.9	2.9	-28.2	-28.3
Mine seep oil	1164	MCC mine	20.0	1.23	64.2	23.4	6.9	1.0	4.5	2.7	-28.2	-28.5
Mine seep oil	1164	MCC mine	19.1	.96	65.8	22.7	5.9	1.5	4.1	2.9	ND	ND
Breccia pipe oil	1281	WIPP-16	ND	.89	46.8	18.3	15.2	10.1	9.6	2.6	-28.1±.1	27.9±.5
Breccia pipe oil	1629	WIPP-31	ND	1.16	65.2	18.0	10.1	3.8	2.9	3.6	-28.5±.1	28.4±.3
Crude oil	1475-1480	Yates	20.0	2.08	54.6	27.9	4.8	4.2	8.5	2.0	-28.4	-28.2
Crude oil	1646-1702	Yates	25.3	0.58	64.2	20.4	3.5	.1	11.8	3.2	-28.1	-28.1
Crude oil	3544-3553	L. Bell Canyon	43.2	.13	52.3	9.2	1.1	.1	37.3	5.7	-28.2	-28.4
Crude oil	3660-3687	L. Bell Canyon	37.8	.31	55.7	9.9	1.2	.2	33.0	5.6	ND	ND
Crude oil	4008-4190	Cherry Canyon or basal Bell Canyon	38.3	.46	58.2	9.7	1.3	.1	30.7	6.0	-28.2	-28.2
Crude oil	7003-7035	L. Brushy Canyon	41.9	.12	57.2	9.1	1.3	.1	32.3	6.3	-28.0	-28.0
Crude oil	12656-12948	Pennsylvanian	49.0	.03	48.5	1.5	.3	.1	49.6	31.6	-27.2	-26.7
Cuttings	8790-8900	Bone Spring	ND	ND	49.8	19.7	15.1	5.8	9.6	2.5	ND	ND

: not determined; S = sulfur; Sat HC = saturated hydrocarbons; arom HC = aromatic hydrocarbons; sat/arom ratio = saturated ocarbon/aromatic hydrocarbon ratio.

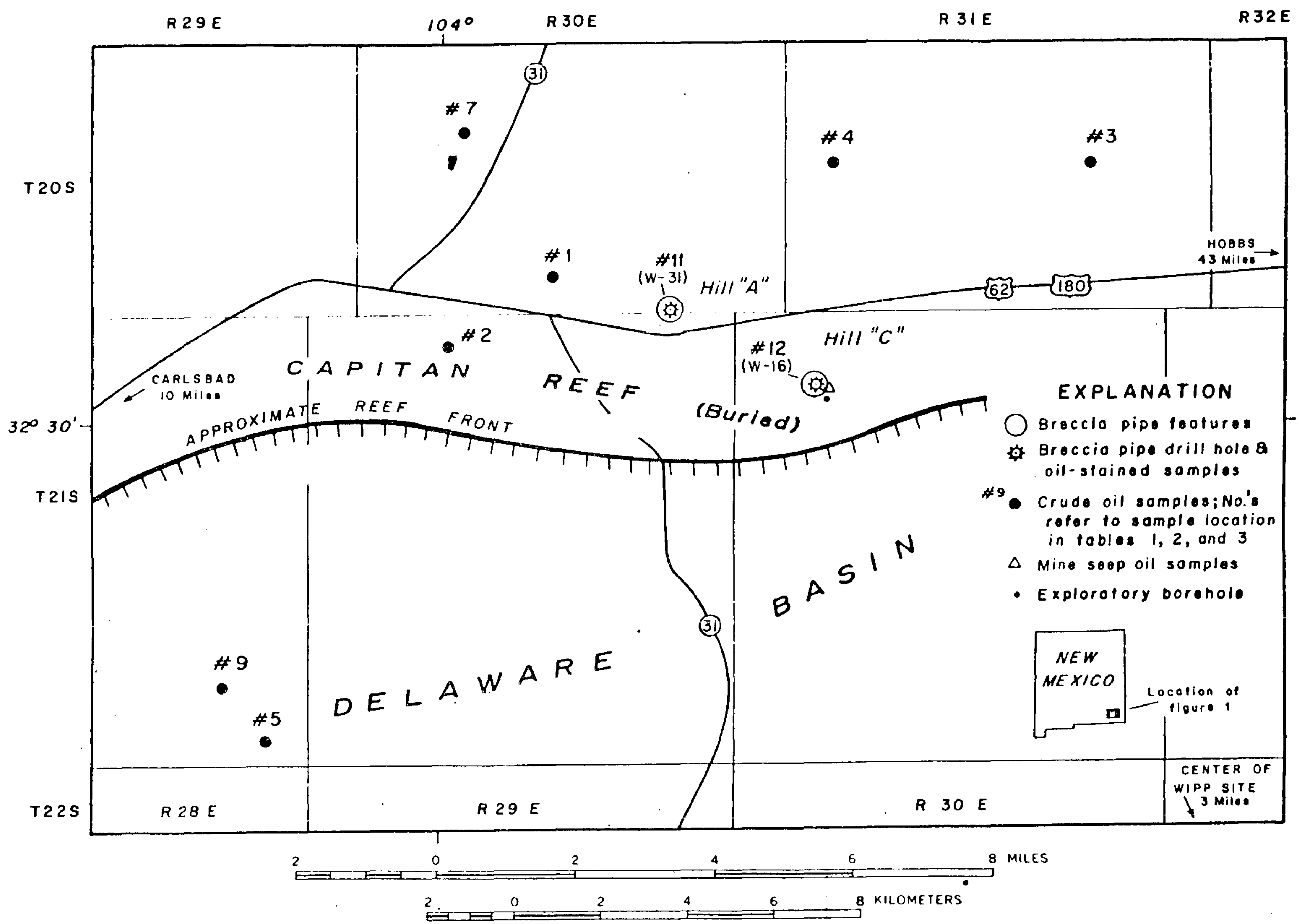


Figure 1.--Location of breccia pipe features, breccia pipe, mine seep, and crude oil samples, and approximate Capitan reef front in Eddy County, New Mexico. [Sample No. 218 not in area of map. W-16 and W-31 are drill holes at breccia pipe features.]

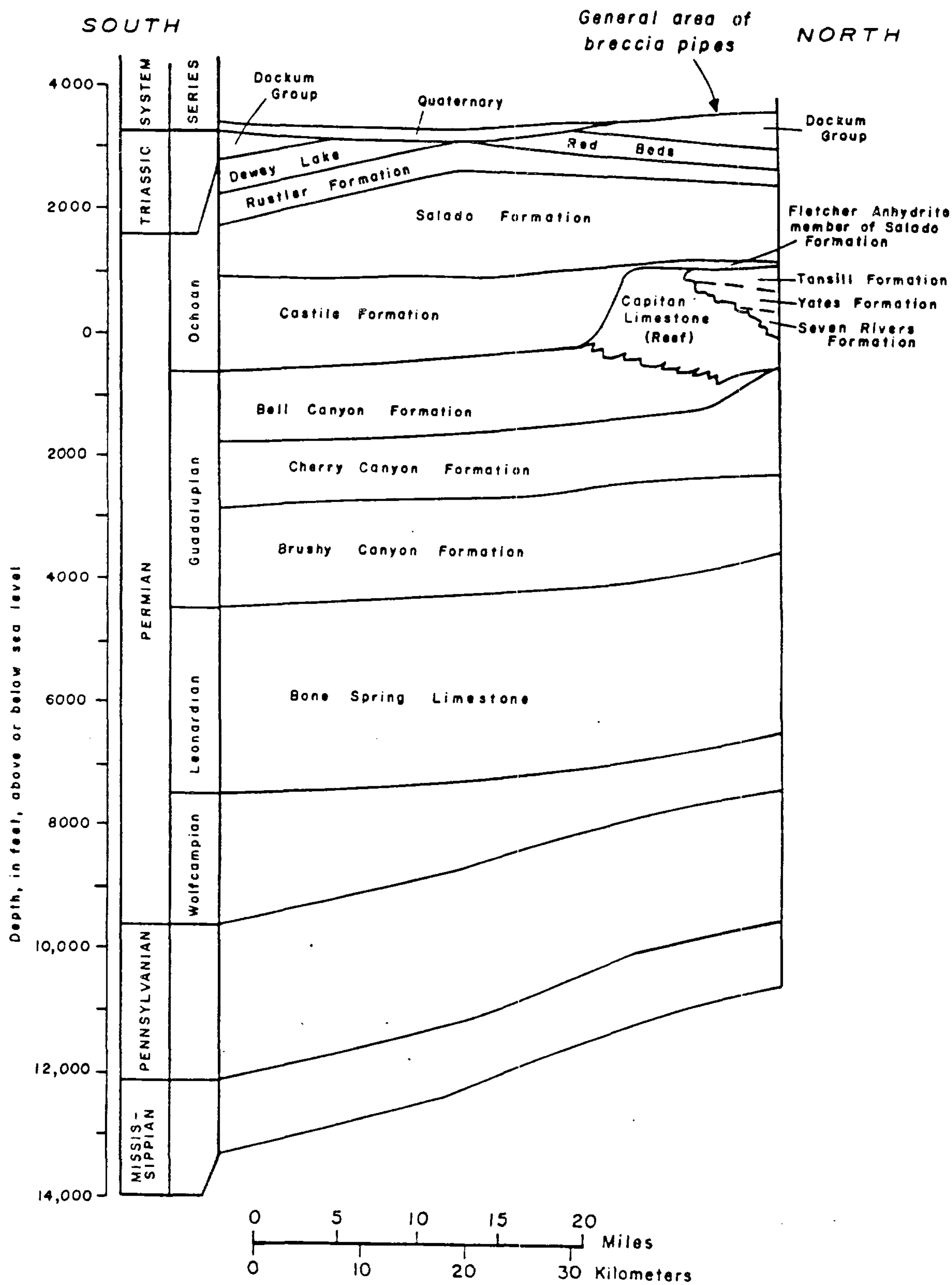


Figure 2.--Generalized geologic cross section across breccia pipe area, Eddy County, New Mexico (modified from Brokaw and others, 1972).

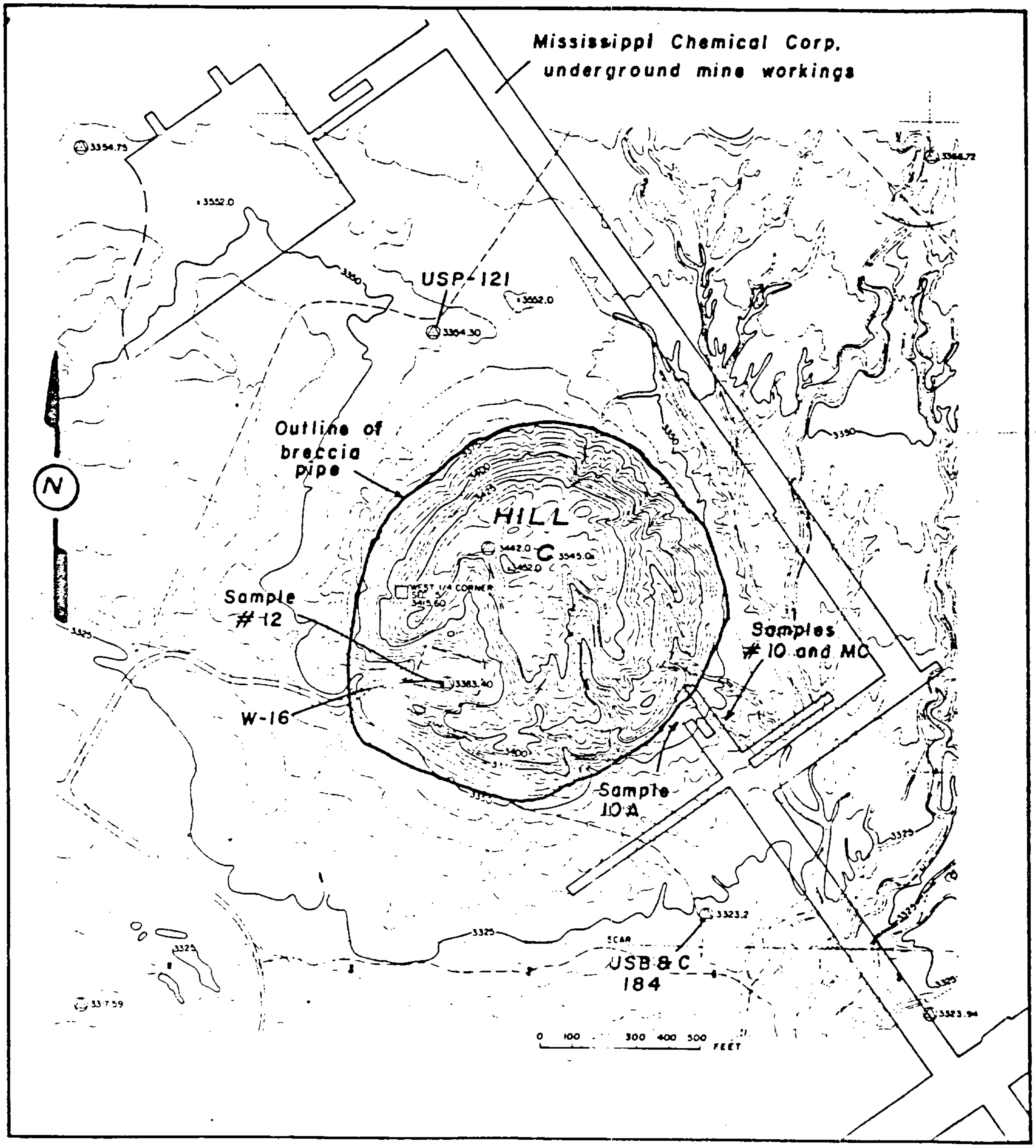


Figure 3.--Enlarged map of Hill C breccia pipe area showing drill holes, mine workings, and oil sample locations.

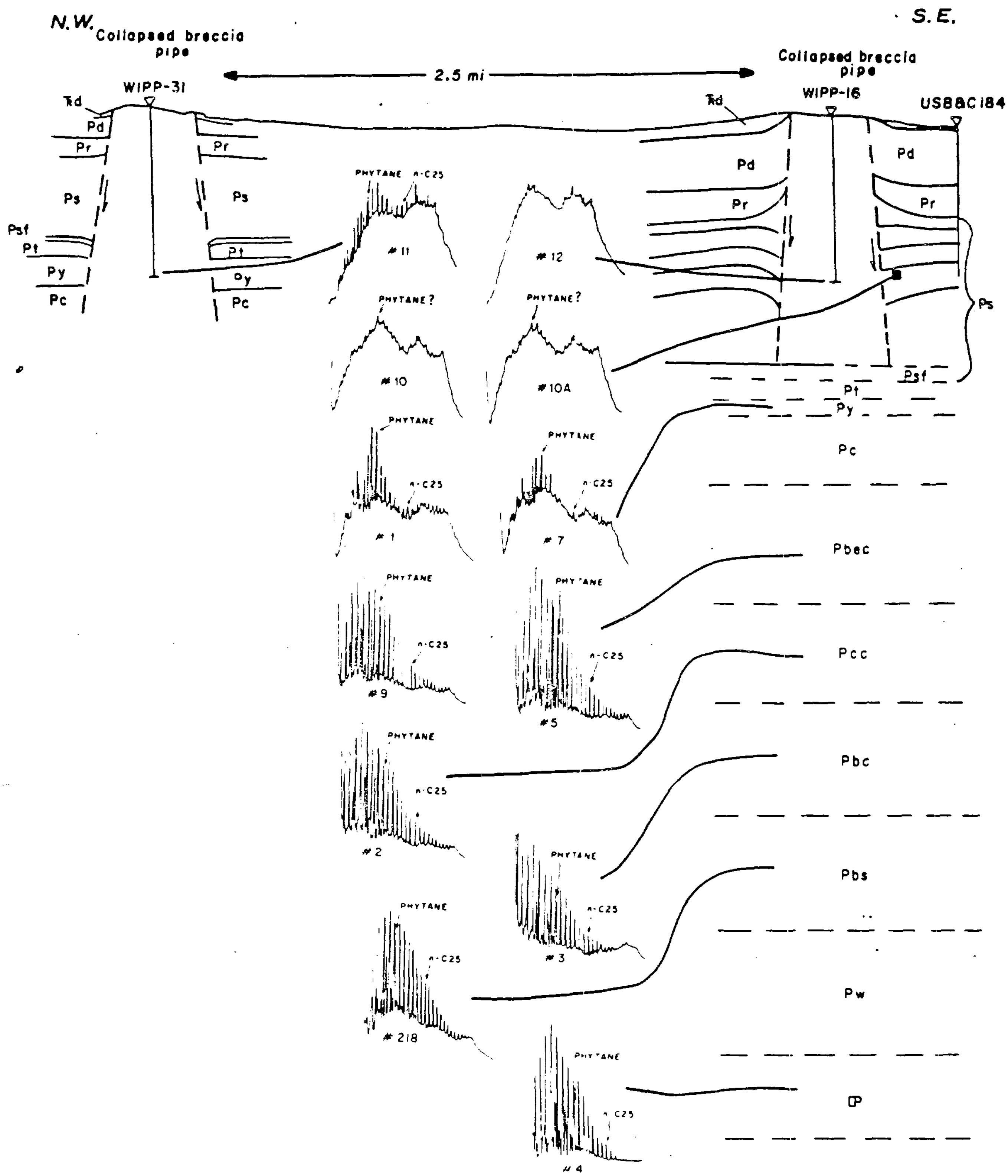


Figure 4 - Diagrammatic cross section of breccia pipe features and generalized stratigraphic section below Salado Fm. showing gas chromatograms of C_{15+} saturated hydrocarbon distributions of mine seep, breccia pipe, and selected crude oils. Caption continued on next page.

EXPLANATION

TRIASSIC

Ŧd	Dockum Group

PERMIAN

Pd	Dewey Lake Red Beds
Pr	Rustler Formation
Ps	Salado Formation
	Marker beds
Psf	Fletcher Anhydrite Member (on reef)
Pt	Tansill Formation
Py	Yates Formation
Pc	Capitan Limestone
Pbec	Bell Canyon Formation
Pcc	Cherry Canyon Formation
Pbc	Brushy Canyon Formation
Pbs	Bone Spring Limestone
Pw	Wolfcampian

₽	Pennsylvanian

Figure 4 - Cont'd. Gas chromatograms (GC) are identified by sample numbers indicated below each chromatogram. Enlargements of GC's are illustrated in Figures 5-17. GC column conditions are described under analytical procedures.

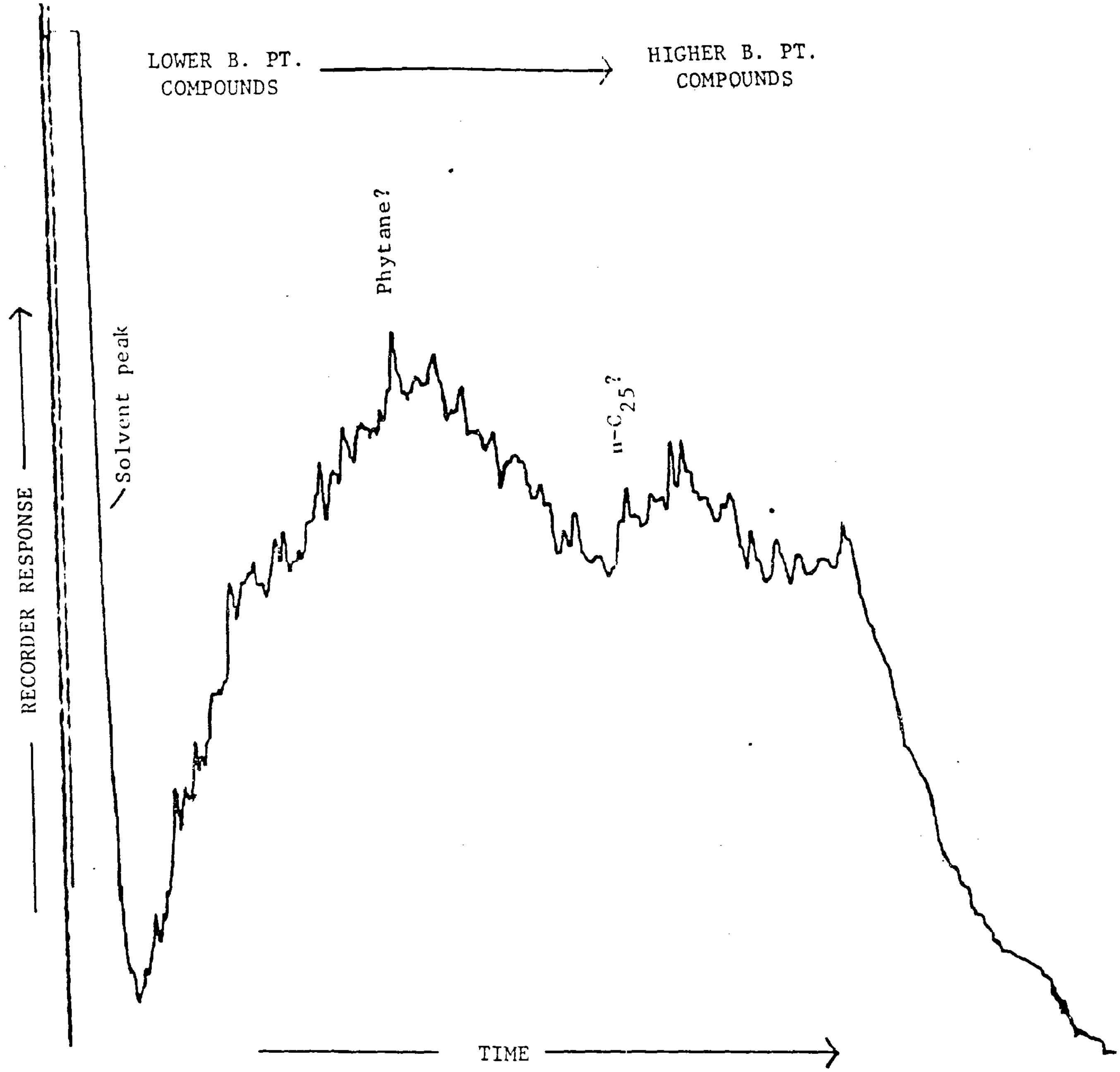


Figure 5. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of potash mine seep oil No. 10. For location of oil sample see Figure 3 and Table 1. The n-paraffin molecules have been removed apparently by microbiologic degradation. The unresolved envelope consists predominantly of naphthenes (cyclic hydrocarbons) and subordinately of branched-chain hydrocarbons. In order to determine the approximate molecular weight distribution of the unresolved saturated hydrocarbons, the approximate positions of phytane and pentacosane (n-C_{25}) are shown. Phytane is a 20-carbon isoprenoid or branched-chain hydrocarbon that is directly related to a specific biologic precursor, and pentacosane is a normal or straight-chain hydrocarbon that has 25 carbon atoms. Gas chromatographic column conditions are given in the text under analytical procedures.

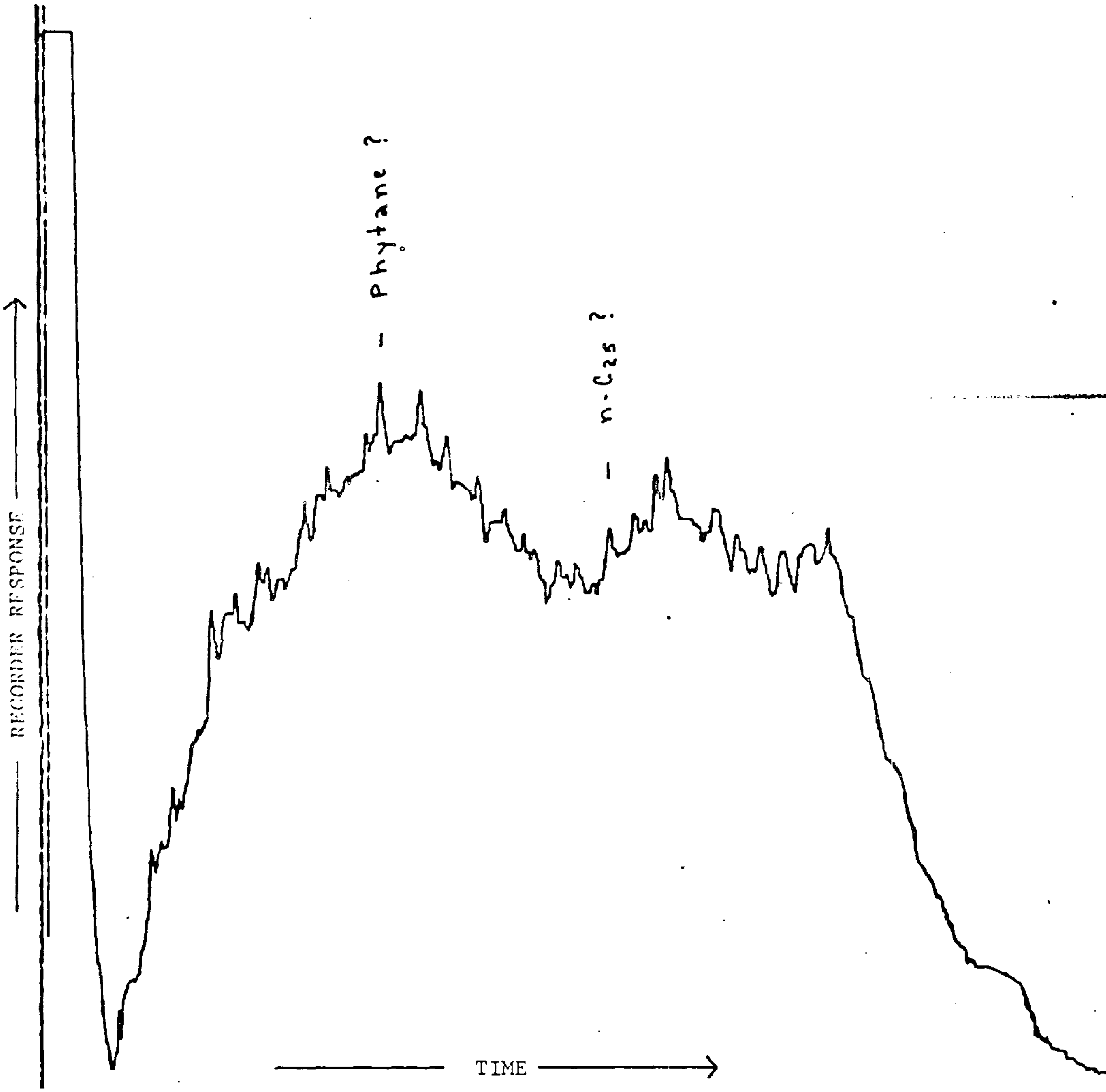


Figure 6. Gas chromatogram (GC) of C_{15+} saturated hydrocarbon fraction of potash mine seep oil No. 10A. The GC fingerprint is essentially identical to that of Figure 5. See caption in Figure 5 for other pertinent information.

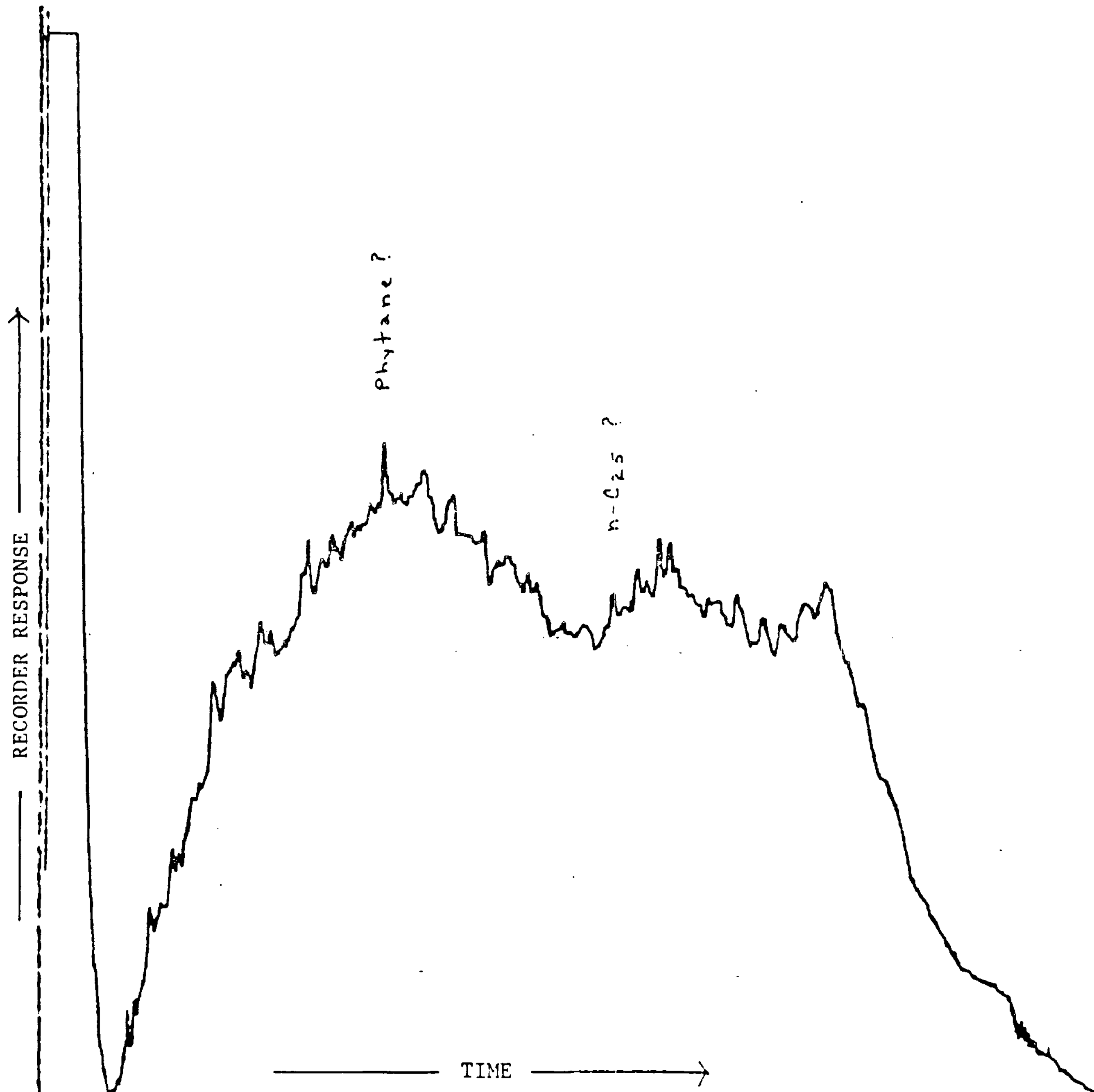


Figure 7. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of potash mine seep oil No. MC. The GC fingerprint is essentially identical to those of Figures 5 and 6. See caption in Figure 5 for other pertinent information.

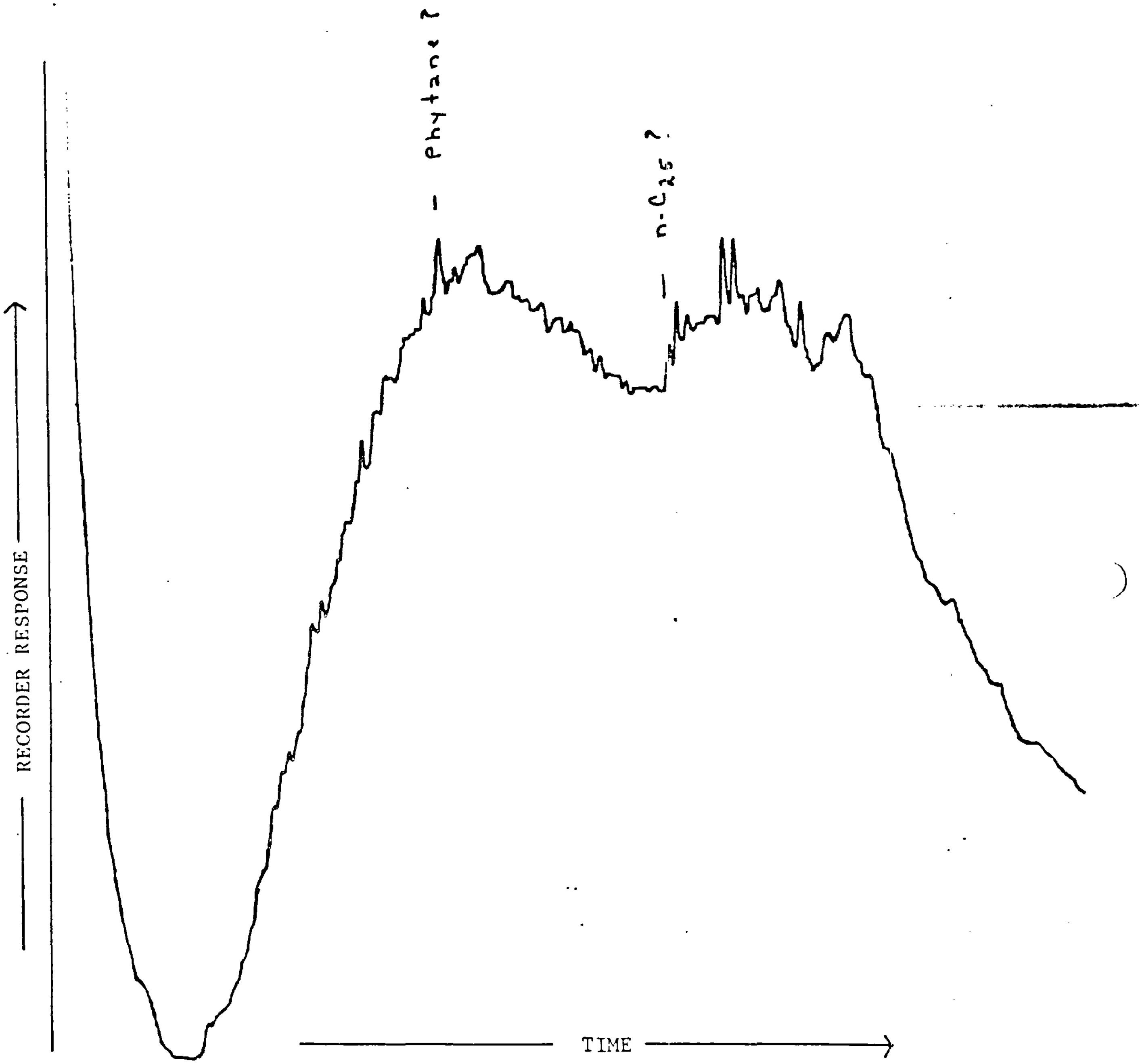


Figure 8. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of breccia pipe oil No. 12 obtained from the WIPP No. 16 borehole. See Table 1 and Figure 3 for location of sample. The GC fingerprint is very similar to those of the mine seep oils (Figs. 5, 6, and 7). Again, the absence of n-paraffins is attributed to biodegradation. See Figure 5 for other pertinent information.

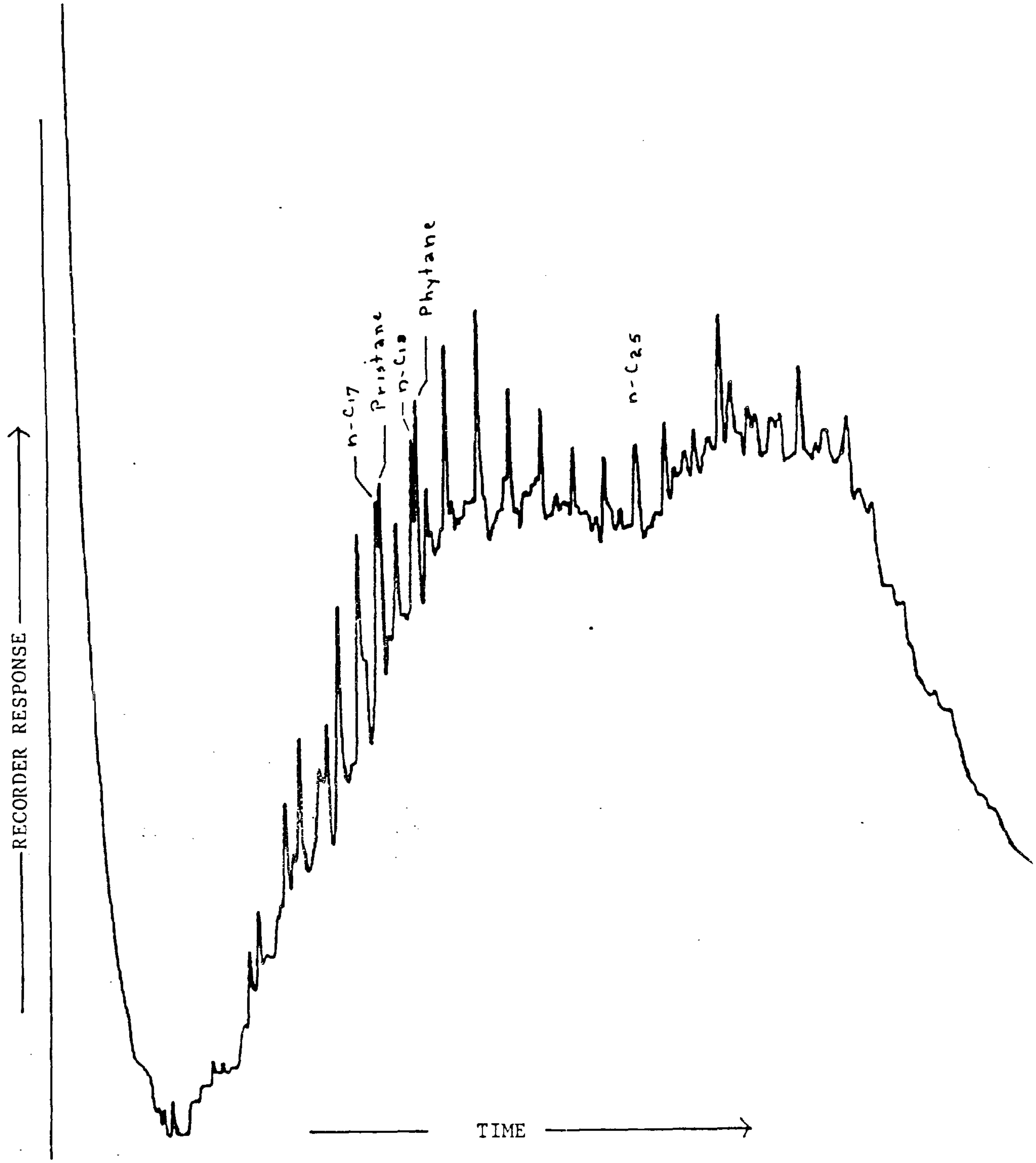


Figure 9. Gas chromatogram of saturated hydrocarbon fraction of breccia pipe oil No. 11 obtained from the WIPP No. 31 borehole. See Table 1 and Figure 1 for location of sample. This breccia pipe oil appears less biodegraded than the other breccia pipe oil (No. 12, Fig. 8). Note that the series of n-paraffin and branched paraffin peaks (including pristane and phytane), below about n-C_{25}, are still projecting above the hump. Pristane, a 19-carbon branched paraffin, like phytane, is considered a biologic marker compound since it is derived from a distinct biologic precursor. See analytical procedures for chromatographic column conditions.

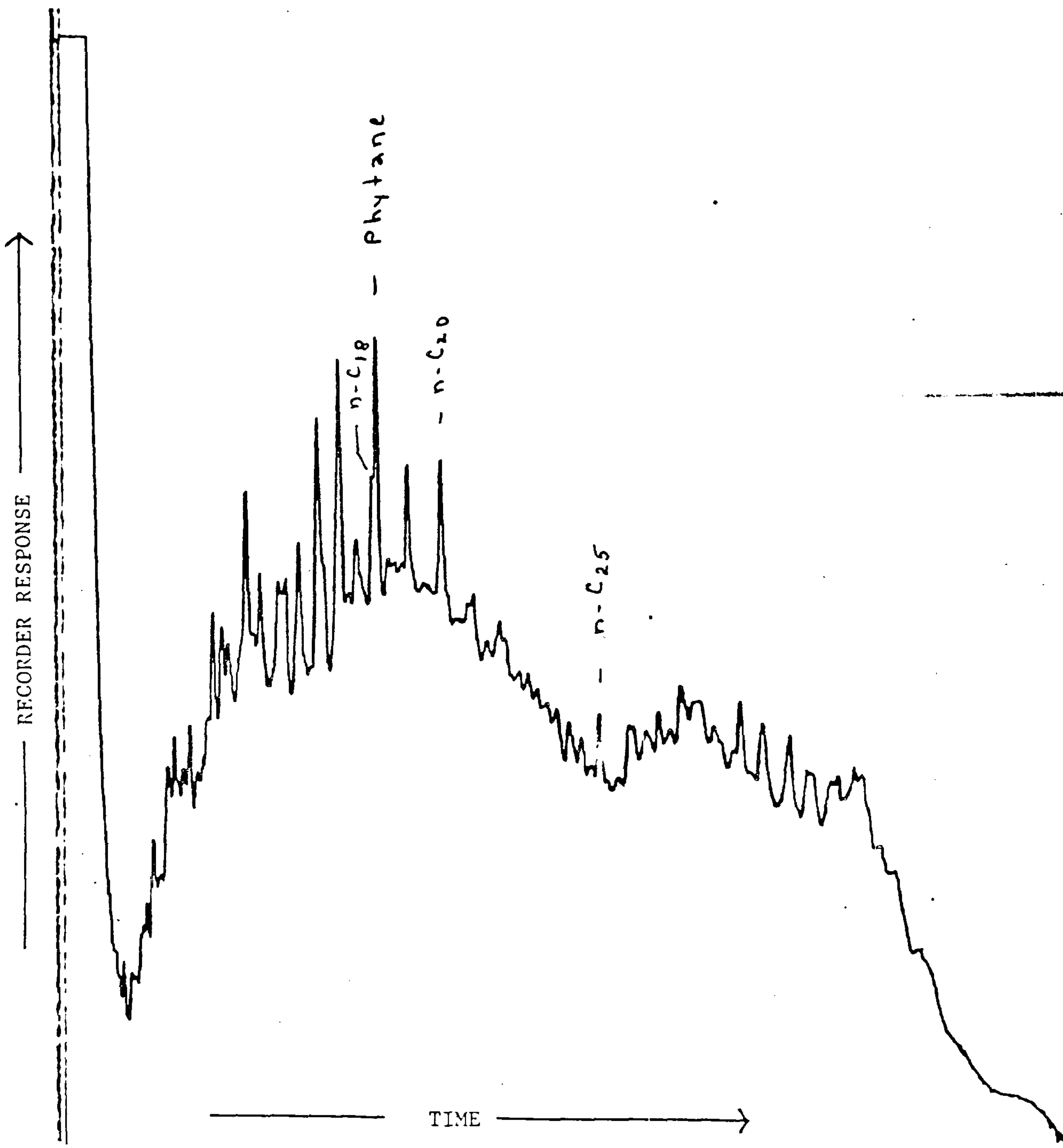


Figure 10. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of Yates crude oil No. 7. See Table 2 and Figure 1 for location of sample. This oil is also considered to have undergone biodegradation as indicated by the disappearance of a significant portion of the n-paraffin distribution above n-C_{20}, especially in the region n-C_{20} to n-C_{25}. See analytical procedures for column conditions.

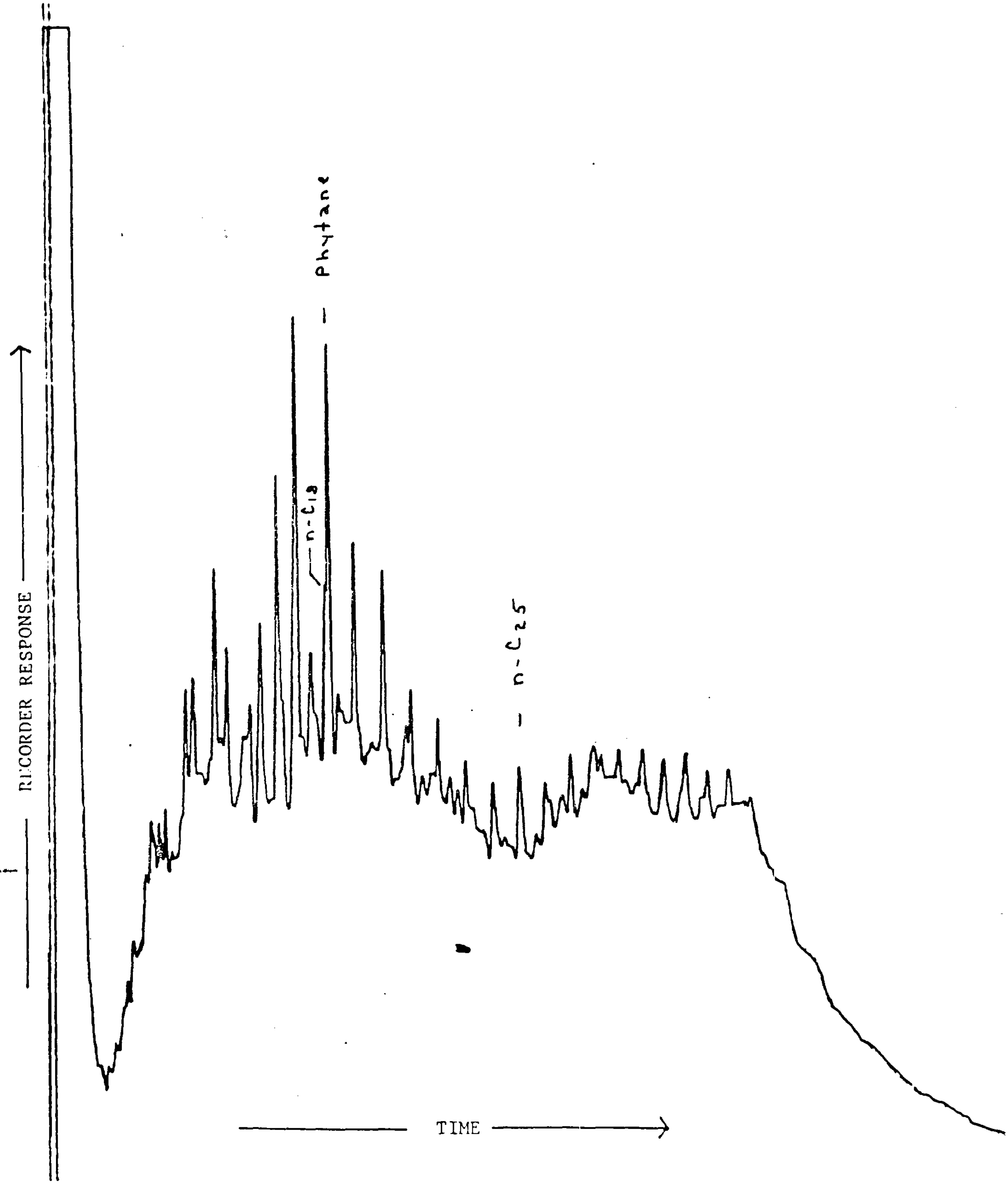


Figure 11. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of Yates crude oil No. 1. See Table 2 and Figure 1 for location of sample. This oil also shows signs of biodegradation but slightly less than that of Yates No. 7 oil (Fig. 10). See analytical procedures for column conditions.

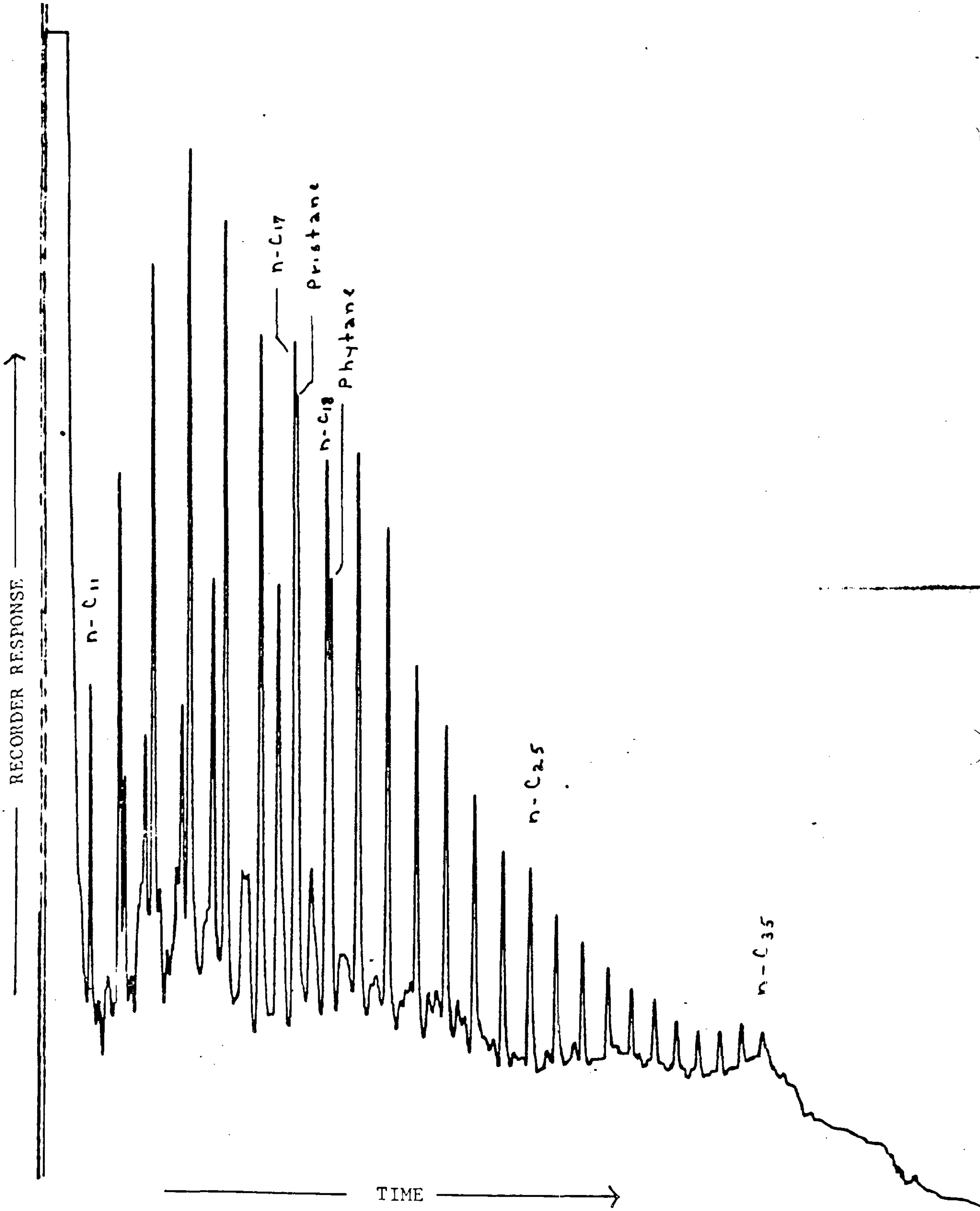


Figure 12. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of lower Bell Canyon crude oil No. See Table 2 and Figure 1 for location of sample. This chromatogram shows the full complement of prominent n-paraffin peaks ranging from about n-C_{11} to n-C_{35}, with no obvious signs of microbiological alteration. See analytical procedures for column conditions.

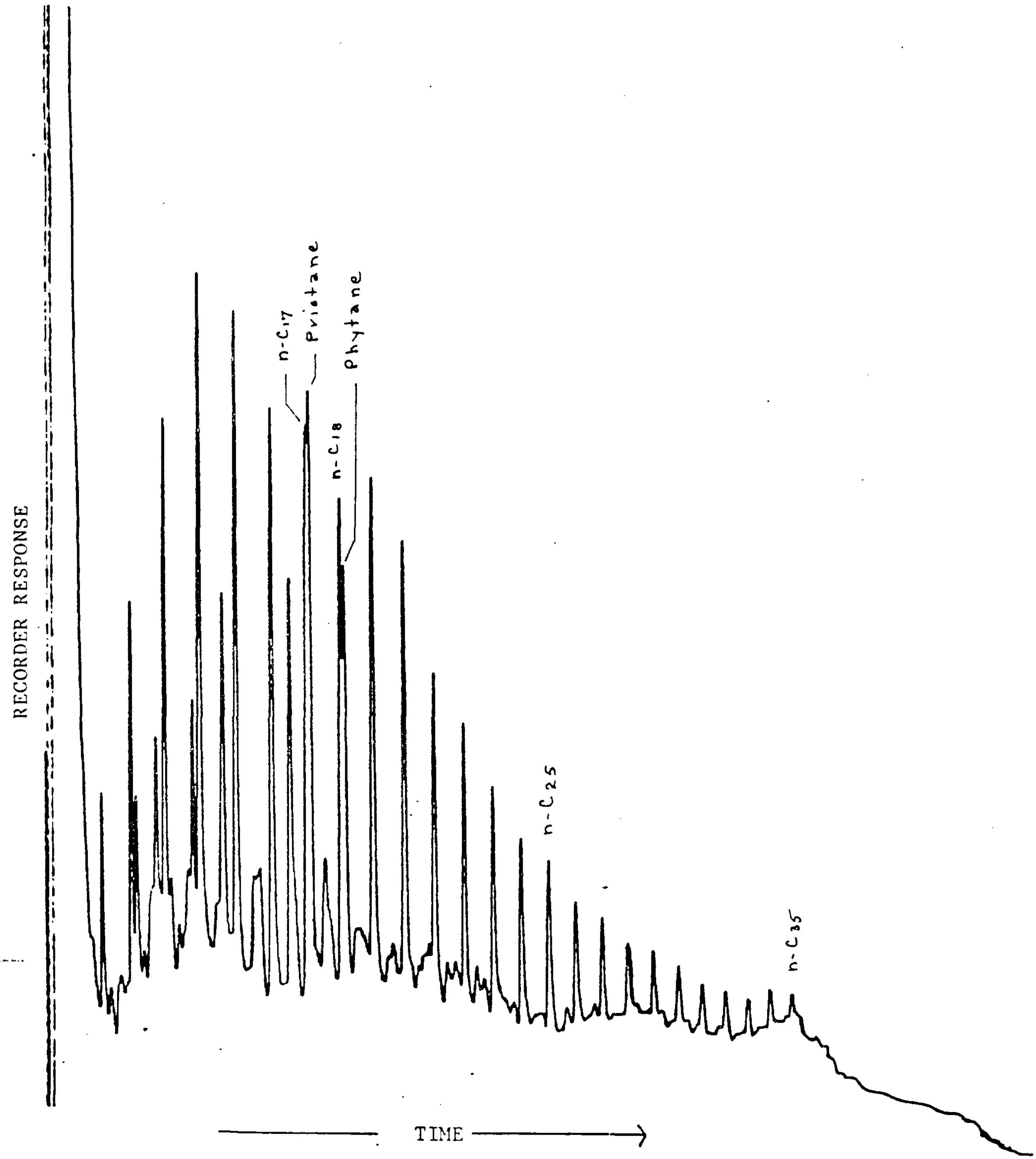


Figure 13. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of lower Bell Canyon crude oil No. 9. See Table 2 and Figure 1 for location of sample. The distribution of saturated hydrocarbons is nearly identical to that of the No. 5 oil in Figure 12 with one minor exception. The No. 9 oil has a slightly lower n-C_{17}/pristane ratio than the No. 5 oil. The similarity of molecular distributions as well as gross chemical characteristics indicates that these two oils (No. 9 and No. 5) were derived from the same sequence of source rocks. See analytical procedures for column conditions.

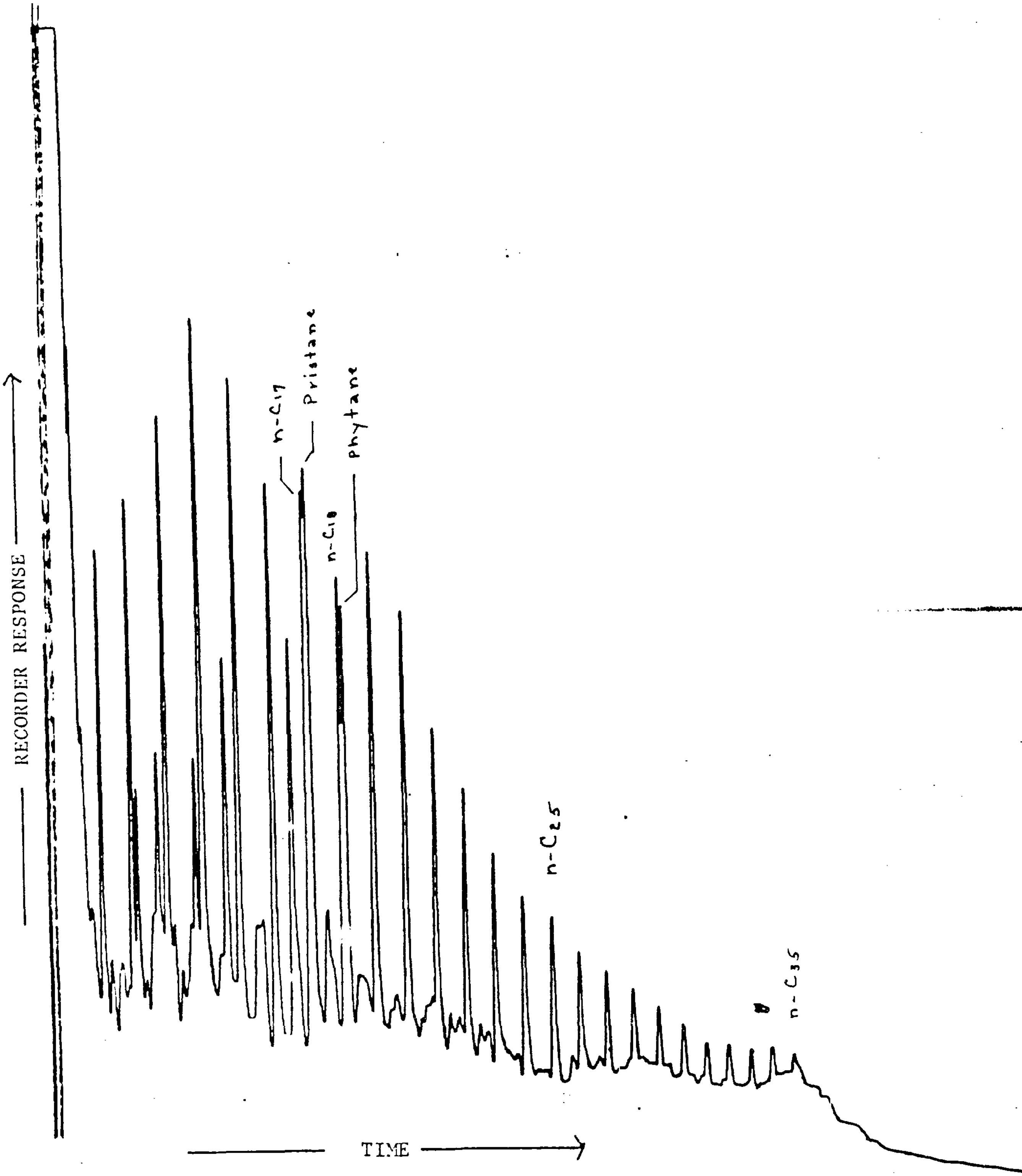


Figure 14. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of Cherry Canyon or basal Bell Canyon crude oil No. 2. See Table 2 and Figure 1 for location of sample. This chromatogram is essentially identical to that of the No. 9 oil (Fig. 13) and quite similar to the No. 5 oil (Fig. 12) indicating that all three oils belong to the same family of oils and hence were derived from the same or a similar source rock sequence. See analytical procedures for column conditions.

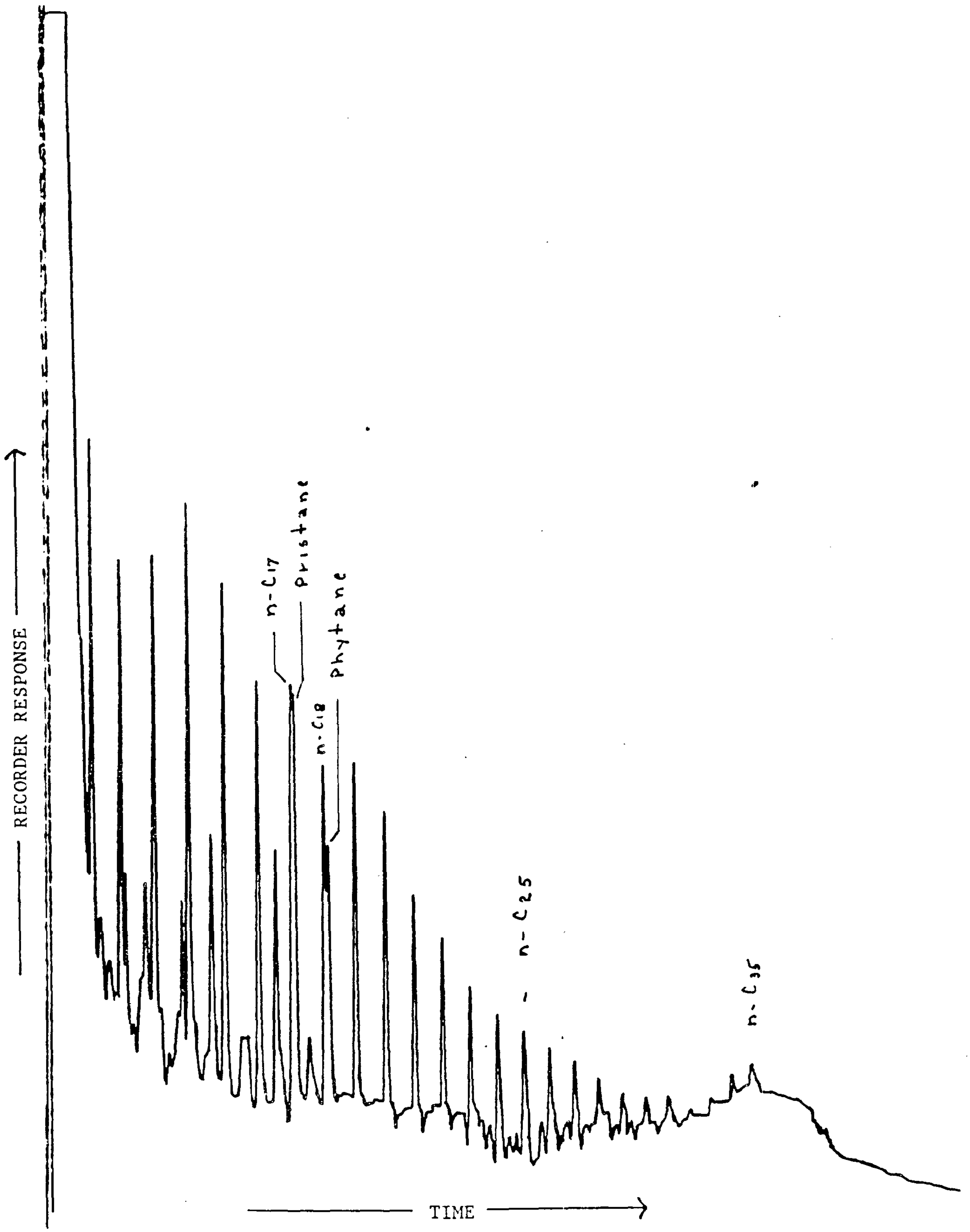


Figure 15. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of lower Brushy Canyon crude oil No. 3. See Table 2 and Figure 1 for location of sample. The distribution of saturated hydrocarbons as well as the gross chemical composition (Table 3) indicate that this oil belongs to the same family of oils as the Bell Canyon crude oils (Figs. 12, 13, 14). See analytical procedures for column conditions.

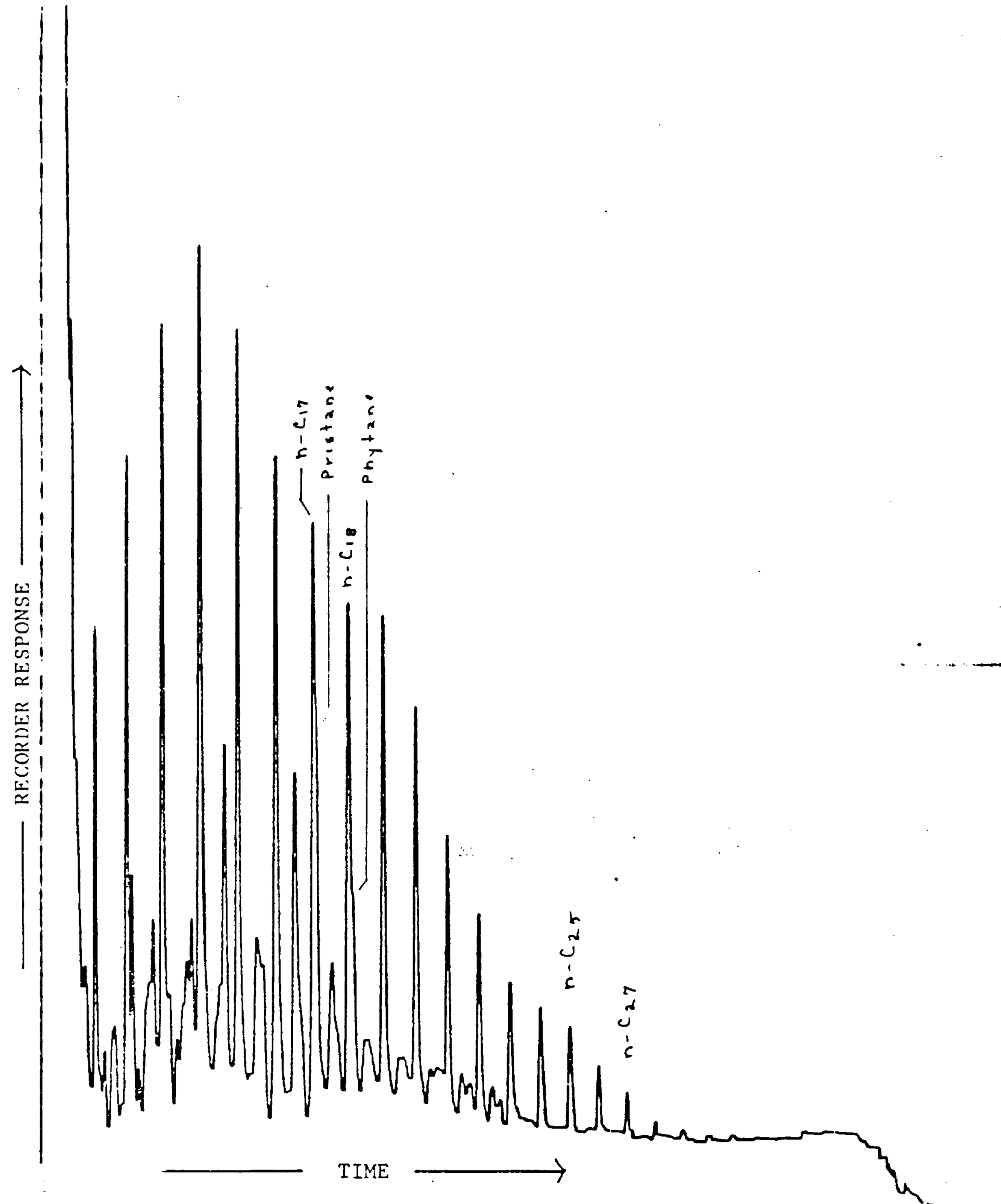


Figure 16. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of Pennsylvanian crude oil No. 4. See Table 2 and Figure 1 for location of sample. Comparable to the four Permian oils (Figs. 12, 13, 14, 15), this Pennsylvanian oil also has a full complement of n-paraffins devoid of any apparent biodegradation but it differs from them in several respects. (1) The range of n-paraffins (that have any appreciable concentration) extends only to n-C_{27} whereas in the 4 Permian oils the range extends to n-C_{35}. (2) The amounts of pristane and phytane relative to n-C_{17} and n-C_{18}, respectively, are much less in the Pennsylvanian oil compared to the Permian oils. (3) Although not reported in this study, molecular sieve analyses show that the isoprenoid distribution of the Pennsylvanian oil is quite different than that of the Permian oils. The above data coupled with carbon isotope and gross chemical analyses (Table 3) strongly indicate that the Pennsylvanian oil is not related to the Permian oils and consequently was derived from a different rock source. See analytical procedures for column conditions.

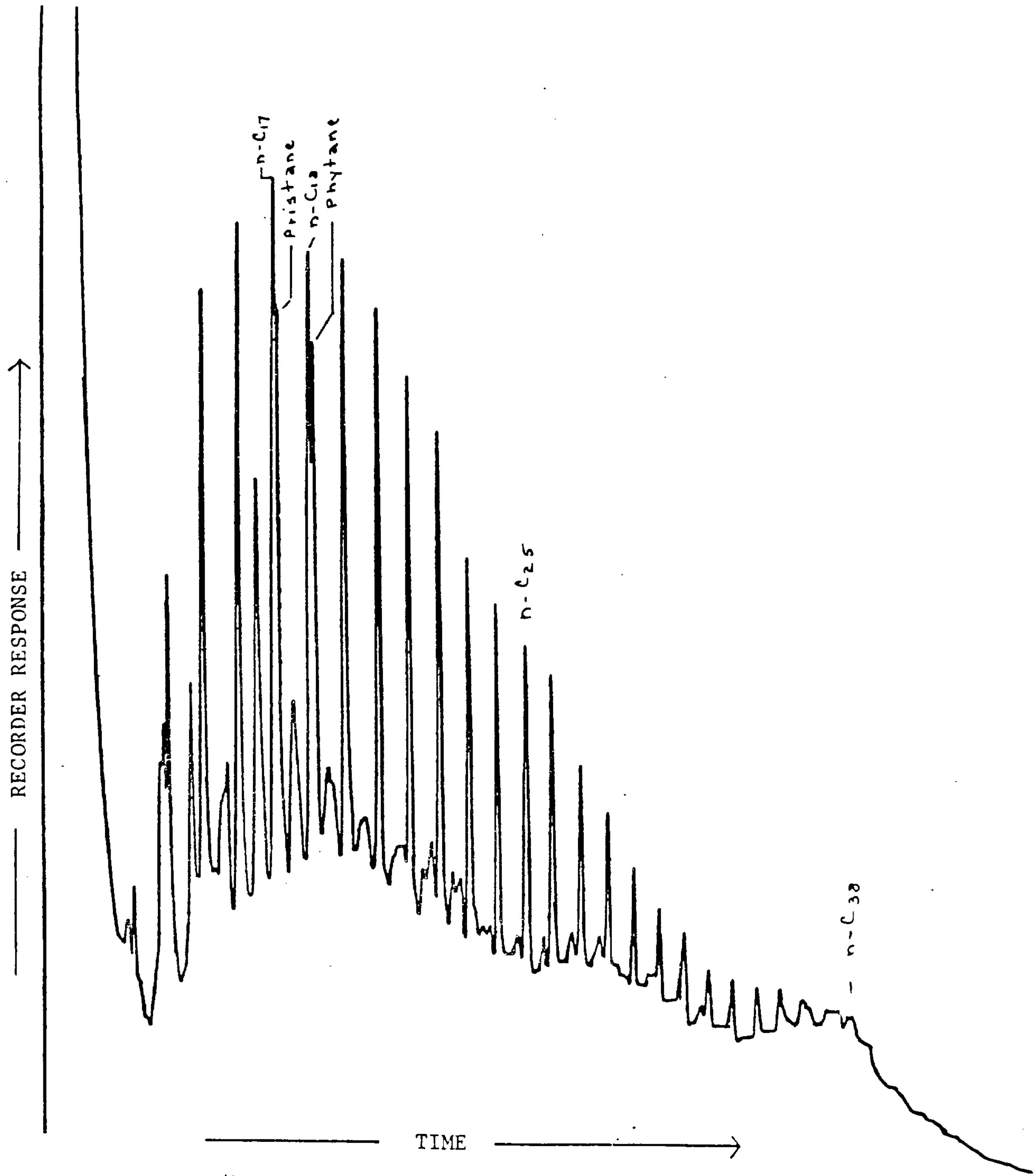


Figure 17. Gas chromatogram of C_{15+} saturated hydrocarbon fraction of a chloroform extract of rock cuttings (No. 218) from the Bone Spring Limestone. See Table 2 for location of sample. The overall character of the saturated hydrocarbon distribution coupled with its stratigraphic position indicates that the Bone Spring may be the source of the four Permian oils shown in Figure 12, 13, 14, and 15. Whether it is also the ultimate source of the Yates, breccia pipe, and mine seep oils has yet to be determined. More detailed and sophisticated oil-to-oil correlation analyses have to be made to ascertain this possibility. See analytical procedures for column conditions.

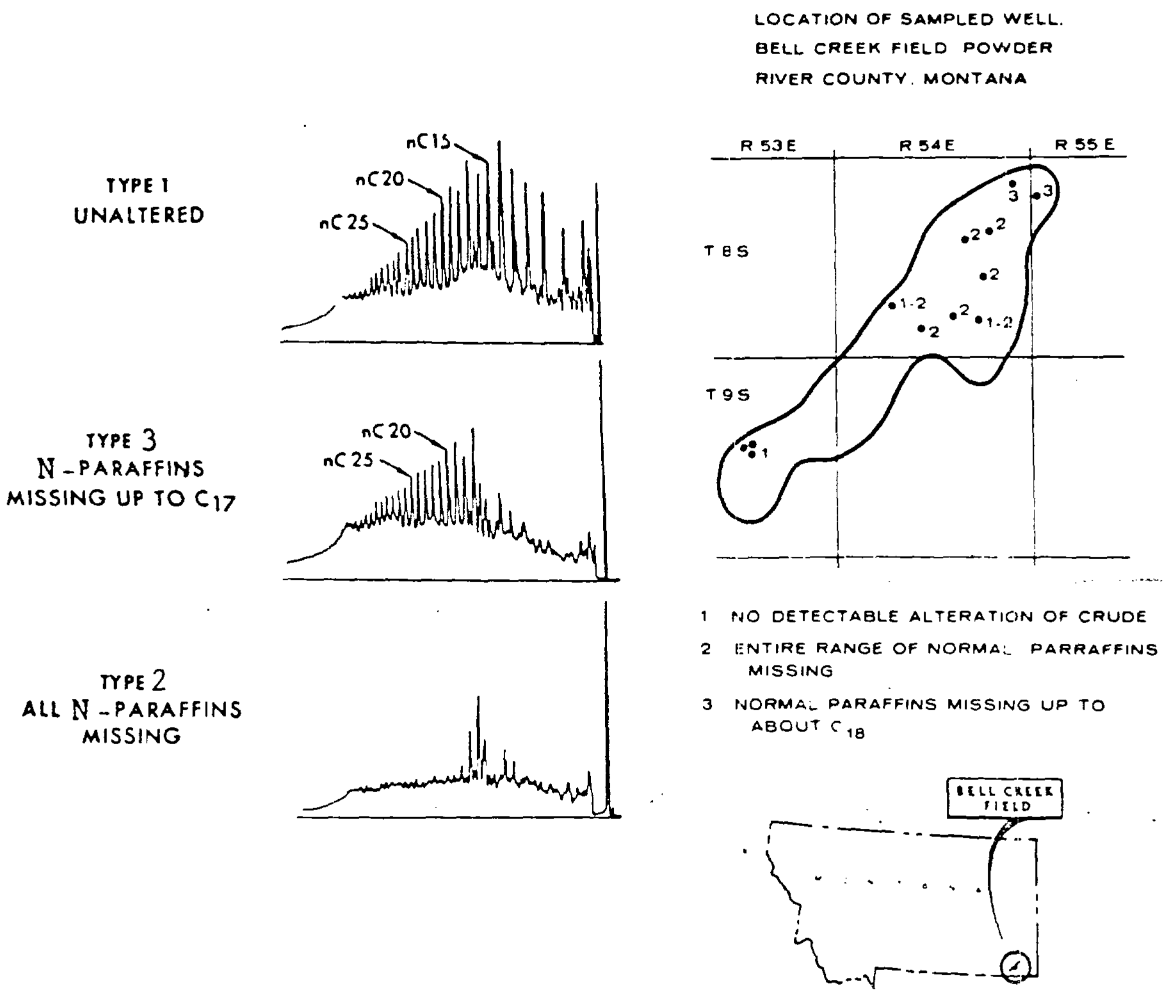


Figure 18 - Gas chromatograms of saturated hydrocarbon fractions of oils from Bell Creek Field, Montana, showing different degrees of microbiological alteration. Type 1 to the southwest is least altered; type 3 in the extreme northeast part of the field is partially altered with n-paraffins missing up to $n\text{-}C_{17}$. The most altered are the type 2 oils which occur in the central and north central part of the field (modified from Winters and Williams, 1969).

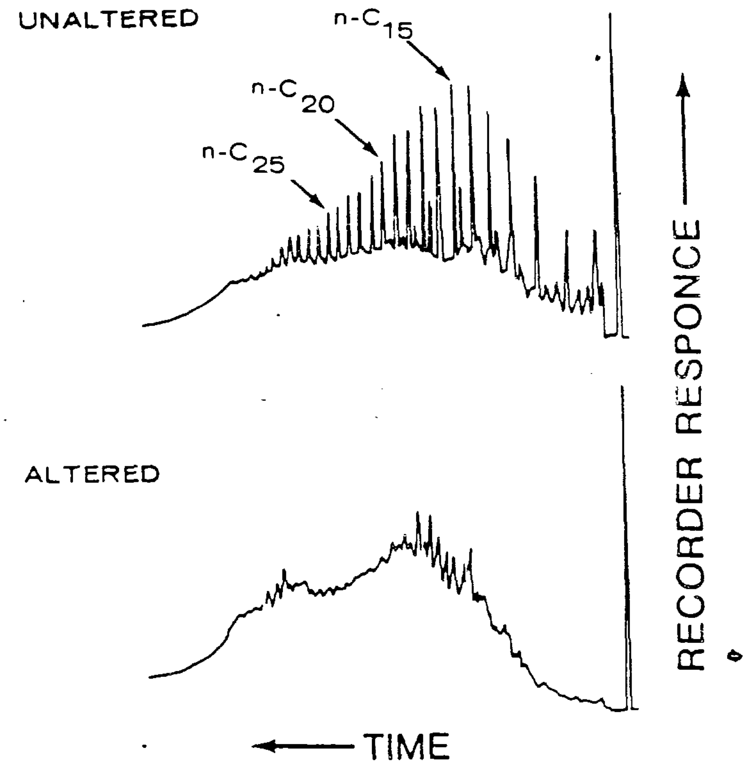


Figure 19 - Gas chromatograms of saturated hydrocarbon fractions of altered and unaltered oils from North Africa. Both oils are believed to be derived from the same source (after Winters and Williams, 1969). Note that the overall shape of the altered oil is more or less similar to that of the mine seep oils (Figs. 5 and 6), suggesting that both biodegraded oils underwent similar degrees of biodegradation at least with respect to the removal of n-paraffins.

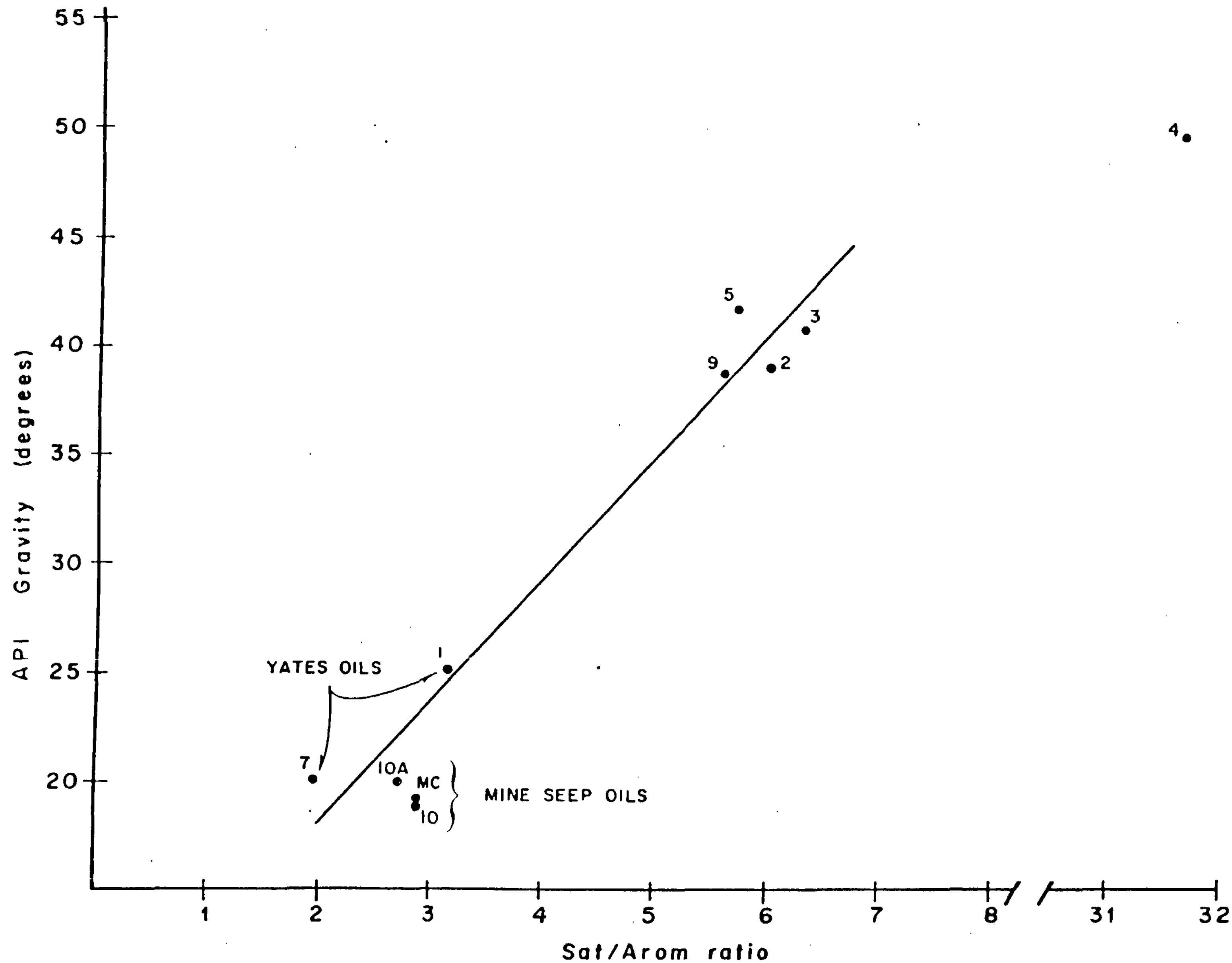


Figure 20 - Plot of API gravity versus saturated hydrocarbon/aromatic hydrocarbon (Sat/Arom) ratios showing relationship of mine seep oils to Yates crude oils in Eddy County, New Mexico. (Key to sample numbers in Table 3).

APPENDIX

6 bbl (0.95 m^3) of oil could fill

9.5 m^3 of rock at 10% porosity

or 19.0 m^3 of rock at 5% porosity.

If this volume of rock were a cylinder 0.3 m (1 ft) in height (h) that represents an oil-filled rock volume eminating radially from a borehole, then the radius or furthest extent of the oil-filled rock porosity is given by the formula:

$$r = \sqrt{\frac{V}{\pi h}}$$

for 10% porosity

$$r = \sqrt{\frac{9.5\ m^3}{\pi \times 0.3\ m}} = 3.2\ m\ (10.4\ ft\ or\ approx.\ 10.5\ ft)$$

for 5% porosity

$$r = \sqrt{\frac{19\ m^3}{\pi \times 0.3\ m}} = 4.5\ m\ (14.7\ ft\ or\ approx\ 15\ ft)$$

DELAWARE PRODUCING WELLS

LIVINGSTON RIDGE AREA

#	WELL NAME	FIELD	LOCATION U	Sec	Twn	Rge	OPERATOR	SPUD DATE	TD (ft)	COMP DATE	CUMULATIVE THRU 03/92 OIL (Bbl)	GAS (Mcf)	ULTIMATE RESERVES OIL (Bbl)	GAS (Mcf)	STATUS
1	Amoco Federal #1	Lusk West	D	21	19S	32E	Woodbine Petro	09/23/88	6650	10/31/88	50,785	49,697	90,764	96,040	
2	Amoco Federal #2	Lusk West	C	21	19S	32E	Woodbine Petro	03/09/89	6650	06/12/89	39,494	50,745	50,184	60,267	
3	Andaway 25 Federal #1	Geronimo	P	25	19S	32E	Grace Petroleum	08/03/91	7920	02/02/92	3,055	0	52,191	0	
4	Cal-Mon #2	Ingle Wells	F	35	23S	31E	Pogo Producing	---	---	---	18,785	39,372	67,093	98,683	
5	Cuervo Federal #2	DiamondTail	C	14	23S	32E	Strata Production	04/21/91	8774	01/17/92	8,009	1,492	144,617	47,542	
6	Exxon Federal #1	Crazy Horse	E	19	19S	33E	Anadarko Petro	06/05/91	7750	08/10/91	4,661	3,202	32,202	42,397	
7	Federal 1 #1	Livingston Ridge	K	1	22S	31E	Pogo Producing	11/15/91	8480	12/16/91	17,934	11,299	209,786	144,333	
8	Federal 1 #2	Lost Tank	J	1	22S	31E	Pogo Producing	01/10/92	8530	02/16/91	5,876	4,025	140,908	96,126	
9	Federal 1 #5	Lost Tank	M	1	22S	31E	Pogo Producing	01/28/92	8485	03/04/92	6,379	4,210	155,389	132,128	
10	Federal 12 #1	Livingston Ridge	M	12	22S	31E	Pogo Producing	06/18/91	8439	08/05/91	35,219	26,980	150,282	175,346	
11	Federal 12 #2	Livingston Ridge	L	12	22S	31E	Pogo Producing	08/22/91	8490	09/19/91	34,937	23,875	167,857	130,035	
12	Federal 12 #3	Livingston Ridge	N	12	22S	31E	Pogo Producing	01/20/92	8515	02/19/92	8,915	4,307	207,447	81,058	
13	Federal 12 #4	Livingston Ridge	E	12	22S	31E	Pogo Producing	11/09/91	8450	12/13/91	21,705	9,876	191,183	98,907	
14	Federal 12 #5	Livingston Ridge	D	12	22S	31E	Pogo Producing	12/13/91	8460	01/19/91	14,334	7,636	190,025	102,793	
15	Federal 12 #7	Livingston Ridge	F	12	22S	31E	Pogo Producing	02/08/92	8535	03/03/92	4,669	2,302	165,350	68,819	
16	Federal 12 #8	Livingston Ridge	C	12	22S	31E	Pogo Producing	03/28/92	8510	04/23/92	0	0	115,000	90,000	
17	Federal 23 #1	Livingston Ridge	P	23	22S	31E	Pogo Producing	06/22/90	8420	08/25/90	33,569	36,119	96,324	147,324	
18	Federal 23 #3	Livingston Ridge	H	23	22S	31E	Pogo Producing	07/05/91	8409	08/09/91	22,972	21,009	93,733	94,934	
19	Federal 23 #5	Livingston Ridge	A	23	22S	31E	Pogo Producing	03/19/91	8439	04/25/91	36,479	30,670	150,579	102,101	
20	Federal 26 #1	Livingston Ridge	A	26	22S	31E	Pogo Producing	05/30/90	8415	07/25/90	40,585	58,105	98,392	117,934	
21	Federal 26 #2	Livingston Ridge	G	26	22S	31E	Pogo Producing	02/21/91	8412	04/24/91	13,043	15,604	46,568	60,931	
22	Federal 26 #3	Livingston Ridge	C	26	22S	31E	Pogo Producing	07/21/91	8430	08/25/91	10,353	12,394	37,933	55,499	
23	Federal 26 #4	Livingston Ridge	D	26	22S	31E	Pogo Producing	10/25/91	8350	12/08/91	6,781	7,700	54,788	55,766	
24	Federal 26 #5	Livingston Ridge	B	26	22S	31E	Pogo Producing	12/03/91	8475	01/13/92	7,477	4,490	62,992	55,657	
25	Federal 30 #1	Lusk West	L	30	19S	32E	Yates Drilling	11/17/90	7300	01/23/90	32,694	28,194	92,519	96,800	
26	Federal 31-G #2	Geronimo	B	31	19S	33E	Manzano Oil Corp	12/09/91	9400	02/15/92	4,836	3,366	106,785	123,898	
27	Federal AW #1	Lusk East	E	26	19S	32E	Meridian Oil	01/16/87	13520	01/27/87	3,868	6,427	3,868	6,427	
28	Federal AW #2	Lusk East	O	26	19S	32E	Meridian Oil	09/28/90	7806	12/10/90	11,154	11,553	28,169	59,139	
29	Federal K #1	Triste Draw	I	34	23S	32E	Union Oil	06/16/65	5080	07/02/65	8,578	4,780	8,578	4,780	P&A 07/02/65
30	Federal L #1	Triste Draw	P	34	23S	32E	Union Oil	09/18/65	5039	10/03/65	3,525	2,782	3,525	2,782	P&A 10/03/65
31	Federal SB #1	Tonto West	J	12	19S	32E	Mitchell Energy	03/31/89	13689	04/04/89	5,481	4,664	5,481	4,664	P&A 06/89
32	Federal USA I #1	Lusk West	A	31	19S	32E	Texaco Expl & Prod	09/04/87	11385	12/03/87	39,202	97,300	50,902	112,038	
33	Federal USA J #1	Lusk West	P	30	19S	32E	Texaco Expl & Prod	08/17/87	11296	09/25/87	56,874	116,057	63,096	142,781	
34	Federal WL #1	Triste Draw	G	35	23S	32E	Union Oil	03/06/62	5110	03/24/62	47,374	27,700	47,374	27,700	P&A 03/24/62
35	Federal WL #2	Triste Draw	H	35	23S	32E	Snow Gene Oil	03/17/62	5105	03/29/62	24,134	9,021	24,134	9,021	P&A 03/29/62
36	Federal WL #3	Triste Draw	P	26	23S	32E	Snow Gene Oil	03/26/62	5144	04/09/62	23,695	6,530	23,695	6,530	P&A 04/09/62
37	Federal WL #4	Triste Draw	O	26	23S	32E	Snow Gene Oil	04/05/62	5105	04/16/62	47,528	27,644	47,528	27,644	P&A 04/16/62
38	Fields #1	Cruz	P	24	23S	32E	Baber Well Serv	04/15/63	5168	05/10/63	85,501	170,424	86,118	171,638	
39	Fields #1	Cruz	I	24	23S	32E	Johnston,Hugh Sr	04/15/63	5168	05/10/63	22,061	22,032	22,061	22,032	P&A 11/02/61
40	Fields #2	Cruz	M	25	23S	32E	Conoco, Inc	07/21/62	5206	08/05/62	17,533	40,220	17,533	40,220	P&A 08/05/62
41	Fields #4	Cruz	A	25	23S	32E	Baber Well Serv	10/10/76	5250	12/01/76	50,866	100,228	54,587	105,019	
42	Foran NF State #1	Lusk	B	32	19S	32E	Matador Operating	12/16/87	6588	04/09/88	2,461	0	2,461	8,259	
43	Ganso State #1	Hat Mesa	O	32	20S	33E	Strata Production	10/06/90	7318	11/06/90	38,092	18,701	121,228	75,795	
44	Ganso State #2	Hat Mesa	J	32	20S	33E	Strata Production	03/29/91	8380	05/09/91	30,910	25,285	119,611	71,335	
45	Ganso State #3	Hat Mesa	P	32	20S	33E	Strata Production	08/15/91	8374	10/07/91	10,956	5,303	100,943	36,003	
46	Geronimo Federal #1	Geronimo	D	31	19S	33E	Mitchell Energy	10/25/90	10564	10/31/90	53,045	36,606	159,934	149,173	

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 22

	WELL NAME	FIELD	LOCATION U	Sec	Twn	Rge	OPERATOR	SPUD DATE	TD (ft)	COMP DATE	CUMULATIVE THRU 03/92 OIL (Bbl)	GAS (Mcf)	ULTIMATE RESERVES OIL (Bbl)	GAS (Mcf)	STATUS
47	Geronimo Federal #6	Geronimo	E	31	19S	33E	Mitchell Energy	09/24/91	7900	12/15/91	18,709	14,240	183,592	254,725	
48	Getty Federal 24 #1	Livingston Ridge	G	24	22S	31E	Texaco Expl & Prod	05/15/89	14935	06/12/89	62,634	46,751	128,682	108,818	
49	Getty Federal 24 #2	Livingston Ridge	M	24	22S	31E	Texaco Expl & Prod	02/24/90	8000	03/27/90	40,603	37,753	75,340	82,160	
50	Getty Federal 24 #3	Livingston Ridge	B	24	22S	31E	Texaco Expl & Prod	03/15/90	8410	05/17/90	24,007	25,174	66,550	44,205	
51	Getty Federal 24 #4	Livingston Ridge	K	24	22S	31E	Texaco Expl & Prod	01/15/91	8400	02/18/91	25,798	25,179	92,357	65,670	
52	James Federal #1	Triste Draw	A	35	23S	32E	P M Drilling	---	---	---	43,883	55,067	43,883	55,067	P&A 02/14/61
53	James Federal #2	Triste Draw	B	35	23S	32E	P M Drilling	03/02/61	5145	04/06/61	52,374	52,307	52,374	52,307	P&A 04/06/61
54	Lusk 16 State #1	Lusk West	M	16	19S	32E	HEYCO	03/14/89	6600	05/03/89	15,962	22,533	20,415	25,705	
55	Lusk 16 State #2	Lusk West	L	16	19S	32E	HEYCO	07/30/89	6600	08/23/89	5,684	9,787	6,641	12,261	
56	Lusk Deep Unit A #12	Lusk West	G	20	19S	32E	Phillips Petro	04/11/89	12817	06/24/89	53,879	126,759	73,533	302,261	
57	Lusk Deep Unit A #14	Lusk West	O	20	19S	32E	Phillips Petro	01/02/88	7200	02/09/89	6,987	27,492	12,707	76,021	
58	Lusk Deep Unit A #15	Lusk West	H	20	19S	32E	Phillips Petro	11/22/88	7220	02/22/89	27,729	68,613	45,544	108,979	
59	Lusk Deep Unit A #17	Lusk West	A	20	19S	32E	Phillips Petro	11/17/89	7500	01/25/90	41,032	67,242	85,255	122,561	
60	Lusk Deep Unit A #19	Lusk West	B	20	19S	32E	Phillips Petro	01/26/90	7220	03/18/90	35,925	169,648	83,199	360,295	
61	Lusk Deep Unit A #20	Lusk West	I	20	19S	32E	Phillips Petro	03/17/90	7230	06/29/90	5,372	22,168	7,664	26,853	
62	Lusk Deep Unit A #4	Lusk West	J	20	19S	32E	Phillips Petro	10/04/62	11550	12/12/62	78,001	203,180	110,705	362,201	
63	Mobil Federal #1	Lusk West	E	21	19S	32E	Woodbine Petro	06/14/88	6700	07/13/88	105,825	190,197	142,855	256,714	
64	Mobil Federal #2	Lusk West	F	21	19S	32E	Woodbine Petro	08/30/88	6690	09/25/88	105,070	202,598	128,823	247,005	
65	Mobil Federal #3	Lusk West	L	21	19S	32E	Woodbine Petro	10/25/89	7240	01/01/90	33,228	117,707	85,759	345,297	
66	Mobil Federal #4	Lusk West	K	21	19S	32E	Woodbine Petro	03/13/90	7230	05/05/90	24,764	81,171	52,236	166,322	
67	Molly State #1	Lost Tank	C	1	22S	31E	Phillips Petro	09/25/91	8420	11/22/91	4,005	9,457	89,516	239,709	
68	Molly State #2	Lost Tank	F	1	22S	31E	Phillips Petro	09/26/91	8425	11/27/91	6,702	5,616	101,191	174,211	
69	Molly State #3	Lost Tank	D	1	22S	31E	Phillips Petro	10/20/91	8400	12/16/91	4,762	2,187	65,568	68,704	
70	Molly State #4	Lost Tank	E	1	22S	31E	Phillips Petro	10/16/91	8409	12/27/91	943	513	51,582	44,920	
71	Neff #1	Livingston Ridge	J	13	22S	31E	Pogo Producing	04/14/88	14975	09/27/88	70,429	91,921	94,182	137,192	
72	Neff 13 Federal #2	Livingston Ridge	H	13	22S	31E	Texaco Expl & Prod	09/07/89	8450	10/07/89	52,034	40,820	87,422	88,979	
73	Neff 13 Federal #3	Livingston Ridge	O	13	22S	31E	Texaco Expl & Prod	10/02/89	8450	10/28/89	78,024	69,851	155,865	150,850	
74	Neff 13 Federal #4	Livingston Ridge	B	13	22S	31E	Texaco Expl & Prod	12/27/90	8450	02/03/91	30,189	38,851	72,951	108,633	
75	Neff 13 Federal #5	Livingston Ridge	F	13	22S	31E	Texaco Expl & Prod	02/04/91	8398	05/22/91	8,804	14,510	29,769	31,047	
76	Neff 13 Federal #6	Livingston Ridge	D	13	22S	31E	Texaco Expl & Prod	10/19/91	8400	12/01/91	23,575	14,001	211,978	128,190	
77	Neff Federal #1	Livingston Ridge	C	25	22S	31E	Pogo Producing	11/01/89	15026	11/04/89	13,471	19,843	44,692	40,582	
78	Neff Federal #2	Livingston Ridge	E	25	22S	31E	Pogo Producing	10/07/91	8440	11/12/91	1,882	2,794	26,659	40,984	
79	New Mexico A Federal #1	Hat Mesa	F	4	21S	32E	Strata Production	07/13/89	14000	09/18/89	6,838	7,786	12,517	33,010	
80	New Mexico A Federal #2	Hat Mesa	G	4	21S	32E	Strata Production	10/27/88	14047	12/01/88	26,956	7,522	72,989	15,027	
81	New Mexico A Federal #3	Hat Mesa	C	4	21S	32E	Strata Production	03/15/90	7150	05/02/90	44,330	22,419	103,528	117,620	
82	New Mexico A Federal #4	Hat Mesa	H	4	21S	32E	Strata Production	09/12/90	7230	10/22/90	8,858	6,092	25,602	66,130	
83	New Mexico A Federal #5	Hat Mesa	D	4	21S	32E	Strata Production	02/09/91	8370	03/22/91	31,836	14,101	124,434	150,261	
84	New Mexico A Federal #6	Hat Mesa	E	4	21S	32E	Strata Production	09/14/91	8414	11/12/91	15,152	2,786	118,443	79,537	
85	New Mexico CR State #1	Lusk West	D	32	19S	32E	Texaco Expl & Prod	07/03/90	11500	07/12/90	69,725	64,749	72,464	69,774	
86	New Mexico DH State #1-Y	Lusk	A	32	19S	32E	Texaco, Inc	03/13/71	5050	05/13/71	533	1,462	533	1,462	P&A 05/13/71
87	Payne Federal #1	Triste Draw	F	35	23S	32E	Tempo Energy	05/18/61	5092	06/10/61	89,346	88,412	89,346	88,412	P&A 06/10/61
88	Payne Federal #2	Triste Draw	C	35	23S	32E	Tempo Energy	05/16/62	5074	05/25/62	71,311	78,114	71,311	78,114	P&A 05/25/62
89	Payne Federal #3	Triste Draw	L	35	23S	32E	P M Drilling	08/08/65	5026	08/25/65	29,366	33,972	29,366	33,972	P&A 08/25/65
90	Payne Federal #4	Triste Draw	K	35	23S	32E	Tempo Energy	07/31/85	5030	08/31/85	17,130	13,038	26,928	21,619	
91	Plains Unit Federal #10	Lusk	N	28	19S	32E	Amoco Production	11/21/69	4895	12/18/69	2,884	2,896	2,884	2,896	P&A 01/30/71
92	Plains Unit Federal #7	Lusk	D	33	19S	32E	Meridian Oil	04/28/64	11589	12/29/68	208,113	406,178	208,113	406,178	

	WELL NAME	FIELD	LOCATION U	Sec	Twn	Rge	OPERATOR	SPUD DATE	TD (ft)	COMP DATE	CUMULATIVE THRU 03/92 OIL (Bbl)	GAS (Mcf)	ULTIMATE RESERVES OIL (Bbl)	GAS (Mcf)	STATUS
93	Plains Unit Federal #9	Lusk	F	33	19S	32E	Amoco Production	04/28/69	5150	05/27/69	24,974	16,537	24,974	16,537	P&A 05/27/69
94	Polewski Federal #1	Lusk West	D	31	19S	32E	Anadarko Petro	01/08/88	12976	03/01/88	81,625	101,669	113,411	168,110	
95	S.A. Bowman Federal #4	Lusk West	N	29	19S	32E	Texaco Expl & Prod	12/08/87	6850	01/24/88	54,467	92,584	70,427	124,687	
96	S.A. Bowman Federal #5	Lusk West	K	29	19S	32E	Texaco Expl & Prod	01/17/88	6850	03/02/88	94,908	227,080	124,044	284,174	
97	Sapphire Federal #1	Gem East	J	23	19S	33E	Mitchell Energy	04/02/91	13600	04/26/91	4,082	3,344	21,449	31,163	
98	Sapphire Federal #2	Gem East	C	23	19S	33E	Mitchell Energy	04/18/91	8000	06/26/91	13,384	11,105	77,721	59,202	
99	Southern California Fed #1	Lusk West	H	29	19S	32E	Parker & Parsley	03/23/62	12834	07/24/62	141,897	233,322	191,274	351,635	
100	Southern California Fed #5	Lusk West	J	29	19S	32E	Parker & Parsley	12/05/87	7200	12/30/87	107,237	214,880	148,159	297,814	
101	Southern California Fed #6	Lusk West	M	29	19S	32E	Parker & Parsley	11/13/87	7200	12/21/87	48,518	137,153	64,536	189,951	
102	Southern California Fed #7	Lusk West	F	29	19S	32E	Parker & Parsley	03/23/88	7204	05/17/88	42,658	99,331	47,147	116,263	
103	Southern California Fed #8	Lusk West	B	29	19S	32E	Parker & Parsley	04/16/88	7200	05/14/88	78,047	156,181	91,677	203,248	
104	State 2 #1	Lost Tank	P	2	22S	31E	Pogo Producing	12/15/91	8440	01/22/92	4,979	5,255	80,944	82,006	
105	State 2 #3	Lost Tank	I	2	22S	31E	Pogo Producing	11/28/91	8415	01/11/92	2,531	3,045	99,317	41,108	
106	State DR #5	Lusk West	G	16	19S	32E	Meridian Oil	02/13/89	6607	07/14/89	131	0	131	0	P&A 03/06/89
107	Texaco Federal #3	Gem	N	14	19S	33E	Manzano Oil	12/15/91	7980	03/07/92	891	0	23,405	8,179	
108	Tonto State #1	Gem	J	32	19S	33E	JFG Enterprises	11/05/90	13630	11/09/90	5,973	7,582	16,232	19,032	
109	Unocal HPC Federal #1	Lost Tank	G	1	22S	31E	Hanagan Petroleum	07/01/91	8461	08/14/91	35,304	25,314	163,519	130,197	
110	Unocal HPC Federal #2	Lost Tank	H	1	22S	31E	Hanagan Petroleum	10/10/91	8532	12/02/91	10,943	9,061	111,533	97,874	
111	Urraca Federal #1	DiamondTail	N	11	23S	32E	Strata Production	12/27/90	15950	03/20/91	9,684	4,675	39,737	31,729	
112	Aqueduct AGG Fed #1	Lusk West	P	17	19S	32E	Yates Petroleum	06/11/89	7300	08/08/89	22,064	41,135	25,399	50,102	
113	Belco AIA Federal #1	Salt Lake	J	14	20S	32E	Yates Petroleum	06/22/90	13250	08/29/90	40,476	0	227,279	0	
114	Bonneville AKK Federal #2	Lusk West	M	19	21S	32E	Yates Petroleum	04/28/92	8610	06/29/92	0	0	22,000	40,000	
115	Cleary AKC Federal #1	Livingston Ridge	J	17	22S	32E	Yates Petroleum	12/17/91	14800	02/15/92	454	0	18,000	15,000	
116	David Ross AIT Federal #1	Livingston Ridge	H	35	22S	31E	Yates Petroleum	02/22/91	8450	04/12/91	---	---	---	---	Last Prod 06/91
117	Dolores AIL Federal #1	Livingston Ridge	A	14	22S	31E	Yates Petroleum	02/16/91	8425	03/26/91	42,153	25,966	144,505	159,599	
118	Dolores AIL Federal #2	Livingston Ridge	I	14	22S	31E	Yates Petroleum	08/16/91	8440	09/24/91	45,453	43,380	266,179	355,499	
119	Dolores AIL Federal #3	Livingston Ridge	H	14	22S	31E	Yates Petroleum	06/01/91	8420	07/02/91	49,361	29,826	189,641	110,998	
120	Flood AFN Federal #1	Lusk West	M	30	19S	32E	Yates Petroleum	07/16/90	7270	09/03/90	45,132	73,432	100,384	196,233	
121	Graham AKB State #1	Lost Tank	A	2	22S	31E	Yates Petroleum	02/05/92	8450	03/16/92	2,948	2,816	120,000	150,000	
122	Graham AKB State #2	Lost Tank	H	2	22S	31E	Yates Petroleum	03/24/92	8400	04/28/92	0	0	140,000	175,000	
123	Kiwi AKX State #1	Livingston Ridge E	P	16	22S	32E	Yates Petroleum	04/28/92	8775	05/23/92	0	0	225,000	275,000	
124	Kiwi AKX State #2	Livingston Ridge E	I	16	22S	32E	Yates Petroleum	05/16/92	8825	06/11/92	0	0	205,000	225,000	
126	Lost Tank AIS State #1	Lost Tank	I	36	21S	31E	Yates Petroleum	12/07/91	8550	1/17/92	12,001	11,221	153,170	190,306	
126	Lost Tank AIS State #2	Lost Tank	O	36	21S	31E	Yates Petroleum	10/21/91	8500	11/30/91	16,500	11,866	128,451	107,023	
127	Lost Tank AIS State #3	Lost Tank	N	36	21S	31E	Yates Petroleum	12/29/90	8620	03/20/91	18,161	11,794	53,614	48,938	
128	Lost Tank AIS State #4	Lost Tank	K	36	21S	31E	Yates Petroleum	11/19/91	8450	12/26/91	6,091	6,867	67,188	68,267	
129	Lost Tank AIS State #5	Lost Tank	M	36	21S	31E	Yates Petroleum	12/27/91	8440	01/28/92	4,798	5,146	58,848	61,430	
130	Lost Tank AIS State #6	Lost Tank	J	36	21S	31E	Yates Petroleum	11/05/91	8610	12/21/91	3,188	5,041	25,929	37,821	
131	Lost Tank AIS State #8	Lost Tank	P	36	21S	31E	Yates Petroleum	10/02/91	8530	11/10/91	42,177	32,133	232,042	226,568	
132	Lusk AHB Federal #2	Lusk East	G	35	19S	32E	Yates Petroleum	10/21/90	10600	12/25/90	52,039	27,994	276,079	460,724	
133	Lusk AHB Federal #3	Lusk East	J	35	19S	32E	Yates Petroleum	01/21/92	7900	03/01/92	1,517	2,340	62,719	65,887	
134	Lusk AHB Federal #5	Lusk East	B	35	19S	32E	Yates Petroleum	11/19/91	7940	01/14/92	14,089	28,854	233,060	449,366	
135	Lusk AHB Federal #6	Lusk East	A	35	19S	32E	Yates Petroleum	02/29/92	7900	04/09/92	0	0	33,000	30,000	
136	Martha AIK Federal #1	Livingston Ridge	P	11	22S	31E	Yates Petroleum	12/07/90	8425	02/21/91	44,876	24,109	106,461	99,940	
137	Martha AIK Federal #2	Livingston Ridge	I	11	22S	31E	Yates Petroleum	03/19/91	8450	04/17/91	45,033	40,950	166,953	144,598	
138	Martha AIK Federal #3	Livingston Ridge	O	11	22S	31E	Yates Petroleum	05/06/91	8411	06/10/91	24,262	15,799	93,218	86,763	

	WELL NAME	FIELD	LOCATION U	Sec	Twn	Rge	OPERATOR	SPUD DATE	TD (ft)	COMP DATE	CUMULATIVE THRU 03/92 OIL (Bbl)	GAS (Mcf)	ULTIMATE RESERVES OIL (Bbl)	GAS (Mcf)	STATUS
139	Martha AIK Federal #4	Livingston Ridge	J	11	22S	31E	Yates Petroleum	09/02/91	8530	10/12/91	16,707	18,680	121,690	148,957	
140	Martha AIK Federal #5	Livingston Ridge	H	11	22S	31E	Yates Petroleum	01/08/92	8420	02/21/92	2,864	3,691	101,843	75,325	
141	Martha AIK Federal #6	Livingston Ridge	A	11	23S	33E	Yates Petroleum	03/09/92	8410	04/15/92	0	0	90,000	100,000	
142	Mary AIV State #1	Lost Tank	G	36	21S	31E	Yates Petroleum	01/31/91	8470	04/18/91	23,772	14,414	86,991	63,319	
143	Mary AIV State #3	Lost Tank	B	36	21S	31E	Yates Petroleum	05/20/91	8500	07/02/91	11,331	8,384	43,144	48,511	
144	Mary AIV State #5	Lost Tank	A	36	21S	31E	Yates Petroleum	12/13/91	8565	01/30/92	2,009	2,248	45,192	52,998	
145	Medano VA St #1	Los Medanos	K	16	23S	31E	Yates Petroleum	08/26/82	12175	04/21/83	18,966	1,875	54,596	9,780	
146	Medano VA St #3	Los Medanos	F	16	23S	31E	Yates Petroleum	01/02/91	8130	02/21/91	6,022	7,078	67,757	58,114	
147	Pronghorn AAP Federal #1	Cruz Delaware	M	8	23S	33E	Yates Petroleum	10/01/84	5370	12/03/84	7,619	0	9,173	0	
148	Rosemary AJB Federal #1	Livingston Ridge NE	L	6	22S	32E	Yates Petroleum	04/26/91	8600	06/15/91	13,608	11,819	58,454	73,386	
149	Unocal AHU Federal #1	Lost Tank	B	1	22S	31E	Yates Petroelum	04/02/91	8500	05/06/91	38,024	33,119	171,273	191,737	
150	Unocal AHU Federal #2	Lost Tank	A	1	22S	31E	Yates Petroleum	07/18/91	8560	08/31/91	43,056	21,525	198,962	128,976	
151	Wolf AJA Federal #4	Lost Tank	I	25	21S	31E	Yates Petroleum	07/05/91	8600	08/28/91	17,867	10,244	76,725	50,541	
152	Wolf AJA Federal #5	Lost Tank	H	25	21S	31E	Yates Petroleum	09/23/91	8550	10/29/91	6,076	2,592	53,404	12,825	
153	Wolf AJA Federal #7	Lost Tank	P	24	21S	31E	Yates Petroleum	02/19/92	8495	03/24/92	1,722	949	173,523	118,633	
										TOTALS	4,295,697	5,740,788	13,686,147	16,167,811	
										AVERAGE			89,452	105,672	

LIVINGSTON RIDGE AREA
DELAWARE COMPLETION
DRILLING COST = $0.7 MILLION
RESERVES = 89 MBO

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 23

R E S E R V E S   A N D   E C O N O M I C S

GAS/OIL = 1.18 MCF/BO
PRICE = $19/BO, $1.75/MCF

AS OF OCTOBER 1, 1992

-END- MO-YR	---GROSS PRODUCTION--- OIL, MBBL	GAS, MMCF	----NET PRODUCTION---- OIL, MBBL	GAS, MMCF	--PRICES--- OIL $/B	GAS $/M	--------OPERATIONS, M$-------- NET OPER REVENUES	SEV+ADV+ WF TAXES	NET OPER EXPENSES	CAPITAL COSTS, M$	CASH FLOW BTAX, M$	10.00 PCT CUM. DISC BTAX, M$
12-92	9.215	10.874	7.833	9.243	19.00	1.75	165.002	16.246	7.052	700.000	-558.296	-559.971
12-93	24.863	29.338	21.134	24.937	19.00	1.75	445.186	43.833	26.069	.000	375.284	-210.445
12-94	14.872	17.549	12.641	14.917	19.00	1.75	266.284	26.219	23.302	.000	216.763	-26.913
12-95	10.062	11.873	8.553	10.092	19.00	1.75	180.168	17.740	21.227	.000	141.201	81.773
12-96	7.338	8.659	6.237	7.360	19.00	1.75	131.383	12.936	19.670	.000	98.777	150.892
12-97	5.630	6.643	4.786	5.647	19.00	1.75	100.816	9.926	18.503	.000	72.387	196.940
12-98	4.467	5.271	3.797	4.480	19.00	1.75	79.983	7.876	17.627	.000	54.480	228.446
12-99	3.574	4.218	3.038	3.585	19.00	1.75	63.996	6.300	16.970	.000	40.726	249.857
12- 0	2.859	3.373	2.430	2.867	19.00	1.75	51.187	5.040	16.478	.000	29.669	264.037
12- 1	2.287	2.699	1.944	2.294	19.00	1.75	40.951	4.032	16.108	.000	20.811	273.079
12- 2	1.829	2.158	1.555	1.834	19.00	1.75	32.755	3.225	15.831	.000	13.699	278.490
12- 3	1.464	1.728	1.244	1.469	19.00	1.75	26.207	2.581	15.623	.000	8.003	281.364
12- 4	1.171	1.382	.995	1.175	19.00	1.75	20.961	2.064	15.467	.000	3.430	282.484
12- 5												
12- 6												
12- 7												
12- 8												
12- 9												
12-10												
12-11												
S TOT	89.631	105.765	76.187	89.900	19.00	1.75	1604.879	158.018	229.927	700.000	516.934	282.484
REM.	.000	.000	.000	.000	.00	.00	.000	.000	.000	.000	.000	282.484
TOTAL	89.631	105.765	76.187	89.900	19.00	1.75	1604.879	158.018	229.927	700.000	516.934	282.484

	OIL	GAS
CUM.	.000	.000
ULT.	89.631	105.765

NET OIL REVENUES (M$)	1447.553
NET GAS REVENUES (M$)	157.326
TOTAL REVENUES (M$)	1604.879

BTAX RATE OF RETURN (PCT)	34.80	PROJECT LIFE (YEARS)	12.250
BTAX PAYOUT YEARS	2.09	DISCOUNT RATE (PCT)	10.000
BTAX PAYOUT YEARS (DISC)	2.50	GROSS OIL WELLS	1.000
BTAX NET INCOME/INVEST	1.74	GROSS GAS WELLS	.000
BTAX NET INCOME/INVEST (DISC)	1.40	GROSS WELLS	1.000
INITIAL W.I. FRACTION	1.000000	INITIAL NET OIL FRACTION	.850000
FINAL W.I. FRACTION	1.000000	FINAL NET OIL FRACTION	.850000
PRODUCTION START DATE	10- 1-92	INITIAL NET GAS FRACTION	.850000
MONTHS IN FIRST LINE	3.00	FINAL NET GAS FRACTION	.850000

---------PRESENT WORTH PROFILE---------

DISC RATE	PW OF NET BTAX, M$	DISC RATE	PW OF NET BTAX, M$
.0	516.934	30.0	37.111
2.0	459.491	35.0	-1.579
5.0	384.448	40.0	-34.986
8.0	320.290	45.0	-64.151
10.0	282.484	50.0	-89.855
12.0	248.049	60.0	-133.147
15.0	201.811	70.0	-168.282
18.0	161.054	80.0	-197.445
20.0	136.470	90.0	-222.091
25.0	82.483	100.0	-243.236

WATER GROSS PROD. (MU)	153.920	WATER NET PRODUCTION (MU)	130.832	WATER NET REVENUES (M$)	.000

GRAHAM AKB STATE
DELAWARE COMPLETION
DRILLING COST = $0.7 MILLION
RESERVES = 130 MBO

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 24

R E S E R V E S   A N D   E C O N O M I C S

GAS/OIL = 1.25 MCF/BO
PRICE = $19/BO, $1.75/MCF

AS OF OCTOBER 1, 1992

-END- MO-YR	GROSS PRODUCTION OIL, MBBL	GROSS PRODUCTION GAS, MMCF	NET PRODUCTION OIL, MBBL	NET PRODUCTION GAS, MMCF	PRICES OIL $/B	PRICES GAS $/M	OPERATIONS, M$ NET OPER REVENUES	OPERATIONS, M$ SEV+ADV+ WF TAXES	OPERATIONS, M$ NET OPER EXPENSES	CAPITAL COSTS, M$	CASH FLOW BTAX, M$	10.00 PCT CUM. DISC BTAX, M$
12-92	13.117	16.396	11.149	13.937	19.00	1.75	236.221	23.259	7.052	700.000	-494.090	-496.524
12-93	35.390	44.238	30.082	37.602	19.00	1.75	637.362	62.755	26.069	.000	548.538	14.365
12-94	21.170	26.462	17.995	22.493	19.00	1.75	381.268	37.539	23.302	.000	320.427	285.669
12-95	14.322	17.903	12.174	15.218	19.00	1.75	257.938	25.397	21.227	.000	211.314	448.322
12-96	10.446	13.057	8.879	11.098	19.00	1.75	188.123	18.523	19.670	.000	149.930	553.235
12-97	8.013	10.017	6.811	8.514	19.00	1.75	144.309	14.209	18.503	.000	111.597	624.226
12-98	6.359	7.948	5.405	6.756	19.00	1.75	114.518	11.276	17.627	.000	85.615	673.738
12-99	5.086	6.358	4.323	5.404	19.00	1.75	91.594	9.018	16.970	.000	65.606	708.229
12- 0	4.070	5.087	3.460	4.324	19.00	1.75	73.307	7.218	16.478	.000	49.611	731.940
12- 1	3.255	4.069	2.767	3.459	19.00	1.75	58.626	5.772	16.108	.000	36.746	747.906
12- 2	2.605	3.256	2.214	2.768	19.00	1.75	46.910	4.618	15.831	.000	26.461	758.358
12- 3	2.083	2.604	1.771	2.213	19.00	1.75	37.522	3.695	15.623	.000	18.204	764.895
12- 4	1.667	2.084	1.417	1.771	19.00	1.75	30.022	2.956	15.467	.000	11.599	768.681
12- 5	1.333	1.666	1.133	1.416	19.00	1.75	24.005	2.364	15.351	.000	6.290	770.548
12- 6	1.067	1.334	.907	1.134	19.00	1.75	19.218	1.893	15.263	.000	2.062	771.104
12- 7												
12- 8												
12- 9												
12-10												
12-11												
S TOT	129.983	162.479	110.487	138.107	19.00	1.75	2340.943	230.492	260.541	700.000	1149.910	771.104
REM.	.000	.000	.000	.000	.00	.00	.000	.000	.000	.000	.000	771.104
TOTAL	129.983	162.479	110.487	138.107	19.00	1.75	2340.943	230.492	260.541	700.000	1149.910	771.104

CUM.	.000	.000
ULT.	129.983	162.479

NET OIL REVENUES (M$)	2099.253
NET GAS REVENUES (M$)	241.690
TOTAL REVENUES (M$)	2340.943

BTAX RATE OF RETURN (PCT)	90.19
BTAX PAYOUT YEARS	1.15
BTAX PAYOUT YEARS (DISC)	1.22
BTAX NET INCOME/INVEST	2.64
BTAX NET INCOME/INVEST (DISC)	2.10
INITIAL W.I. FRACTION	1.000000
FINAL W.I. FRACTION	1.000000
PRODUCTION START DATE	10- 1-92
MONTHS IN FIRST LINE	3.00
WATER GROSS PROD. (MU)	155.965

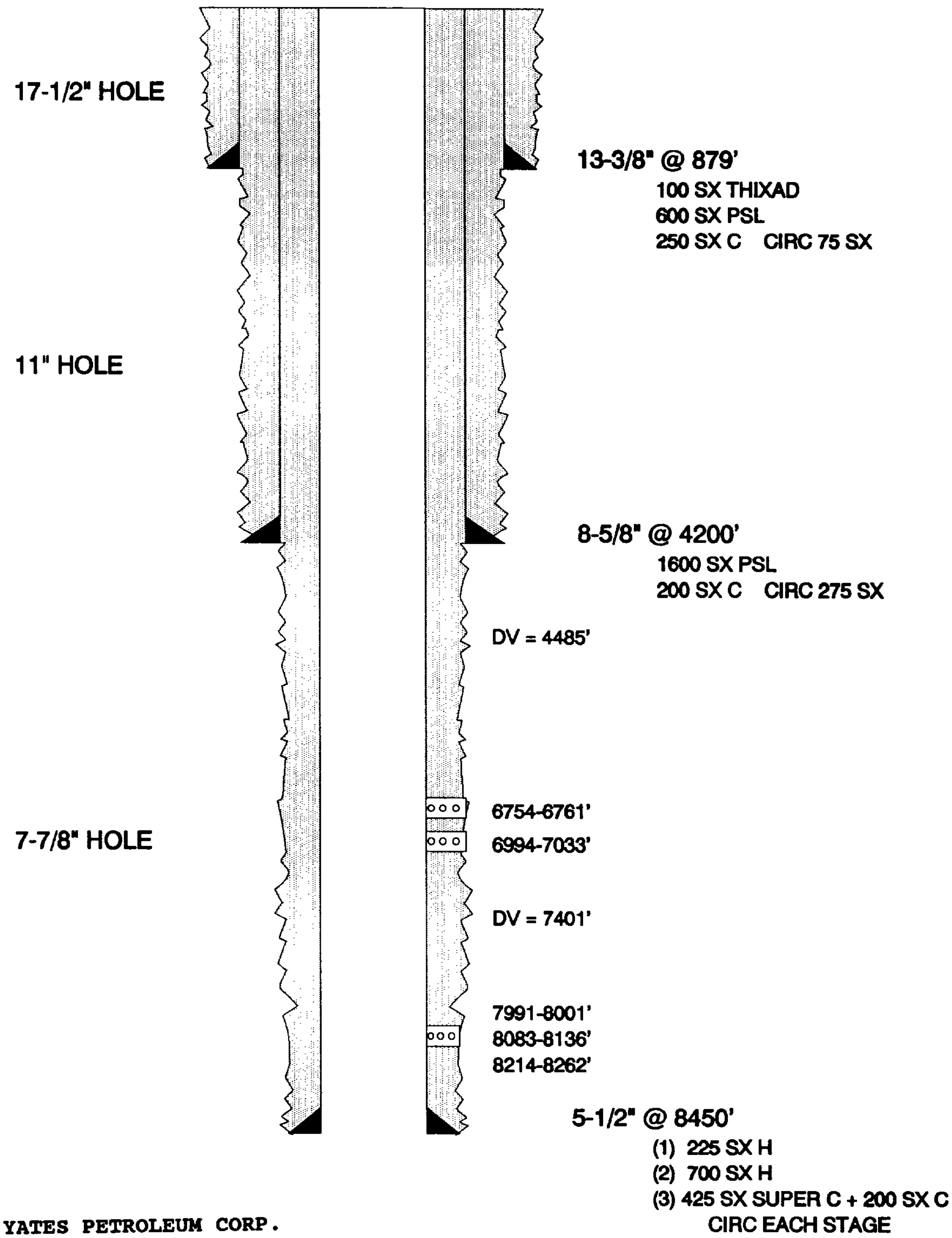
PROJECT LIFE (YEARS)	14.250
DISCOUNT RATE (PCT)	10.000
GROSS OIL WELLS	1.000
GROSS GAS WELLS	.000
GROSS WELLS	1.000
INITIAL NET OIL FRACTION	.850000
FINAL NET OIL FRACTION	.850000
INITIAL NET GAS FRACTION	.850000
FINAL NET GAS FRACTION	.850000
WATER NET PRODUCTION (MU)	132.571

PRESENT WORTH PROFILE

DISC RATE	PW OF NET BTAX, M$	DISC RATE	PW OF NET BTAX, M$
.0	1149.910	30.0	389.954
2.0	1055.710	35.0	331.108
5.0	934.012	40.0	280.531
8.0	831.182	45.0	236.542
10.0	771.104	50.0	197.896
12.0	716.712	60.0	133.031
15.0	644.161	70.0	80.590
18.0	580.659	80.0	37.188
20.0	542.549	90.0	.582
25.0	459.360	100.0	-30.773

WATER NET REVENUES (M$) .000

GRAHAM AKB STATE #1 CEMENT & CASING



YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 25

GRAHAM AKB STATE #1
DETAILED CEMENTING PROGRAM

A. 20 Joints 13 3/8" 54.5# J-55 set at 879 feet

One Stage	100 sx H with 12% Thixad	-- 1.38 cf/sx, 15.2 #/gal
	600 sx Pacesetter Lite C 2% CaCl2 0.5 #/sx Celloseal	-- 1.76 cf/sx, 12.9 #/gal
	250 sx C with 2% CaCl2	-- 1.32 cf/sx, 14.8 #/gal

B. 96 Joints 8 5/8" 32# HC-80 & J-55 set at 4200 feet

One Stage	1600 sx Pacesetter Lite C 10 #/sx salt (NaCl) 5 #/sx Gilsonite 0.25 #/sx Celloseal	-- 1.94 cf/sx, 12.9 #/gal
	200 sx C with 2% CaCl2	-- 1.32 cf/sx, 14.8 #/gal

C. 202 Joints 5 1/2" 17# & 15.5# J-55 set at 8450 feet

Stage 1 DV = 7401'	225 sx Class H 8 #/sx CSE - Fused Silica 0.6% CF-14 5 #/sx Gilsonite 0.35% Thriftylite	-- 1.75 cf/sx, 13.6 #/gal
Stage 2 DV = 4485'	700 sx Class H 8 #/sx CSE - Fused Silica 0.5% CF-14 5 #/sx Gilsonite 0.35% Thriftylite	-- 1.82 cf/sx, 13.4 #/gal
Stage 3	425 sx Super C	-- 2.25 cf/sx, 11.5 #/gal
	200 sx Class C	-- 1.32 cf/sx, 14.8 #/gal

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
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EXHIBIT NO. 26

LIFE of DELAWARE FIELDS

FIELD NAME	COUNTY	1-1-92 # WELLS	START PRIMARY	YEARS PRIMARY	YEARS FLOODED	1-1-92 CUM BO	1-1-92 CUM Mcf	COMMENTS
Avalon Delaware	Eddy	26	1983	9	NA	2869662	5788176	Limited by allowable
Brushy Draw Delaware	Eddy	85	1983	9	NA	4641158	7091402	Primary end = 1998 (15 Yrs)
Cabin Lake Delaware	Eddy	18	1987	5	NA	594834	393356	Being Developed
Corbin Delaware West	Lea	29	1989	3	NA	1075431	1219021	Being Developed
Corral Canyon Delaware	Eddy	14	1984	8	NA	543742	295405	Primary end = 1998 (14 Yrs)
Cruz Delaware	Lea	16	1984	8	NA	1131028	1865816	Primary end = 1994 (10 Yrs)
Double X Delaware	Lea	19	1961	31	NA	1258649	3751318	Marginal many years, MaxW=31
El Mar Delaware	Lea	9	1960	15	17	5966651	13593904	WF end=1996(21 Yrs), MaxW=51
Fenton Delaware NW	Eddy	11	1985	7	NA	510772	864693	Primary end = 1997 (12 Yrs)
Herradura Bend Delaware	Eddy	19	1978	14	NA	791274	59863	Primary end = 1995 (18 Yrs)
Indian Draw Delaware	Eddy	11	1974	10	8	2504283	163456	WF end=1999(15 Yrs), MaxW=21
Indian Draw Delaware E	Eddy	9	1985	7	NA	427803	129367	Primary end = 1995 (10 Yrs)
Indian Flats Delaware	Eddy	7	1977	15	NA	442812	149721	Primary end = 1994 (17 Yrs)
Livingston Ridge Delaware	Eddy	29	1989	3	NA	762888	674388	Being Developed
Loving Delaware East	Eddy	88	1988	4	NA	2777758	7706868	Being Developed
Lusk Delaware West	Lea	28	1987	5	NA	1501456	2968362	Primary end = 1998 (11 Yrs)
Malaga Delaware	Eddy	6	1951	23	18	866700	73303	WF end=1994(20Yrs), MaxW=13
Mason Delaware East	Lea	23	1982	10	NA	1195598	1964011	Primary end = 1996 (14 Yrs)
Mason Delaware North	Eddy+Lea	46	1954	38	NA	4361443	7950914	Marginal many years
Paduca Delaware	Lea	21	1960	8	24	13564001	15592265	WF end=1996(28Yrs), MaxW=47
Parkway Delaware	Eddy	30	1988	4	NA	1223043	2152346	Primary end = 2003 (15 Yrs)
Shugart Delaware East	Eddy+Lea	18	1986	6	NA	1459244	2560674	Primary end = 2002 (16 Yrs)

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449
DATE: 09/09/92 DE NOVO
EXHIBIT NO. 27

NELSON A. MUNCY

RESUME

SEPTEMBER 1, 1992

YATES PETROLEUM CORP.
BEFORE THE COMMISSION
NMOCD CASE NOS. 10446-10449 DE NOVO
DATE: 09/09/92
EXHIBIT NO. 28

EDUCATION:

GRADUATED FROM ARTESIA HIGH SCHOOL IN 1962.
GRADUATED FROM THE UNIVERSITY OF ARIZONA IN 1966 B.S., BUSINESS MANAGEMENT
GRADUATED FROM THE UNIVERSITY OF ARIZONA IN 1971 B.S., MINING ENGINEERING

PROFESSIONAL REGISTRATIONS:

REGISTERED PROFESSIONAL MINING ENGINEER- ARIZONA #10326 (JUL '75)
REGISTERED LAND SURVEYOR - ARIZONA #17392 (AUG '84)
REGISTERED PROFESSIONAL ENGINEER - TEXAS #50771 (MAR '82)

AFFILIATIONS:

SOCIETY OF MINING ENGINEERS - MEMBER (1969-1984)
SOCIETY OF PETROLEUM ENGINEERS - MEMBER (1982-PRESENT)
PAST MEMBER NEW MEXICO SOCIETY OF PROFESSIONAL ENGINEERS
ROSWELL GEOLOGICAL SOCIETY - MEMBER

EXPERIENCE:

TOTAL OF 21-YEARS COMPRISED OF 9-YEARS MINING EXPERIENCE AND 12-YEARS OIL-GAS EXPERIENCE AS FOLLOWS:.

(1968-69)
* INSPIRATION CONSOLIDATED COPPER CO., GLOBE, AZ., INDUSTRIAL ENGINEER
CONDUCTED MOTION-TIME STUDIES UNDERGROUND, OPEN PIT, CONCENTRATOR, SMELTER AND ROD PLANT.

(1971-72)
* KENNECOTT COPPER CORP., BINGHAM CANYON, UT., SHOVEL-TRAIN & DRILLING-BLASTING FOREMAN "THE WORLD'S LARGEST OPEN PIT COPPER MINE"

(1972-77)
* JAQUAYS MINING CORP, GLOBE, AZ., MINE ENGINEER, SURVEYOR, MILL SUPERINTENDENT, MINE SUPERINTENDENT AND VICE PRESIDENT. CHRYSOTILE MINING AND MILLING - GOLD HEAP LEACH CONGRESS MINE.
* D.W. JAQUAYS MINING & CONTRACTORS EQUIPMENT AND SUPPLIES, GLOBE AZ., BRANCH MANAGER SOLD MINING EQUIPMENT AND EXPLOSIVES.

(1977-81)
* MARNEL PIPE AND SUPPLY COMPANY, ARTESIA, NM, OWNER. PLUGGED AND ABANDONED OIL AND GAS WELLS IN SOUTHEAST NEW MEXICO AND WEST TEXAS. DRILLED AND OPERATED OIL AND GAS WELLS IN SOUTHEAST NEW MEXICO. MINING AND OIL-GAS CONSULTANT.

(1979-80)

* AMAX POTASH, EDDY COUNTY, NM.,CONSULTANT, MINE ENGINEER, RELIEF SHIFT BOSS, SURVEYOR AND NEW MINER TRAINING COORDINATOR. SURVEYED, CORE DRILLED & LOGGED SOME TWENTY POTASH CORE HOLES. INVOLVED IN MINE PLANNING AND EQUIPMENT SELECTION AND EVALUATION. CO-AUTHORED THE AMAX MARIETTA CONTINUOUS MINER USBM SAFETY-OPERATING GUIDELINES. MONITORED AND EVALUATED THE IMPACT OF OIL-GAS WELLS IN THE AMAX LEASE AREA.

(1980-81)

* JET CONSTRUCTION CO., ARTESIA, NM BRANCH MANAGER OF AN OIL FIELD ROUSTABOUT SERVICE SERVING SE NEW MEXICO AND WEST TEXAS.

(1981)

* HAMON OIL CO., MIDLAND, TX., FIELD ENGINEER. DRILLED AND COMPLETED DEEP POOL OIL-GAS WELLS IN NM., TX., KS. AND OK.

(1982-85)

* YATES PETROLEUM CORP., ARTESIA, NM., DRILLING FOREMAN, NGPA COORDINATOR, PETROLEUM ENGINEER AND COMPLETIONS ENGINEER. RESPONSIBLE FOR NGPA FILINGS ON ALL YPC WELLS. PETROLEUM ENGINEERING TASKS INCLUDING RESERVOIR WORK, COMPUTER GENERATED ECONOMIC AND FEASIBILITY STUDIES. DEVELOPED AND SUBMITTED IN-FILL DRILLING PROPOSALS TO TOP MANAGEMENT. RESPONSIBLE FOR WRITTEN ENGINEERED COMPLETION PROCEDURES, WORK REQUIRED COORDINATION WITH ENGINEERING, GEOLOGY, SERVICE COMPANIES, COMPLETION FOREMAN DRILLING FOREMAN, GOVERNMENTAL AGENCIES AND TOP MANAGEMENT.

(1985-90)

* BASSETT AND BIRNEY OIL CORP. ARTESIA, NM., PETROLEUM ENGINEER SUPERVISED THE NON-OPERATED WORKING INTERESTS OF SOME FIFTY-SIX OIL AND GAS PROPERTIES IN SOUTHEAST NEW MEXICO AND THE RELATED UNDEVELOPED ACREAGE FOR A PERIOD OF FIVE YEARS. EVALUATED ALL PROPERTIES, FORMULATED A BID PACKAGE AND COORDINATED THE SALES OF SAID PROPERTIES WORKING WITH LAND, GEOLOGY AND TOP MANAGEMENT.

(1985-PRESENT)

* MYCO INDUSTRIES, INC., ARTESIA, NM., ENGINEER AND OPERATIONS MANAGER. RESPONSIBLE FOR MYCO'S DAILY OPERATIONS OF OPERATED PROPERTIES IN SOUTHEAST NEW MEXICO AND WEST TEXAS. COORDINATE WITH TOP MANAGEMENT, LAND AND GEOLOGY TO DRILL AND EXPLORE FOR OIL AND GAS IN SOUTHEAST NEW MEXICO AND WEST TEXAS. RESPONSIBLE FOR THE ENGINEERING AND MANAGERIAL FUNCTIONS RELATED TO SOME 2,800 NON-OPERATED PROPERTIES IN SOUTHEAST NEW MEXICO AND THE WESTERN U.S. FOR MYCO, THE ESTATES OF MARTIN YATES, III, AND LILLIE M. YATES, ANSWERING DIRECTLY TO TOP MANAGEMENT.

SME Mining Engineering Handbook

In Two Volumes

Volume 1

ARTHUR B. CUMMINS

Chairman, Editorial Board

IVAN A. GIVEN

Editor

Sponsored by

Seeley W. Mudd Memorial Fund of AIME
Society of Mining Engineers of AIME
U.S. Bureau of Mines, Dept. of the Interior

Society of Mining Engineers
of
The American Institute of Mining, Metallurgical, and Petroleum Engineers, Inc.
New York, New York
1973

1

Mining's Place and Contribution

John V. Beall

The *Mining Engineering Handbook* is written primarily for persons interested in the economic extraction of minerals. Not everyone referring to this book will be knowledgeable about mining and, therefore, this section is intended to explain to interested persons the scope of mining as well as fulfilling the title of "Mining's Place and Contribution" among the industries of society.

1.1—MINERALS, ROCKS AND ORE

In the year 1971, the number of known elements amounted to 104. Fifteen of these have been made only in the laboratory, others may have persisted from the primitive atmosphere, but, by and large, elements originated from magmas or igneous rocks of the outer rocky shell of the earth. Only eight elements constitute 98% by weight of the earth's crust. These are oxygen, 47%; silicon, 28%; aluminum, 8%; iron, 5%; and sodium, magnesium, potassium and calcium, less than 4% each. These common elements and the other less common ones are the building blocks of minerals, of which there are over 2,000 varieties.

According to Webster: "A *mineral* is an inorganic substance occurring naturally in the earth and having a consistent and distinctive set of physical properties and a composition that can be expressed by a chemical formula. The term is sometimes applied to organic substances, such as coal." Thus, minerals are precise combinations of elements. *Rocks,* as distinct from minerals, are composed of assemblages of minerals.

When minerals are found in sufficient concentration to warrant extraction by mining, the mineralized area is considered an *ore deposit*. The definition of *ore* is mineral that can be extracted from the ground at a profit. The economic connotation is implicit in the word *ore*.

Since most of the useful elements compose such a small percentage of the earth's crust, the occurrence of ore deposits as we know them would not have transpired had not geologic processes concentrated the elements (see Sec. 4).

1.2—DEFINITIONS OF MINING TERMS

Extensive coverage of the many descriptive terms used in mining may be found in a good mining glossary, such as is available from the Superintendent of Documents (see Sec. 35), but for convenience a number of the more common definitions are given here.

Mining may be defined, as by A. B. Cummins, as the act, process or work of extracting minerals or coal from their natural environment and transporting them to the point of processing or use. Mining techniques are applied to extracting metallic minerals, such as ores of gold, copper, lead or zinc; to fuels, such as coal, anthracite, lignite and tar sands; and to nonmetallic minerals, such as lime-

stone, sand and gravel
of the many minerals ex
A mine, therefore, is
minerals. Such excavati
and underground metho
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acteristics of the depo
selecting the mining me
important in determinin
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with waste minerals cal
of the valuable miner
The material coming
valuable minerals and g
The ore, in the ca
to concentrate the val
facility. The gangue is
Nonmetallic deposit
the valuable mineral o
industrial minerals, are
mineral may be shippe
Coal usually is *wasl*
slate and other impur
other consumer. A mc
the mine, which have b
There are several ty
to the surface is dug
pit, digging progresses
(called *spoil, overburd*
A *quarry* is an excava
the valuable material
fossil stream beds or
dredging (see Sec. 17).
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the province of the mi
In underground mi
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are many methods is
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a bearing on the choic
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ing coal underground
Another important
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are sulfur and salt n
chemical solutions to
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mined in this mann
gilsonite underground
ground coal and phos
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floor or in the strata