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GEOLOGICAL SURVEY

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# ORGANIC GEOCHEMISTRY, LITHOLOGY, AND PALEONTOLOGY OF TERTIARY AND MESOZOIC ROCKS FROM WELLS ON THE ALASKA PENINSULA

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Menlo Park, California
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FIGURES

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## ABSTRACT

Core chips and drill cuttings from eight of the nine wells drilled along the Bering Sea lowlands of the Alaska Peninsula were subjected to lithologic and paleontologic analyses. Results suggest that at least locally, sedimentary rocks of Tertiary age contain oil and gas source and reservoir rocks capable of generating and accumulating liquid and gas hydrocarbons.

Paleogene strata rich in organic carbon are immature. However, strata in offshore basins to the north and south may have been subjected to a more productive thermal environment. Total organic carbon content of fine grained Neogene strata appears to be significantly lower than in Paleogene rocks, possibly reflecting nonmarine or brackish water environments of deposition. Neogene sandstone beds locally yield high values of porosity and permeability to depths of about 8,000 feet (2,439 m). Below this depth, reservoir potential rapidly declines.

The General Petroleum, Great Basins No. 1 well drilled along the shore of Bristol Bay reached granitic rocks. Other wells drilled closer to the axis of the present volcanic arc indicate that both Tertiary and Mesozoic sedimentary rocks have been intruded by dikes and sills of andesite and basalt. Although the Alaska Peninsula has been the locus of igneous activity throughout much of Mesozoic and Tertiary time, thermal maturity indicators such as vitrinite reflectance and coal rank suggest, that on a regional scale, sedimentary rocks have not been subjected to abnormally high geothermal gradients.

# INTRODUCTION

Core chips and washed cuttings from several wells drilled on the Alaska Peninsula were studied to determine the petroleum potential, lithology, and age relations of subsurface rocks on the peninsula and in adjacent offshore sedimentary basins. The Bristol basin is to the north and the Shumagin Shelf is to the south. This study reports on the paleontology, and lithology of rock samples from wells drilled mainly along the Bristol Bay coastal lowlands from Lake Becharof to the Black Hills (Fig. 1).

The first part of the study investigated the oil and gas source rock potential of this area. Three wells were selected for detailed source rock analyses, but cuttings from the AMOCO Cathedral River No. 1 well were found to be contaminated from 8,600 feet to T.D. with a petroleum based mud additive that could not be removed. The contaminated part of the well was eliminated from the study. Supplemental data (thermal analysis/pyrolysis-FID) on coal and black shale from five wells was provided by George Claypool of the U.S. Geological Survey in Denver, Colorado.

The second part of the study involved petrographic examination of selected intervals in seven wells. Fifty-one grain mount thin sections were made where sandstone or crystalline rocks were observed in the washed cuttings. Eight thin sections of sandstone from selected core chips were cut for petrographic examination. Thin sections were studied to determine sandstone texture, composition, and degree of alteration, as these parameters can be helpful in predicting reservoir characteristics. The effects of intrusive igneous activity on sedimentary rocks were noted to determine the extent to which petroleum potential has been affected by contact metamorphism.

The third part of the study deals with paleontology, principally foraminifera, and the palynology of carbonaceous intervals. It was hoped that

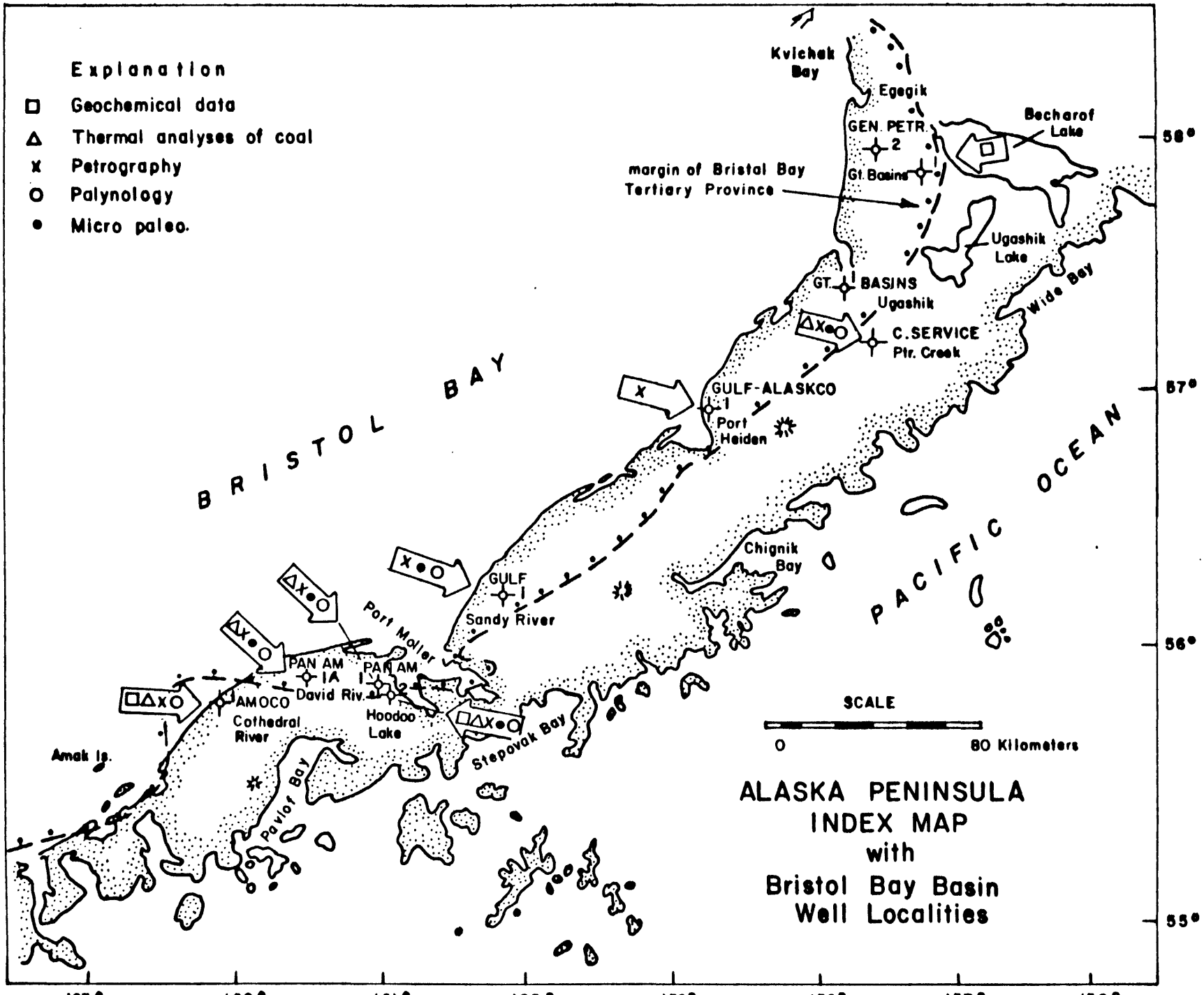

Explanation
Geochemical data
Thermal analyses of coal
Petrography
Palynology
Micro paleo.
Kvichek Bay
Egegik
GEN. PETR. 2
Becharof Lake
margin of Bristol Bay Tertiary Province
Gt. Basins
Ugashik Lake
GT. BASINS Ugashik
C. SERVICE Ptr. Creek
Wide Bay
GULF-ALASKCO 1
Port Heiden
BRISTOL BAY
PACIFIC OCEAN
Chignik Bay
GULF 1
Sandy River
Port Moller
PAN AM IA
PAN AM 1
David Riv.
AMOCO Cathedral River
Hoodoo Lake
Stepovak Bay
Amak Is.
Pavlof Bay
SCALE
0
80 Kilometers
ALASKA PENINSULA
INDEX MAP
with
Bristol Bay Basin
Well Localities
58°
57°
56°
55°
163°
162°
161°
160°
159°
158°
157°
156°

Figure 1

the microfauna would provide additional information on the ages of rocks which now rely mainly on reconnaissance field work by Burk (1965) and a stratigraphic section published by Brockway and others (1975). Unfortunately, fossil recovery was poor, probably because only washed cuttings were available from most of the wells. Better microfaunal control might be possible if outcrop or core samples were available. In Tertiary rocks recovery of palynomorphs was more encouraging and age calls were possible in several sequences.

## ACKNOWLEDGMENTS

The study was made possible through the cooperation and financial assistance of the General Crude Oil Company, Houston, Texas and coordinated by Dr. Claude C. Rust. Additional geochemical data were provided by George E. Claypool, U.S. Geological Survey, Denver, Colorado. Foraminifera were identified by Kristen McDougall, and palynomorphs by Jack A. Wolfe, both of the U.S. Geological Survey, Menlo Park, California. Paleontological samples were prepared by Milton Randall.

## GEOCHEMISTRY

Oil and gas source rock analyses of washed cuttings were run on two wells from the Alaska Peninsula. Cuttings from the General Petroleum Corporation Great Basins No. 1 (2-27S-49W) were examined from a depth of 1,300 to 11,080 feet (total depth). Material from the Pan American Hoodoo Lake No. 2 well (35-50S-76W) was analyzed between 227 and 11,243 feet (T.D.).

At GeoChem Laboratories, Inc. in Houston, Texas, cuttings were hand-picked by a geologist and a small sample (approximately 5 grams) was collected at 150 feet intervals. Each sample was analyzed for organic carbon content. Based on these results, various single, or composite samples were selected for more detailed study. The analytical data for this study are documented in Appendix 1 for the Great Basin well and Appendix 2 for the Hoodoo Lake well.

Summary of Results

General Petroleum Corporation, Great Basins No. 1: The stratigraphic intervals penetrated by the Great Basins No. 1 are as follows: (Data from Brockway and others, 1975).

| Age | Formation | Formation Top | Geochemical Subunit |
|---|---|---|---|
| Pliocene | Milky River | ? | |
| Miocene | Bear Lake | 2,110 feet | a1 |
| Oligocene | Stepovak | 5,600 feet | a2 |
| Jurassic | Granitic basement | 10,970 feet | |
| | Total Depth | 11,080 ± feet | |

In terms of organic richness, source rock maturity, type of organic matter, and lithology, the Bear Lake and Stepovak formations can be summarized in the following manner. The Bear Lake Formation consists of tuffaceous shale, carbonaceous shale, and coal, with secondary amounts of siltstone and sandstone. Organic carbon averages 13%, extractable bitumen averages 5,000 ppm, and kerogen is predominantly woody with a minor amount of amorphous-sapropel. The high extractable bitumen content with a correspondingly low hydrocarbon fraction is interpreted to reflect the coal-rich and/or woody character of the organic material in the formation.

Vitrinite reflectance values ($R_o$) average 0.29%,suggesting that the Bear Lake Formation is immature. Significant amounts of steranes and terpanes, a pronounced odd carbon preference in the $C_{22}$-$C_{33}$ normal paraffins, and a low paraffin-naphthene/aromatic hydrocarbon ratio (average 0.55) also suggest immature source rock.

Source rocks in the underlying Stepovak Formation are characterized by an average organic carbon content of 11%, a mean value of extractable bitumen

6,600 ppm, and a predominance of woody kerogen with minor amounts of herbareous kerogen.

Maturation indices suggest immature source rocks. $R_o$ averages 0.51% and steranes and terpanes are present in significant amounts. Odd-even carbon ratios and paraffin-naphthene/aromatic hydrocarbon ratios are similar to those reported in the overlying Bear Lake Formation.

The hydrocarbon potential of the Bear Lake and Stepovak formations are similar. Organic carbon is abundant but immature. Presumably, if source rocks similar to those in the Great Basins No. 1 well were present in deeper offshore parts of Bristol basin, probably at depths of 15,000 feet or greater, then chances of petroleum generation would be greatly improved because of higher temperatures.

Pan Am-Socal, Hoodoo Lake No. 2: The stratigraphic interval penetrated by the Hoodoo Lake No. 2 well includes seven geologic formations. Specific tops of the formations reported by Brockway and others,(1975) are as follows:

| Age | Formation | Formation top | Geochemical Subunit |
|---|---|---|---|
| Pliocene | Milky River | ? | |
| Miocene | Bear Lake | 1,000 ± feet | A 200- 5,500 feet |
| Oligocene | Stepovak | 2,160 feet | |
| Eocene | Tolstoi | 5,780 feet | |
| Upper Cretaceous | Chignik | 7,700 feet | B 5,500- 7,700 feet |
| Lower Cretaceous | Herendeen Limestone | 8,650 feet | C 7,700-11,243 feet |
| Lower Cretaceous-Upper Jurassic | Staniukovich | 9,670 feet | |
| | Total Depth | 11,243 feet | |

The stratigraphic section of the Hoodoo Lake No. 2 well can be subdivided into 3 subunits based on percentage of total organic carbon, type of kerogen, abundance and composition of the extractable bitumen. The zonation is independent of formation tops and is as follows:

Subunit A 200 ± to 5,500 ± feet

Subunit B 5,500 ± to 7,700 ± feet

Subunit C 7,700 ± to 11,243 ± feet (Total Depth)

Subunit A (200 ± to 5,500 ± feet) roughly correlates with the Milky River, Bear Lake, and Stepovak formations. The section comprises light colored claystone, shale, siltstone and sandstone. Near the base, the light colored rocks grade downward into darker strata higher in organic content. Geochemically, subunit A is characterized by generally low organic carbon contents (average 0.26%) and low values of extractable bitumen (average 36 ppm). Kerogen is predominantly woody with lesser amounts of amorphous-sapropel and coal. Maturity indices indicate the sequence is immature. $R_o$ averages 0.65%.

Compared with the organic richness of the Bear Lake and Stepovak formations in the Great Basins No. 1 well, subunit A has little potential of generating substantial quantities of petroleum.

Subunit B occurs within the Tolstoi Formation of Eocene age. The section consists of carbonaceous, dark gray to black siltstone, shale, and mudstone with minor thicknesses of coal. Zone B is characterized by high organic carbon content (average 9.69%), a moderate amount of extractable bitumen (average 469 ppm) and an average hydrocarbon fraction of 225 ppm. The kerogen type is predominantly woody with some accessory amounts of amorphous-sapropel.

Maturity indicators in subunit B suggest that the rocks are mature. Vitrinite reflectance values average 1.15%. Other indicators include an absence of any apparent odd carbon dominance in the $C_{22}$-$C_{33}$ normal paraffins, and a

paraffin-naphthene (P-N) hydrocarbon curve skewed toward more mature $C_{15}$-$C_{22}$ hydrocarbons. Whether or not a significant amount of petroleum has been generated and entrapped in the local area is problematic.

Subunit C includes the Chignik Formation (Upper Cretaceous), Herendeen Limestone (Upper Jurassic-Lower Cretaceous), and Staniukovich Formation (Upper Jurassic). Strata in subunit C include sandstone, conglomerate, carbonaceous shale, and limestone, all locally cut by intrusive rocks. This zone is characterized by a variable organic carbon content averaging 4%,by low values of extractable bitumen (average 41 ppm),and by a low hydrocarbon fraction averaging about 16 ppm. Kerogen type includes wood and coal with a minor constituent of amorphous-sapropel.

Analyses indicate that organic matter in subunit C is mature. $R_o$ values average 1.76%, and an odd carbon preference index is apparently absent. Also, hydrocarbons in the $C_{15}$-$C_{22}$ range are more common. The woody-coaly character of subunit C organic matter suggests that these rocks have not generated liquid hydrocarbons and very little gas. The extent to which nearby intrusive bodies have affected maturity and reservoir rock properties is unknown.

AMOCO, Cathedral River No. 1: A third well, the AMOCO Cathedral River No. 1 (Sec. 29-51S-83W) with a total depth of 14,300 feet, was included in the source rock and maturity study. Formation tops reported in the well history released by AMOCO are as follows:

| Age | Formation | Formation Tops | Geochemical Subunit |
|---|---|---|---|
| Upper Jurassic | Naknek Fm. | surface | |
| Middle Jurassic | Shelikof Fm. | 3,600 feet | 0-8,600 feet |
| Lower Jurassic | Kialagvik Fm. | 10,240 feet | -- |
| Lower Jurassic | | 11,980 feet | 8,600 feet |
| Triassic | | 14,200 feet | |

Due to contamination (gilsonite? was added to the drilling mud) reliable data could only be obtained from samples collected above 8,600 feet. Only the percentage of organic carbon was measured on samples from 50 + feet to T.D. Percentage of organic carbon between 50 ± and 8,600 feet is low, averaging 0.20%. Although contamination was present from 8,600 ± to 14,300 ± feet, percentages of organic carbon remained low, averaging 0.68%.

Detailed analyses of six samples selected between 12,400 and 13,650 feet were made to determine the type of mud contaminant, and whether or not the contamination could be washed from samples to permit further work. It was concluded that the contaminant could not be washed from the samples and additional analyses were suspended.

Thermal Analyses of Coal and Black Shale

Twenty hand picked samples of coal and black shale were analyzed from five wells to determine coal rank and level of organic maturity. Results of thermal analysis and pyrolysis-FID measurements are listed in tabular form in Appendix 3. The following observations were made by George E. Claypool, Research Chemist with the Branch of Oil and Gas Resources, U.S. Geological Survey, Denver, Colorado: (1) In the Pan Am Hoodoo Lake No. 1 well the samples are immature throughout; coals are lignite rank above 5,000 feet, and subbituminous below, (2) the Pan Am Hoodoo Lake No. 2 coal samples are mature, ranging from medium to low-volatile bituminous rank. The two Hoodoo Lake wells are separated by an east-west trending fault with several thousand feet of vertical displacement. The north side has moved down with respect to the south side, (3) the Pan Am David River 1-A has immature low rank (subbituminous) coal at 4,250 and 7,230 feet, and mature high-volatile to low-volatile bituminous coals between 8,500 and 10,250 feet, (4) the single sample from the Cities Service Painter Creek well

(1,018-1,019 feet) is a mature, medium-volatile bituminous coak, (5) samples from the AMOCO Cathedral Rive No. 1 well are contaminated with gilsonite, but otherwise appear to be mature coals of high-volatile bituminous rank.

## LITHOLOGY

Washed cuttings from several wells were examined to determine depths of major changes in lithology and to correlate the lithologies of the cuttings with the published stratigraphic cross section of Brockway and others (1975). Selected intervals containing sandstone and siltstone were sampled for grain mount thin section petrography. Brief lithologic descriptions of grain mount and core chip thin sections are included in Appendix 4.

The following summary discusses the major rock types observed in seven Alaska Peninsula wells. In some wells, good correlations exist between published formation boundaries and lithologic changes observed in cuttings. In other cases however, there appears to be little or no correlation. General stratigraphic relations are shown in Figure 2.

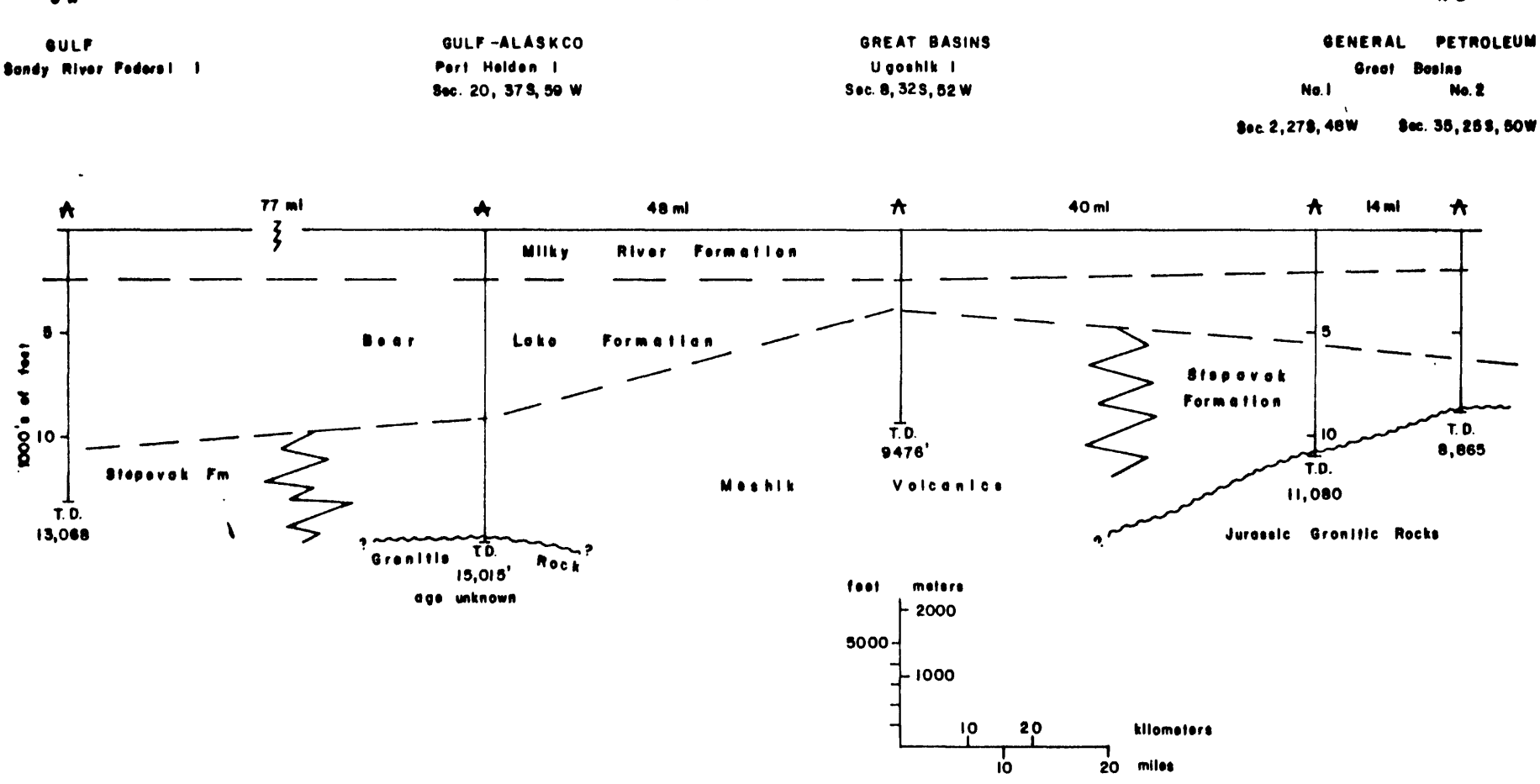
### Mesozoic Rocks

Sedimentary rocks of Mesozoic age were drilled in only three wells outside of the Wide Bay area on the Alaska Peninsula. The lithology of each well will be discussed below on a well-by-well basis.

AMOCO Cathedral River No. 1: The oldest rocks drilled south of Wide Bay on the Alaska Peninsula occur in the AMOCO Cathedral River No. 1 well that spudded in the Upper Jurassic Naknek Formation and reached total depth in Triassic age rocks. These rocks are calcareous arkosic sandstone interbedded with carbonaceous siltstone, and fine grained calcarenite. The Triassic age is apparently based on a radiolarian fauna. Lithologies studied in thin section agree reason-

Figure 2A

# STRATIGRAPHIC CROSS SECTION
# BRISTOL BAY REGION
# ALASKA PENINSULA




*modified from Brockway and others (1975)*

Figure 28

# STRATIGRAPHIC CROSS SECTION
## BRISTOL BAY REGION
## ALASKA PENINSULA

SW

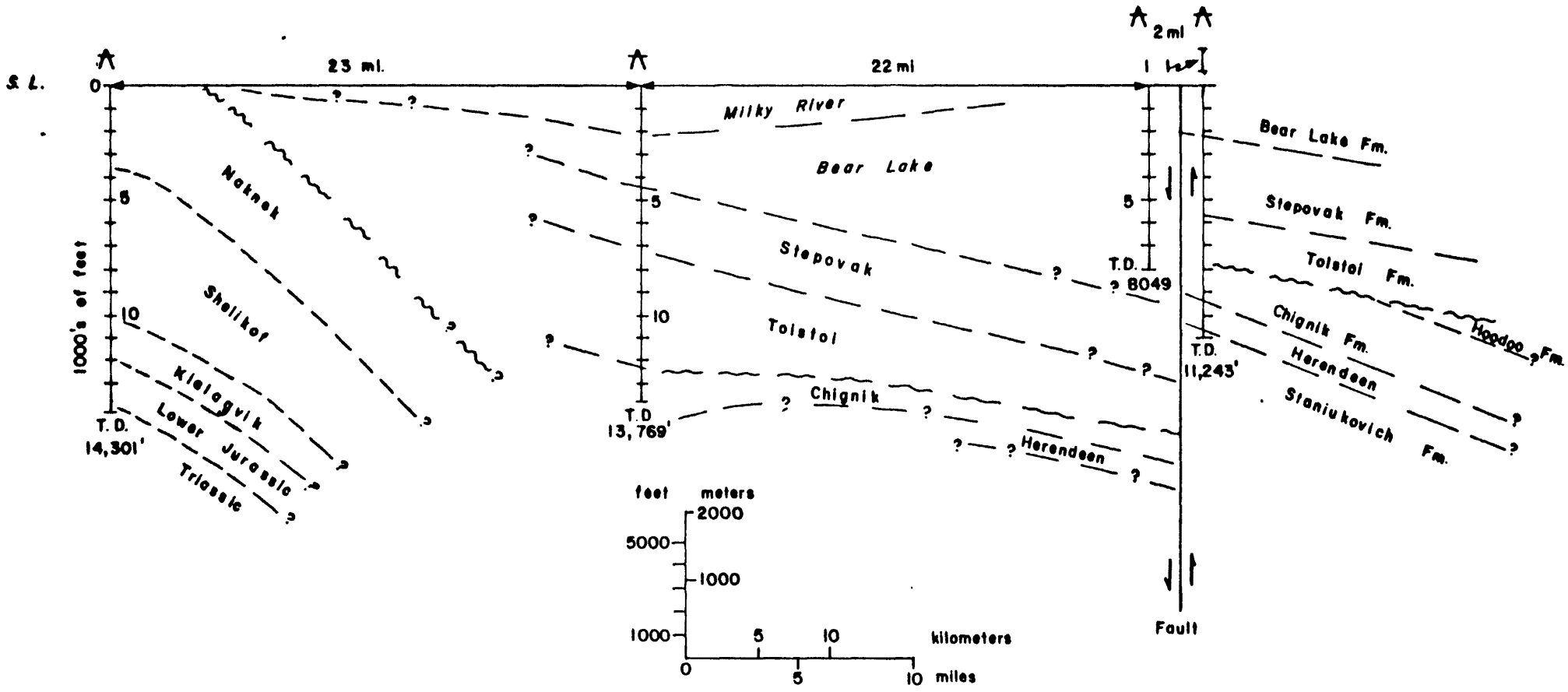
AMOCO
Cathedral River 1
Sec. 29, 51S, 83W

PAN AM
David River 1-A
Sec. 12, 50S, 80W

NE

PAN AM
Hoodoo Lake 1
Sec. 21, 50S, 76W

PAN AM
Hoodoo Lake 2
Sec. 35, 50S, 76W




*modified from Brockway and others (1975)*

ably well with formation tops reported in the well history. However, arkosic sandstone similar to that of the Naknek Formation was observed at 5,500 feet, considerably deeper than the base of the formation reported in the well history at 3,598 feet.

Pan American-David River No. 1-A: Published data on the age of the rocks in the Pan American-David River No. 1-A well conflicts with palynological ages presented herein (see Appendix 5). Palynomorphs from 3,270 to 11,300 feet suggest an early to middle Eocene age, whereas Brockway and others (1975) list the following formation tops:

| | | Brockway and others (1975) | This report |
|---|---|---|---|
| Bear Lake Formation | (Miocene) | 2,430 feet | |
| Stepovak Formation | (Oligocene) | 4,400 feet | 3,200 feet |
| Tolstoi Formation | (Eocene) | 7,240 feet | |
| Chignik Formation | (Upper Cret.) | 12,200 feet | 11,300 feet |

No change in lithology of cuttings was noted at 4,400 feet although coal content increases in the cuttings downward in the section between 3,500 and 4,400 feet. At a depth of 7,200 feet arkosic sandstone is interbedded with carbonaceous siltstone. A major change in lithology occurs at 11,640 feet where chert bearing arkosic sandstone of probable Upper Cretaceous age becomes abundant. Sandstone of similar composition occurs in the Chignik Formation, drilled by the Pan American Hoodoo Lake No. 2 well and in the Gulf Sandy River well between 13,003 and 13,110 feet in rocks of uncertain age.

The David River 1-A well contains volcanic derived siltstone and sandstone with thin coal stringers from about 2,540 feet down to 11,640 feet where early to middle Eocene strata appear to either unconformably overlie, or be in fault

contact with arkosic sandstone and mudstone of the Chignik Formation.

Pan American Hoodoo Lake No. 2: Rocks of Mesozoic age were also drilled in the Pan American Hoodoo Lake No. 2 well. Arkosic sandstone and limy siltstone presumably correlate with the Staniukovich Formation from 9,670 to 11,250 feet (T.D.). This section is cut by several diabase intrusions and appears to have minimal porosity and permeability. The Herendeen Limestone (8,650-9,670 feet) conformably overlies the Staniukovich Formation. It consists of gray, silty limestone with locally abundant *Inoceramus* prisms and contains numerous calcite filled veinlets. Herendeen strata are in turn overlain by the Chignik Formation (7,770-8,650 feet), which consists of interbedded siltstone, coal, and volcanic derived sandstone and pebble conglomerate.

Cities Service, Painter Creek No. 1: Conglomerate and sandstone of the Chignik Formation was drilled in the Cities Service-Painter Creek No. 1 well from approximately 200 to 1,260 feet. Sandstone framework grains consist mainly of chloritic basalt and andesite. Fractures are filled with a zeolite mineral that is probably laumontite.

The Staniukovich Formation (1,260 to 2,040 feet) consists mainly of polymict conglomerate containing clasts of metachert, dacite porphyry, granodiorite, altered mafic volcanic porphyry, and pyroxene diabase. Sandstone in this interval consists of fine- to medium-grained, poorly sorted quartz-lithic subwacke. Some chips are well sorted and tightly packed whereas others are poorly sorted and have abundant matrix.

The Naknek Formation (2,040 to 6,510 feet) consists primarily of polymictic conglomerate that contains an abundance of granitic and granulitic metamorphic rocks. Much of the granitic material is presumably derived from nearby Jurassic

plutonic rocks (Naknek Lake Batholith). Naknek conglomerate overlies conglomerate of the Shelikof Formation (6,750 feet to T.D.). Clasts in the Shelikof conglomerate sequence contain a significantly higher percentage of porphyritic volcanic rocks than in the Naknek Formation, particularly epidote and chlorite-prehnite bearing andesites. At 7,800 feet, volcanic clasts consist of altered diabase, granitic fragments are highly sericitized and a variety of metamorphic clasts includes amphibolite, quartzite, and jadeite bearing granulite. It should be noted that palynomorphs from coal beds between 1,800 and 2,300 feet are reported to be Paleocene or Eocene (see Appendix 5). This age conflicts with the Late Cretaceous (Chignik Formation) age assignment of Brockway and others (1975).

Gulf, Sandy River Federal No. 1:

A pronounced change in sandstone composition and a $30^{o}$ increase in the angle dip suggests that rocks below about 12,525 feet in the Sandy River well may be correlative with the Upper Cretaceous Chignik Formation in the David River 1-A well. A core sample at 13,003-13,009 feet consists of medium to coarse grained pebbly sandstone containing grains of quartz, plagioclase, dacite, porphery, and rare granitic rock fragments. Quartz and dacite are more abundant, giving the rock a light color. Core descriptions in the well history describe the rocks as "granite wash sandstone" which is a misnomer.

Tertiary Rocks

Thin sections from grain mounts and core chips of Tertiary rocks were studied petrographically from the following five wells:

Cities Service, Painter Creek No. 1

Gulf-Alaskco, Port Heiden No. 1

Gulf, Sandy River Federal No. 1

Pan American, Hoodoo Lake No. 1

Pan American, David River No. 1A

Brief descriptions of each thin section are listed in Appendix 4. Tertiary strata in the five wells consist of tuffaceous and/or carbonaceous siltstone, arkosic and volcanolithic sandstone, and coal stringers. In the section below the general lithology of the Tolstoi, Stepovak, and Bear Lake formations is described following the correlations of Brockway and others (1975).

Tolstoi Formation: The Tolstoi Formation (Eocene) contains abundant coal stringers and disseminated carbonaceous material in siltstone laminae. Sandstone framework grains consist of andesite and basaltic rock fragments with nearly equal amounts of quartz and plagioclase. Porosity values appear to be quite low, primarily because of grain interpenetration or an abundance of zeolite cement.

Stepovak Formation: Lithologically the Stepovak Formation (Oligocene) is similar to the Tolstoi Formation; at least, in the Port Moller area where the two formations may interfinger. Stepovak strata appear to grade imperceptibly into the overlying Bear Lake Formation. This gradation is indicated by electric logs and cuttings which show no observable changes at formation boundaries shown in Figure 2. The Bear Lake and Stepovak formations are generally lighter colored and contain less carbonaceous material than the Tolstoi Formation.

Bear Lake Formation: Porosity and permeability data reported in the well history of the Gulf Sandy River well indicate the upper part of the Bear Lake Formation (Miocene) has the best reservoir characteristics of the three principal sedi-

mentary formations of Tertiary age on the Alaska Peninsula. In the Gulf Sandy River No. 1 well, Bear Lake sandstone above 6,300 feet has porosity values as high as 36.5% and permeability as high as 1,268 mds. Below 6,300 feet, high values for porosity and permeability are 29% and 43 mds, respectively.

The Bear Lake Formation contains an abundance of tuffaceous siltstone and the ratio of quartz and feldspar grains to volcanic rock fragments in sandstone is higher than in the Tolstoi and Stepovak formations. This difference in lithology was first noted by Burk (1965).

Igneous Rocks

Drilling logs from the Gulf-Alaskco, Port Heiden No. 1 and Pan Am Hoodoo Lake No. 2 indicate that igneous rocks were drilled in each well.

Gulf-Alaskco Port Heiden No. 1: Data from the Gulf-Alaskco, Port Heiden No. 1 well indicates that volcanic rocks were drilled from approximately 9,300 to 15,000 feet. Thin sections of core samples from 11,833-11,834 feet and 11,955-11,956 feet consist of mildly altered dacite microbreccia, sandy tuff, and porphyritic dacite flow rocks. Hornblende phenocrysts in the dacite are replaced by chlorite and epidote. Plagioclase is partly altered to calcite and sericite. Radiometric dates reported by Brockway and others (1975) in the volcanic section of the Port Heiden well are 42 $\pm$ 4 m.y. (11,832-11,850 feet) and 36 $\pm$ 8 m.y. (13,980 feet).

Two thin sections were cut from core samples near the bottom of the well at 15,001 and 15,015 feet. The textures of these samples suggest a granitic rock. Both are medium grained, salt and pepper colored quartz diorite or granodiorite. Phenocrysts include plagioclase and quartz with local graphic intergrowths, green hornblende and biotite. The age of the granitic rocks in the

Port Heiden well is unknown, as is their stratigraphic relation to the overlying volcanic sequence. Granitic and metamorphic rocks were also drilled in the bottom of the General Petroleum Great Basins Nos. 1 and 2 wells. The age of these granitic rocks is reported to be Jurassic.

Pan American Hoodoo Lake No. 2: Cuttings with crystalline textures were studied from two intervals in the Pan American Hoodoo Lake No. 2. The lithologies from intervals of 1,210 to 10,220 feet and 1,480 to 10,490 feet deep consists of basalt, diabase, and coarser grained fragments that may be gabbro. The rocks are interpreted as hyabyssal bodies that have intuded the Staniukovich Formation. It should be noted that dikes and sills cutting rocks as young as Miocene are widespread all along the Alaska Peninsula, especially in the Port Moller area, as indicated on the geologic map of Burk (1965).

## PALEONTOLOGY AND PALYNOLOGY

In an attempt to better document published stratigraphic correlations of wells drilled on the Alaska Peninsula, samples of washed well cuttings were analyzed for foraminifera by Kristin McDougall and palynomorphs by Jack Wolfe (Appendix 5). Forty-two samples from six wells were selected for paleontological studies. Thirty-nine of these samples were found to be barren of foraminifera. Fossils of probable early Tertiary age were recovered from only one well, the Pan Am Hoodoo Lake No. 2, where forams were found between 2,100 and 7,690 feet.

Because of the poor percentage of foram recovery, additional sample material was examined for palynomorphs. A total of 27 samples from five wells were analyzed. Thirteen samples from four wells contained palynomorphs.

The palynomorphs from the Gulf Sandy River No. 1 (11,686-11,691 feet) and those from the Pan Am Hoodoo Lake No. 1 (4,010-4,180 feet and 2,590-2,840 feet) are very similar to one another and resemble the Alaskan Neogene (especially

Miocene) reported from other areas. The similarities in the two wells include (1) dominance of PICEA, (2) common representation of TSUGA, (3) low representation of broadleaved exotics (PTEROCARYA, ULMUS/ZELKOVA), and (4) presence of some herbaceous types (Centrospermae, Cyperaceae). These palynomorphs are of Neogene age and are thus probably from the Bear Lake Formation.

However, palynomorphs in the David River 1-A well from 3,200 to 9,100 feet are dominated by broadleaved exotics while TSUGA is absent suggesting an Eocene age. It should be emphasized however, that there is almost no palynological control material available for the Alaskan Eocene (J. A. Wolfe, written commun., 1977).

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_____ 1976b, Hydrocarbon source rock evaluation study, organic geochemical analyses of dry well cuttings, General Petroleum Corporation, Great Basins No. 1 well, sec. 2-27S-48W, Bristol Bay area, Alaska: Confidential Geochemical Service Report prepared by GeoChem Labs., Inc., 1143-C Brittmore Rd., Houston, Texas, 11 p.

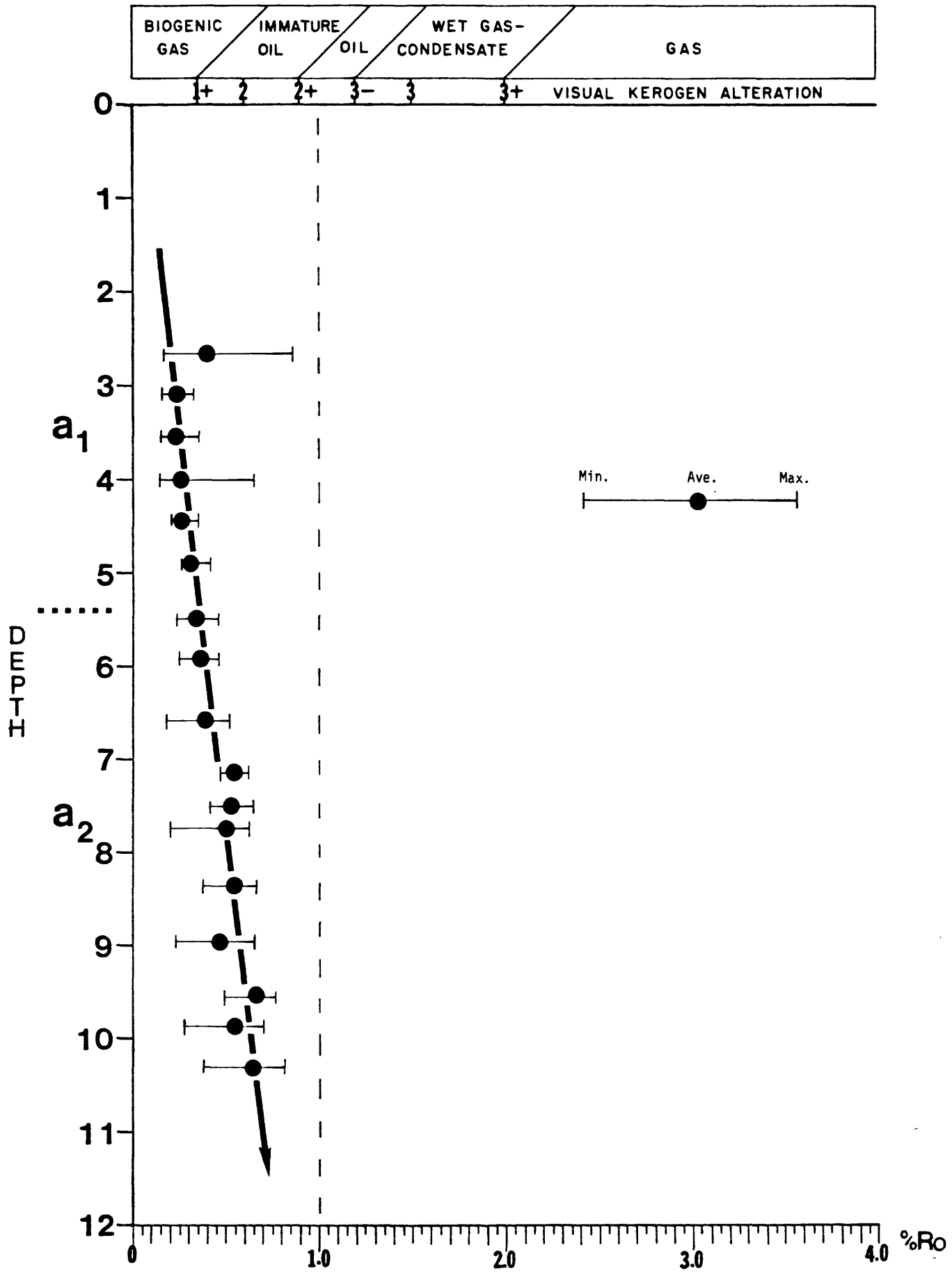
# APPENDIX 1

## Geochemical Data for General Petroleum Great Basins No. 1 Well

_____ 1976c, Hydrocarbon source rock evaluation study organic geochemical analyses of dry well cuttings AMOCO Production Company, Cathedral River Unit No. 1 well, sec. 29-51S-83W, Cold Bay County, Alaska: Confidential Geochemical Service Report prepared by GeoChem Labs., Inc., 1143-C Brittmore Rd., Houston, Texas, 8 p.

# GENERAL PETROLEUM - GREAT BASINS NO. 1

## VITRINITE REFLECTANCE DATA

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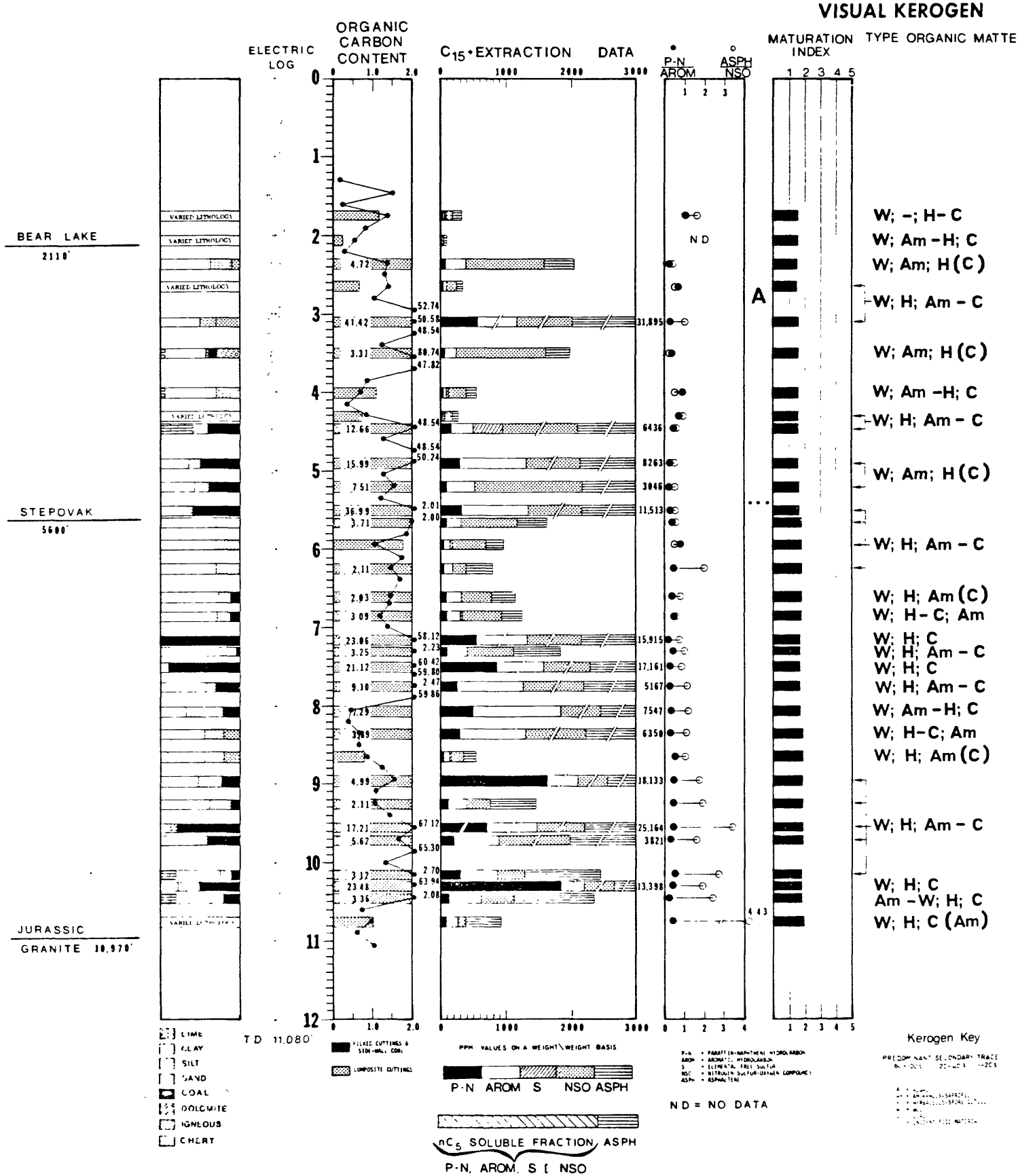
# GENERAL PETROLEUM-GREAT BASINS NO. 1 WELL

## SUMMARY OF ORGANIC ANALYSES

### SOURCE CHARACTER




"Figure prepared by Geo Chem Labs., Inc."

## Table I

### Organic Carbon and Lithology Screen Analyses

| GeoChem Sample Number | Well Depth Interval | Description | Percent Organic Carbon |
|---|---|---|---|
| 788-001 | 1300'- 1310' | Composite. | 0.18 |
| 788-002 | 1450'- 1460' | Composite. | 1.52 |
| 788-003 | 1600'- 1610' | Dark gray shale. | 0.25 |
| 788-004 | 1750'- 1760' | Dark gray shale. | 1.40; 1.39 R |
| 788-005 | 1900'- 1920' | Composite. | 0.83 |
| 788-006 | 2050'- 2060' | Medium dark gray shale. | 0.56 |
| 788-007 | 2200'- 2210' | Medium dark gray shale, chert, sand, sandstone. | 0.29 |
| 788-008 | 2350'- 2360' | Claystone. | 1.37; 1.36 R |
| 788-009 | 2500'- 2510' | Dark gray shale. | 1.32 |
| 788-010 | 2650'- 2660' | Dark gray shale. | 1.42 |
| 788-011 | 2800'- 2810' | Claystone. | 1.06 |
| 788-012 | 2950'- 2960' | Coal. | 52.74 |
| 788-013 | 3100'- 3110' | Coal. | 50.58; 50.82 R |
| 788-014 | 3250'- 3260' | Coal. | 48.54 |
| 788-015 | 3400'- 3410' | Claystone. | 1.23 |
| 788-016 | 3550'- 3560' | Coal. | 80.74 |
| 788-017 | 3700'- 3710' | Coal. | 47.82 |
| 788-018 | 3850'- 3860' | Claystone. | 0.86; 0.83 R |
| 788-019 | 4000'- 4010' | Claystone. | 0.70 |
| 788-020 | 4150'- 4160' | Sandstone. | 0.34 |
| 788-021 | 4300'- 4310' | Claystone. | 0.84 |
| 788-022 | 4450'- 4460' | Coal. | 48.54 |
| 788-023 | 4600'- 4610' | Siltstone. | 1.28; 1.21 R |
| 788-024 | 4750'- 4760' | Coal. | 48.54 |
| 788-025 | 4900'- 4910' | Coal. | 50.24 |
| 788-026 | 5050'- 5060' | Siltstone. | 1.25 |
| 788-027 | 5200'- 5210' | Siltstone. | 1.56 |
| 788-028 | 5350'- 5360' | Siltstone. | 1.21; 1.21 R |
| 788-029 | 5500'- 5510' | Siltstone. | 2.01 |
| 788-030 | 5650'- 5660' | Siltstone. | 2.00 |
| 788-031 | 5800'- 5810' | Siltstone. | 1.87 |
| 788-032 | 5940'- 5950' | Siltstone. | 1.07 |
| 788-033 | 6100'- 6110' | Siltstone. | 1.75; 1.78 R |

## Table I

### Organic Carbon and Lithology Screen Analyses

| GeoChem Sample Number | Well Depth Interval | Description | Percent Organic Carbon |
|---|---|---|---|
| 788-034 | 6250'- 6260' | Siltstone. | 1.47 |
| 788-035 | 6400'- 6410' | Siltstone. | 1.70 |
| 788-036 | 6600'- 6610' | Silty gray shale. | 1.45 |
| 788-037 | 6700'- 6710' | Silty gray shale. | 1.42 |
| 788-038 | 6850'- 6860' | Silty gray shale. | 1.19; 1.19 R |
| 788-039 | 7000'- 7010' | Silty gray shale. | 1.39 |
| 788-040 | 7150'- 7160' | Coal. | 58.12 |
| 788-041 | 7300'- 7310' | Silty gray shale. | 2.23 |
| 788-042 | 7500'- 7510' | Coal. | 60.42 |
| 788-043 | 7600'- 7610' | Coal. | 59.80;60.04 R |
| 788-044 | 7750'- 7760' | Silty gray shale. | 2.47 |
| 788-045 | 7900'- 7910' | Coal. | 59.86 |
| 788-046 | 8050'- 8060' | Greenish gray siltstone. | 0.46 |
| 788-047 | 8200'- 8210' | Medium gray-medium light gray siltstone. | 0.38 |
| 788-048 | 8350'- 8360' | Medium light gray siltstone. | 0.67; 0.69 R |
| 788-049 | 8500'- 8510' | Medium light gray siltstone. | 0.67 |
| 788-050 | 8650'- 8660' | Medium light gray siltstone. | 0.87 |
| 788-051 | 8800'- 8810' | Medium gray silty shale. | 1.24 |
| 788-052 | 8950'- 8960' | Medium gray silty shale. | 1.57 |
| 788-053 | 9100'- 9110' | Medium gray silty shale. | 1.09; 1.10 R |
| 788-054 | 9240'- 9250' | Medium gray silty shale. | 1.08 |
| 788-055 | 9400'- 9410' | Medium gray silty shale. | 1.45 |
| 788-056 | 9540'- 9550' | Coal. | 67.12 |
| 788-057 | 9700'- 9710' | Medium gray silty shale. | 1.67 |
| 788-058 | 9840'- 9850' | Coal. | 65.30;66.08 R |
| 788-059 | 10000'-10010' | Medium gray silty shale. | 1.33 |
| 788-060 | 10140'-10150' | Medium gray silty shale. | 2.70 |
| 788-061 | 10300'-10310' | Coal. | 63.94 |
| 788-062 | 10440'-10450' | Medium dark gray silty shale. | 2.08 |
| 788-063 | 10600'-10610' | Medium dark gray silty shale. | 0.73; 0.71 R |
| 788-064 | 10740'-10750' | Medium dark gray silty shale. | 0.98 |
| 788-065 | 10900'-10910' | Medium dark gray silty shale. | 0.60 |
| 788-066 | 11060'-11070' | Medium dark gray silty shale. | 1.04 |

Table 2

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 788-004D | 1760' | Varied lithology consisting of chert, reworked material, siliceous shale, shale and sand. | | 1.15; 1.10 |
| 788-006D | 2060' | Varied lithology consisting of chert, reworked material, siliceous shale, shale and sand. | | 0.23 |
| 788-008D | 2360' | | | 4.72 |
| -A | | 90% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| -B | | 10% Coal. | | |
| 788-010D | 2660' | Varied lithology consisting of chert, reworked material, siliceous shale, and sand. | | 0.66 |
| 788-013D | 3110' | | | 41.42 |
| -A | | 100% Shale, noncalcareous, silty, very carbonaceous, blocky, black. | N1 | |
| 788-016D | 3560' | | | 3.31; 3.32 |
| -A | | 60% Shale, slightly calcareous, very silty, blocky, soft, light gray. | N7 | |
| -B | | 30% Reworked material. | | |
| -C | | 10% Coal. | | |
| 788-019D | 4010' | | | 1.10 |
| -A | | 100% Shale, very slightly calcareous, very silty, blocky, soft, light gray. Trace of reworked material. | N7 | |
| 788-021D | 4310' | Varied lithology consisting of chert, reworked material, shale and sand. | | 0.71 |
| 788-022D | 4460' | | | 12.66 |
| -A | | 60% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| -B | | 40% Coal. | | |

Table 2

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 788-025D | 4910' | | | 15.99 |
| -A | | 50% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| -B | | 50% Coal. | | |
| 788-027D | 5210' | | | 7.51; 7.59 R |
| -A | | 60% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| -B | | 40% Coal. | | |
| 788-029D | 5510' | | | 36.99 |
| -A | | 60% Coal and carbonaceous shale. | | |
| -B | | 40% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| 788-030D | 5660' | | | 3.71 |
| -A | | 100% Shale, noncalcareous, very silty, blocky, soft, light gray. Coal associated. | N7 | |
| 788-032D | 5950' | | | 1.76 |
| -A | | 100% Shale, noncalcareous, very silty, blocky, soft, light gray. | N7 | |
| 788-034D | 6260' | | | 2.11 |
| -A | | 100% Shale, noncalcareous, very silty, blocky, soft, light gray. Trace of coal. | N7 | |
| 788-036D | 6610' | | | 2.03; 2.03 R |
| -A | | 90% Shale, noncalcareous, silty, blocky, soft, medium light gray. | N6 | |
| -B | | 10% Coal. | | |
| 788-038D | 6860' | | | 3.09 |
| -A | | 90% Shale, noncalcareous, silty, blocky, soft, medium light gray. | N6 | |
| -B | | 10% Coal. | | |
| 788-040D | 7160' | | | 23.06 |
| -A | | 100% Coal. | | |

Table 2

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 788-041D | 7310' | | | 3.25 |
| -A | | 80% Shale, noncalcareous, silty, blocky, soft, medium light gray. | N6 | |
| -B | | 20% Shale, noncalcareous, silty, carbonaceous, blocky, moderately hard, dark gray. | N3 | |
| 788-042D | 7510' | | | 21.12 |
| -A | | 90% Coal. | | |
| -B | | 10% Shale, noncalcareous, silty, blocky, soft, medium light gray. | N6 | |
| 788-044D | 7760' | | | 9.10; 8.85 |
| -A | | 60% Shale, noncalcareous, silty, blocky, soft, medium light gray. | N6 | |
| -B | | 30% Coal. | | |
| -C | | 10% Bentonite. | | |
| 788-046D | 8060' | | | 7.29 |
| -A | | 50% Siltstone, noncalcareous, argillaceous, soft, fair porosity, no show, greenish gray. | 5GY6/1 | |
| -B | | 30% Shale, noncalcareous, silty, blocky, moderately hard, medium light gray. | N6 | |
| -C | | 20% Coal. Trace of sandstone. | | |
| 788-048D | 8360' | | | 3.89 |
| -A | | 80% Shale, noncalcareous, very silty, blocky, soft, medium light gray. | N6 | |
| -B | | 20% Coal. | | |
| 788-050D | 8660' | | | 0.80 |
| -A | | 50% Shale, noncalcareous, very silty, blocky, soft, medium light gray. | N6 | |
| -B | | 50% Sandstone, carbonate cement, silty, argillaceous, very fine to fine grain, subrounded to subangular, frosted to clear, fair porosity, no show. | | |

Table 2

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 788-052D | 8960' | | | 4.99 |
| -A | | 50% Shale, noncalcareous, silty, blocky, moderately hard, medium light gray. | N6 | |
| -B | | 30% Siltstone, noncalcareous, very argillaceous, blocky, moderately hard, poor porosity, no show, medium light gray. | N6 | |
| -C | | 20% Coal. Trace of sandstone. | | |
| 788-054D | 9250' | | | 2.11; 2.11 |
| -A | | 90% Shale, noncalcareous, very silty, blocky, moderately hard, medium light gray. | N6 | |
| -B | | 10% Coal. Trace of sandstone. | | |
| 788-056D | 9550' | | | 17.21 |
| -A | | 80% Coal. | | |
| -B | | 10% Shale, noncalcareous, very silty, blocky, moderately hard, medium light gray. | N6 | |
| -C | | 10% Sandstone, carbonate cement, silty, argillaceous, very fine to fine grain, subrounded to subangular, frosted to clear, good porosity, no show. | | |
| 788-057D | 9710' | | | 5.62 |
| -A | | 60% Shale, noncalcareous, silty to very silty, blocky, moderately hard, light gray. | N7 | |
| -B | | 40% Coal and very carbonaceous shale. | | |
| 788-060D | 10150' | | | 3.12 |
| -A | | 70% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 20% Limestone, chalk, moderately hard, poor porosity, no show, white. | N9 | |
| -C | | 10% Coal. | | |

Table 2

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 788-061D | 10310' | | | 23.48;23.54 |
| -A | | 50% Coal. | | |
| -B | | 30% Siltstone, noncalcareous, argillaceous, hard, little porosity, no show, light gray. | N7 | |
| -C | | 20% Shale, noncalcareous, silty, blocky, hard, medium dark gray. | N4 | |
| 788-062D | 10450' | | | 3.36 |
| -A | | 60% Shale, noncalcareous, silty to very silty, blocky, hard, medium dark gray. | N4 | |
| -B | | 20% Coal. | | |
| -C | | 20% Limestone, chalk, moderately hard, poor porosity, no show, white. | N9 | |
| 788-064D | 10750' | Varied lithology consisting of shales, siltstone, limestone and coal. | | 1.01 |

Table 3

Summary of Organic Carbon and Visual Kerogen Analysis

| GeoChem Sample Number | Well Depth Interval | Organic Carbon (% of Rock) | Visual Kerogen | |
|---|---|---|---|---|
| | | | Type | Alteration (1-5 Scale) |
| 788-004D | 1750- 1760 | 1.15; 1.10R | W;-;H-C | 1+ to 2- |
| 788-006D | 2050- 2060 | 0.23 | W;Am-H;C | 1+ to 2- |
| 788-008D | 2350- 2360 | 4.72 | W;Am;H (C) | 1+ (2-)* |
| 788-010D | 2650- 2660 | 0.66 | W;H;Am-C | 1+ (2-)* |
| 788-013D | 3100- 3110 | 41.42 | W;H;Am-C | 1+ to 2- |
| 788-016D | 3550- 3560 | 3.31; 3.32R | W;Am;H (C) | 1+ to 2- |
| 788-019D | 4000- 4010 | 1.10 | W;Am-H;C | 1+ to 2- (2- to 2)* |
| 788-021D | 4300- 4310 | 0.71 | W;H;Am-C | 1+ to 2- (2- to 2)* |
| 788-022D | 4450- 4460 | 12.66 | W;H;Am-C | 1+ to 2- |
| 788-025D | 4900- 4910 | 15.99 | W;Am;W (C) | 1+ to 2- |
| 788-027D | 5200- 5210 | 7.51; 7.59R | W;Am;H (C) | 1+ to 2- |
| 788-029D | 5450- 5560 | 36.99 | W;H;Am-C | 1+ to 2- |
| 788-030D | 5650- 5660 | 3.71 | W;H;Am-C | 1+ to 2- |
| 788-032D | 5900- 5950 | 1.76 | W;H;Am-C | 2- (1+)* |
| 788-034D | 6250- 6260 | 2.11 | W;H;Am-C | 2- to 2 (1+)* |
| 788-036D | 6600- 6610 | 2.03; 2.03R | W;H;Am (C) | 2- to 2 (1+)* |
| 788-038D | 6850- 6860 | 3.09 | W;H-C;Am | 2- (1+)* |
| 788-040D | 7150- 7160 | 23.06 | W;H;C | 1+ to 2- |
| 788-041D | 7300- 7310 | 3.25 | W;H;Am-C | 1+ to 2- |
| 788-042D | 7500- 7510 | 21.12 | W;H;C | 1+ to 2- |
| 788-044D | 7750- 7760 | 9.10; 8.85R | W;H;Am-C | 1+ to 2- |
| 788-046D | 8050- 8060 | 7.29 | W;Am-H;C | 1+ to 2- |
| 788-048D | 8350- 8360 | 3.89 | W;H-C;Am | 2- |
| 788-050D | 8650- 8660 | 0.80 | W;H;Am (C) | 2- |
| 788-052D | 8950- 8960 | 4.99 | W;H;Am-C | 2- |
| 788-054D | 9240- 9250 | 2.11; 2.11R | W;H;Am-C | 2- |
| 788-056D | 9540- 9550 | 17.21 | W;H;Am-C | 2- |
| 788-057D | 9700- 9710 | 5.62 | W;H;Am-C | 2- |
| 788-060D | 10140-10150 | 3.12 | W;H;Am-C | 2- |
| 788-061D | 10300-10310 | 23.48; 23.54R | W;H;C | 2- |
| 788-062D | 10440-10450 | 3.36 | Am-W;H;C | 2- |
| 788-064D | 10740-10750 | 1.01 | W;H;C (Am) | 2- to 2 (1+ to 2-)* |

Table 4

Summary of C15+ Soxhlet Extraction, Deasphaltening and Liquid Chromatography

A. Weights of Extracts and Chromatographic Fractions

| GeoChem Sample Number | Well Interval* | Weight of Rock Extd. (grams) | Total Extract (grams) | Precipitated Asphaltenes (grams) | N-C5 Soluble (grams) | Sulfur (grams) | Paraffins-Naphthenes (grams) | Aromatics (grams) | Eluted NSO'S (grams) | Noneluted NSO'S (grams) |
|---|---|---|---|---|---|---|---|---|---|---|
| 788-004D | 1750- 1760 | 80.0 | 0.0262 | 0.0118 | 0.0144 | 0.0021 | 0.0028 | 0.0025 | 0.0041 | 0.0029 |
| 788-006D | 2050- 2060 | 100.0 | 0.0094 | 0.0058 | 0.0036 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 788-008D | 2350- 2360 | 80.0 | 0.1625 | 0.0362 | 0.1263 | N.D. | 0.0060 | 0.0241 | 0.0553 | 0.0409 |
| 788-010D | 2650- 2660 | 85.0 | 0.0285 | 0.0079 | 0.0207 | N.D. | 0.0029 | 0.0038 | 0.0068 | 0.0072 |
| 788-013D | 3100- 3110 | 85.0 | 2.7111 | 1.2753 | 1.4358 | N.D. | 0.0479 | 0.1595 | 0.5690 | 0.659 4 |
| 788-016D | 3550- 3560 | 85.0 | 0.1678 | 0.0311 | 0.1367 | N.D. | 0.0055 | 0.0146 | 0.0583 | 0.0583 |
| 788-019D | 4000- 4010 | 85.0 | 0.0459 | 0.0129 | 0.0330 | 0.0025 | 0.0035 | 0.0038 | 0.0175 | 0.0057 |
| 788-021D | 4300- 4310 | 80.0 | 0.0208 | 0.0075 | 0.0133 | 0.0020 | 0.0014 | 0.0019 | 0.0063 | 0.0017 |
| 788-022D | 4450- 4460 | 90.0 | 0.5792 | 0.1803 | 0.3989 | 0.0397 | 0.0146 | 0.0292 | 0.1608 | 0.1546 |
| 788-025D | 4900- 4910 | 90.0 | 0.7437 | 0.2113 | 0.5324 | N.D. | 0.0261 | 0.0913 | 0.2166 | 0.1984 |
| 788-027D | 5200- 5210 | 50.0 | 0.1523 | 0.0448 | 0.1075 | N.D. | 0.0046 | 0.0211 | 0.0571 | 0.0247 |
| 788-029D | 5450- 5560 | 90.0 | 1.0362 | 0.3170 | 0.7192 | N.D. | 0.0284 | 0.0910 | 0.2843 | 0.3155 |
| 788-030D | 5650- 5660 | 80.0 | 0.1292 | 0.0361 | 0.0931 | N.D. | 0.0068 | 0.0170 | 0.0497 | 0.0196 |
| 788-032D | 5900- 5950 | 90.0 | 0.0872 | 0.0241 | 0.0631 | 0.0039 | 0.0058 | 0.0070 | 0.0304 | 0.0160 |
| 788-034D | 6250- 6260 | 95.0 | 0.0746 | 0.0388 | 0.0358 | N.D. | 0.0053 | 0.0113 | 0.0147 | 0.0045 |
| 788-036D | 6600- 6610 | 85.0 | 0.0962 | 0.0307 | 0.0655 | N.D. | 0.0076 | 0.0189 | 0.0291 | 0.0099 |
| 788-038D | 6850- 6860 | 80.0 | 0.0993 | 0.0251 | 0.0742 | 0.0026 | 0.0077 | 0.0157 | 0.0371 | 0.0111 |
| 788-040D | 7150- 7160 | 80.0 | 1.2732 | 0.4427 | 0.8305 | N.D. | 0.0437 | 0.2131 | 0.3415 | 0.2322 |
| 788-041D | 7300- 7310 | 80.0 | 0.1457 | 0.0577 | 0.0880 | N.D. | 0.0095 | 0.0225 | 0.0481 | 0.0079 |
| 788-042D | 7500- 7510 | 90.0 | 1.5445 | 0.5581 | 0.9864 | N.D. | 0.0771 | 0.2801 | 0.3369 | 0.2923 |
| 788-044D | 7750- 7760 | 85.0 | 0.4392 | 0.1768 | 0.2624 | N.D. | 0 .0211 | 0.0846 | 0.1069 | 0.0498 |
| 788-046D | 8050- 8060 | 55.0 | 0.4151 | 0.1731 | 0.2420 | N.D. | 0.0268 | 0.0736 | 0.0970 | 0.0446 |
| 788-048D | 8350- 8360 | 80.0 | 0.5080 | 0.2114 | 0.2966 | N.D. | 0.0233 | 0.0805 | 0.1112 | 0.0816 |
| 788-050D | 8650- 8660 | 70.0 | 0.0375 | 0.0134 | 0.0241 | 0.0023 | 0.0034 | 0.0060 | 0.0097 | 0.0027 |
| 788-052D | 8950- 8960 | 100.0 | 1.8133 | 0.8269 | 0.9864 | N.D. | 0.1626 | 0.3547 | 0.3805 | 0.0886 |
| 788-054D | 9240- 9250 | 85.0 | 0.1227 | 0.0591 | 0.0636 | N.D. | 0.0107 | 0.0224 | 0.0256 | 0.0049 |
| 788-056D | 9540- 9550 | 80.0 | 2.0131 | 1.1363 | 0.8768 | N.D. | 0.1635 | 0.3827 | 0.2192 | 0.1114 |
| 788-057D | 9700- 9710 | 75.0 | 0.2866 | 0.1377 | 0.1489 | N.D. | 0.0154 | 0.0502 | 0.0567 | 0.0266 |
| 788-060D | 10140-10150 | 85.0 | 0.2073 | 0.0978 | 0.1095 | N.D. | 0.0257 | 0.0480 | 0.0266 | 0.0092 |
| 788-061D | 10300-10310 | 80.0 | 1.0718 | 0.3957 | 0.6761 | N.D. | 0.1471 | 0.3225 | 0.1584 | 0.0481 |
| 788-062D | 10440-10450 | 80.0 | 0.1868 | 0.0980 | 0.0888 | N.D. | 0.0102 | 0.0387 | 0.0367 | 0.0032 |
| 788-064D | 10740-10750 | 90.0 | 0.0820 | 0.0483 | 0.0337 | N.D. | 0.0070 | 0.0158 | 0.0108 | 0.0001 |

* In feet

Table 4 (continued)

B. Concentration of Extracted Materials in Rock

| GeoChem Sample Number | Well Interval* | Total Extract (ppm) | Hydrocarbons: Paraffin-Naphthene (ppm) | Hydrocarbons: Aromatic (ppm) | Hydrocarbons: Total (ppm) | Sulfur (ppm) | Nonhydrocarbons: Precipitd. Asphaltene (ppm) | Nonhydrocarbons: Eluted NSO'S (ppm) | Nonhydrocarbons: Noneluted NSO'S (ppm) | Nonhydrocarbons: Total (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 788-004D | 1750- 1760 | 328 | 35 | 31 | 66 | 26 | 148 | 51 | 36 | 261 |
| 788-006D | 2050- 2060 | 94 | - | - | - | - | 58 | - | - | - |
| 788-008D | 2350- 2360 | 2031 | 75 | 301 | 376 | - | 453 | 691 | 511 | 1655 |
| 788-010D | 2650- 2660 | 335 | 34 | 45 | 79 | - | 93 | 80 | 85 | 256 |
| 788-013D | 3100- 3110 | 31895 | 564 | 1876 | 2440 | - | 15004 | 6694 | 7758 | 29455 |
| 788-016D | 3550- 3560 | 1974 | 65 | 172 | 236 | - | 366 | 686 | 686 | 1738 |
| 788-019D | 4000- 4010 | 540 | 41 | 45 | 86 | 29 | 152 | 206 | 67 | 454 |
| 788-021D | 4300- 4310 | 260 | 18 | 24 | 41 | 25 | 94 | 79 | 21 | 219 |
| 788-022D | 4450- 4460 | 6436 | 162 | 324 | 487 | 441 | 2003 | 1787 | 1718 | 5949 |
| 788-025D | 4900- 4910 | 8263 | 290 | 1014 | 1304 | - | 2348 | 2407 | 2204 | 6959 |
| 788-027D | 5200- 5210 | 3046 | 92 | 422 | 514 | - | 896 | 1142 | 494 | 2532 |
| 788-029D | 5450- 5560 | 11513 | 316 | 1011 | 1327 | - | 3522 | 3159 | 3506 | 10187 |
| 788-030D | 5650- 5660 | 1615 | 85 | 213 | 298 | - | 451 | 621 | 245 | 1318 |
| 788-032D | 5900- 5950 | 969 | 64 | 78 | 142 | 43 | 268 | 338 | 178 | 827 |
| 788-034D | 6250- 6260 | 785 | 56 | 119 | 175 | - | 408 | 155 | 47 | 611 |
| 788-036D | 6600- 6610 | 1132 | 89 | 222 | 312 | - | 361 | 342 | 116 | 820 |
| 788-038D | 6850- 6860 | 1241 | 96 | 196 | 293 | 33 | 314 | 464 | 139 | 949 |
| 788-040D | 7150- 7160 | 15915 | 546 | 2664 | 3210 | - | 5534 | 4269 | 2903 | 12705 |
| 788-041D | 7300- 7310 | 1821 | 119 | 281 | 400 | - | 721 | 601 | 99 | 1421 |
| 788-042D | 7500- 7510 | 17161 | 857 | 3112 | 3969 | - | 6201 | 3743 | 3248 | 13192 |
| 788-044D | 7750- 7760 | 5167 | 248 | 995 | 1244 | - | 2080 | 1258 | 586 | 3924 |
| 788-046D | 8050- 8060 | 7547 | 487 | 1338 | 1825 | - | 3147 | 1764 | 811 | 5722 |
| 788-048D | 8350- 8360 | 6350 | 291 | 1006 | 1298 | - | 2643 | 1390 | 1020 | 5053 |
| 788-050D | 8650- 8660 | 536 | 49 | 86 | 134 | 33 | 191 | 139 | 39 | 401 |
| 788-052D | 8950- 8960 | 18133 | 1626 | 3547 | 5173 | - | 8269 | 3805 | 886 | 12960 |
| 788-054D | 9240- 9250 | 1444 | 126 | 264 | 389 | - | 695 | 301 | 58 | 1054 |
| 788-056D | 9540- 9550 | 25164 | 2044 | 4784 | 6828 | - | 14204 | 2740 | 1393 | 18336 |
| 788-057D | 9700- 9710 | 3821 | 205 | 669 | 875 | - | 1836 | 756 | 355 | 2947 |
| 788-060D | 10140-10150 | 2439 | 302 | 565 | 867 | - | 1151 | 313 | 108 | 1572 |
| 788-061D | 10300-10310 | 13398 | 1839 | 4031 | 5870 | - | 4946 | 1980 | 601 | 7528 |
| 788-062D | 10440-10450 | 2335 | 128 | 484 | 611 | - | 1225 | 459 | 40 | 1724 |
| 788-064D | 10740-10750 | 911 | 78 | 176 | 253 | - | 537 | 120 | 1 | 658 |

* In feet

PPM values are expressed on a weight/weight basis

Table 4 (Continued)

C. Composition of Extracts

| GeoChem Sample Number | Well Interval* | Hydrocarbons: Paraffin-Naphthene % | Hydrocarbons: Aromatic % | Hydrocarbons: PN/Arom | Hydrocarbons: Sulfur % | Nonhydrocarbons: Eluted NSO'S % | Nonhydrocarbons: Noneluted NSO'S % | Nonhydrocarbons: Precipitd. Asphaltene % | Asph/NSO | HC'S % | HC/Non HC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 788-004D | 1750- 1760 | 10.7 | 9.5 | 1.12 | 8.0 | 15.6 | 11.1 | 45.0 | 1.69 | 20.2 | 0.25 |
| 788-006D | 2050- 2060 | - | - | - | - | - | - | 61.7 | - | - | - |
| 788-008D | 2350- 2360 | 3.7 | 14.8 | 0.25 | - | 34.0 | 25.2 | 22.3 | 0.38 | 18.5 | 0.23 |
| 788-010D | 2650- 2660 | 10.2 | 13.3 | 0.76 | - | 23.9 | 25.3 | 27.7 | 0.56 | 23.5 | 0.31 |
| 788-013D | 3100- 3110 | 1.8 | 5.9 | 0.30 | - | 21.0 | 24.3 | 47.0 | 1.04 | 7.7 | 0.08 |
| 788-016D | 3550- 3560 | 3.3 | 8.7 | 0.38 | - | 34.7 | 34.7 | 18.5 | 0.27 | 12.0 | 0.14 |
| 788-019D | 4000- 4010 | 7.6 | 8.3 | 0.92 | 5.4 | 38.1 | 12.4 | 28.1 | 0.56 | 15.9 | 0.19 |
| 788-021D | 4300- 4310 | 6.7 | 9.1 | 0.74 | 9.6 | 30.3 | 8.2 | 36.1 | 0.94 | 15.9 | 0.19 |
| 788-022D | 4450- 4460 | 2.5 | 5.0 | 0.50 | 6.9 | 27.8 | 26.7 | 31.1 | 0.57 | 7.6 | 0.08 |
| 788-025D | 4900- 4910 | 3.5 | 12.3 | 0.29 | - | 29.1 | 26.7 | 28.4 | 0.51 | 15.8 | 0.19 |
| 788-027D | 5200- 5210 | 3.0 | 13.9 | 0.22 | - | 37.5 | 16.2 | 29.4 | 0.55 | 16.9 | 0.20 |
| 788-029D | 5450- 5560 | 2.7 | 8.8 | 0.31 | - | 27.4 | 30.4 | 30.6 | 0.53 | 11.5 | 0.13 |
| 788-030D | 5650- 5660 | 5.3 | 13.2 | 0.40 | - | 38.5 | 15.2 | 27.9 | 0.52 | 18.4 | 0.23 |
| 788-032D | 5900- 5950 | 6.7 | 8.0 | 0.83 | 4.5 | 34.9 | 18.3 | 27.6 | 0.52 | 14.7 | 0.17 |
| 788-034D | 6250- 6260 | 7.1 | 15.1 | 0.47 | - | 19.7 | 6.0 | 52.0 | 2.02 | 22.3 | 0.29 |
| 788-036D | 6600- 6610 | 7.9 | 19.6 | 0.40 | - | 30.2 | 10.3 | 31.9 | 0.79 | 27.5 | 0.38 |
| 788-038D | 6850- 6860 | 7.8 | 15.8 | 0.49 | 2.6 | 37.4 | 11.2 | 25.3 | 0.52 | 23.6 | 0.31 |
| 788-040D | 7150- 7160 | 3.4 | 16.7 | 0.21 | - | 26.8 | 18.2 | 34.8 | 0.77 | 20.2 | 0.25 |
| 788-041D | 7300- 7310 | 6.5 | 15.4 | 0.42 | - | 33.0 | 5.4 | 39.6 | 1.03 | 22.0 | 0.28 |
| 788-042D | 7500- 7510 | 5.0 | 18.1 | 0.28 | - | 21.8 | 18.9 | 36.1 | 0.89 | 23.1 | 0.30 |
| 788-044D | 7750- 7760 | 4.8 | 19.3 | 0.25 | - | 24.3 | 11.3 | 40.3 | 1.13 | 24.1 | 0.32 |
| 788-046D | 8050- 8060 | 6.5 | 17.7 | 0.36 | - | 23.4 | 10.7 | 41.7 | 1.22 | 24.2 | 0.32 |
| 788-048D | 8350- 8360 | 4.6 | 15.8 | 0.29 | - | 21.9 | 16.1 | 41.6 | 1.10 | 20.4 | 0.26 |
| 788-050D | 8650- 8660 | 9.1 | 16.0 | 0.57 | 6.1 | 25.9 | 7.2 | 35.7 | 1.08 | 25.1 | 0.33 |
| 788-052D | 8950- 8960 | 9.0 | 19.6 | 0.46 | - | 21.0 | 4.9 | 45.6 | 1.76 | 28.5 | 0.40 |
| 788-054D | 9240- 9250 | 8.7 | 18.3 | 0.48 | - | 20.9 | 4.0 | 48.2 | 1.94 | 27.0 | 0.37 |
| 788-056D | 9540- 9550 | 8.1 | 19.0 | 0.43 | - | 10.9 | 5.5 | 56.4 | 3.44 | 27.1 | 0.37 |
| 788-057D | 9700- 9710 | 5.4 | 17.5 | 0.31 | - | 19.8 | 9.3 | 48.0 | 1.65 | 22.9 | 0.30 |
| 788-060D | 10140-10150 | 12.4 | 23.2 | 0.54 | - | 12.8 | 4.4 | 47.2 | 2.73 | 35.6 | 0.55 |
| 788-061D | 10300-10310 | 13.7 | 30.1 | 0.46 | - | 14.8 | 4.5 | 36.9 | 1.92 | 43.8 | 0.78 |
| 788-062D | 10440-10450 | 5.5 | 20.7 | 0.26 | - | 19.6 | 1.7 | 52.5 | 2.46 | 26.2 | 0.35 |
| 788-064D | 10740-10750 | 8.5 | 19.3 | 0.44 | - | 13.2 | 0.1 | 58.9 | 4.43 | 27.8 | 0.39 |

* In feet

Table 5-A

Saturate Hydrocarbon Analyses

Summary of Paraffin-Naphthene Distribution

| GeoChem Sample Number | Well Interval* | % Paraffin | % Isoprenoid | % Naphthene | C-P Index A | C-P Index B | ip19/ip20 |
|---|---|---|---|---|---|---|---|
| 788-004D | 1750- 1760 | 5.6 | 0.1 | 94.3 | 1.07 | 1.12 | 4.00 |
| 788-006D | 2050- 2060 | 4.3 | 0.1 | 95.5 | 1.24 | 2.26 | 7.00 |
| 788-008D | 2350- 2360 | 16.3 | 2.3 | 81.4 | 2.37 | 4.21 | 8.69 |
| 788-010D | 2650- 2660 | 6.4 | 1.1 | 92.5 | 1.39 | 1.72 | 45.50 |
| 788-013D | 3100- 3110 | 18.9 | 14.5 | 66.7 | - | - | 94.00 |
| 788-016D | 3550- 3560 | 7.7 | 2.5 | 89.8 | - | - | 17.00 |
| 788-019D | 4000- 4010 | 5.8 | 1.4 | 92.8 | - | - | 32.67 |
| 788-021D | 4300- 4310 | 7.3 | 0.3 | 92.4 | 1.09 | 1.25 | 12.50 |
| 788-022D | 4450- 4460 | 11.9 | 6.9 | 81.2 | - | - | 26.50 |
| 788-025D | 4900- 4910 | 18.1 | 22.5 | 59.3 | - | - | 72.67 |
| 788-027D | 5200- 5210 | 12.5 | 8.6 | 78.9 | - | - | 36.17 |
| 788-029D | 5450- 5560 | 15.7 | 8.0 | 76.2 | - | - | 15.25 |
| 788-030D | 5650- 5660 | 9.5 | 2.9 | 87.6 | - | - | 9.86 |
| 788-032D | 5900- 5950 | 11.7 | 1.8 | 86.6 | - | - | 3.20 |
| 788-034D | 6250- 6260 | 15.0 | 0.8 | 84.2 | - | - | 2.53 |
| 788-036D | 6600- 6610 | 23.2 | 3.6 | 73.2 | - | - | 5.83 |
| 788-038D | 6850- 6860 | 10.2 | 3.3 | 86.4 | - | - | 11.29 |
| 788-040D | 7150- 7160 | 22.5 | 13.4 | 64.1 | - | - | 21.64 |
| 788-041D | 7300- 7310 | 9.2 | 2.8 | 88.0 | - | - | 9.29 |
| 788-042D | 7500- 7510 | 28.4 | 18.8 | 52.8 | - | - | 22.92 |
| 788-044D | 7750- 7760 | 19.7 | 7.3 | 73.0 | - | - | 20.14 |
| 788-046D | 8050- 8060 | 8.0 | 4.5 | 87.4 | - | - | 7.81 |
| 788-048D | 8350- 8360 | 7.8 | 3.8 | 88.4 | - | - | 5.66 |
| 788-050D | 8650- 8660 | 8.5 | 0.8 | 90.7 | 1.46 | 1.69 | 9.40 |
| 788-052D | 8950- 8960 | 2.9 | 1.3 | 95.9 | - | - | 5.58 |
| 788-054D | 9240- 9250 | 8.7 | 2.9 | 88.4 | - | - | 6.13 |
| 788-056D | 9540- 9550 | 20.9 | 7.0 | 72.1 | 1.22 | 1.50 | 8.53 |
| 788-057D | 9700- 9710 | 19.8 | 5.2 | 75.0 | 1.25 | 1.48 | 8.77 |
| 788-060D | 10140-10150 | 13.4 | 3.2 | 83.3 | 1.26 | 1.55 | 4.23 |
| 788-061D | 10300-10310 | 17.9 | 5.8 | 76.3 | 1.12 | 1.27 | 7.24 |
| 788-062D | 10440-10450 | 22.1 | 3.4 | 74.6 | 1.19 | 1.44 | 4.37 |
| 788-064D | 10740-10750 | 14.9 | 1.0 | 84.2 | 1.24 | 1.51 | 3.28 |

* In feet

Table 5-B

Saturate Hydrocarbon Analyses

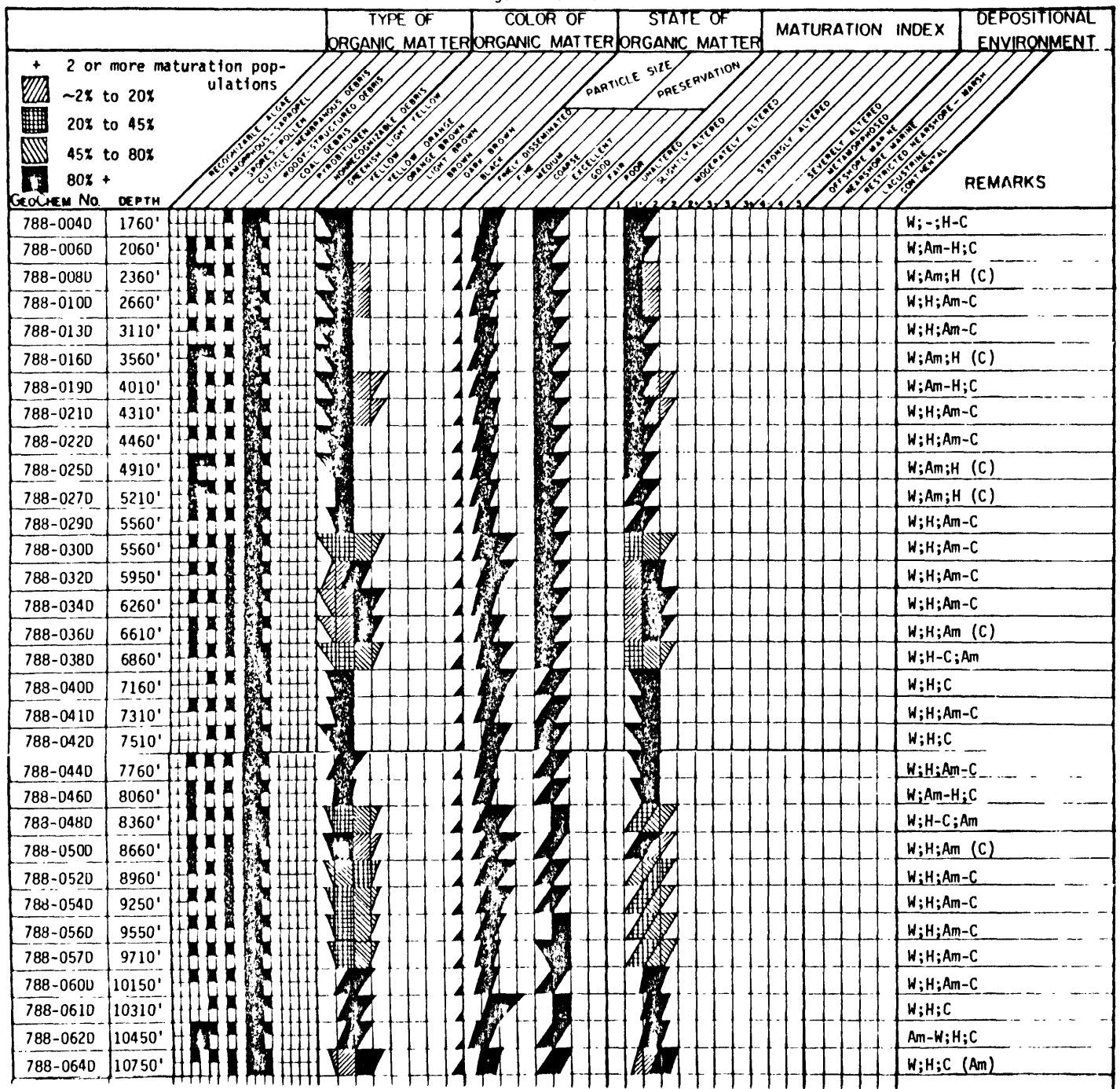
Normalized Paraffin Distribution

| GeoChem Sample Number | Well Interval* | % nC15 | % nC16 | % nC17 | % ip19 | % nC18 | % ip20 | % nC19 | % nC20 | % nC21 | % nC22 | % nC23 | % nC24 | % nC25 | % nC26 | % nC27 | % nC28 | % nC29 | % nC30 | % nC31 | % nC32 | % nC33 | % nC34 | % nC35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 788-004D | 1750- 1760 | 1.1 | 1.1 | 0.7 | 1.5 | 1.1 | 0.4 | 3.3 | 8.5 | 12.6 | 19.3 | 24.8 | 14.1 | 4.8 | 2.2 | 0.7 | 1.1 | 1.1 | 0.4 | 0.7 | 0.4 | 0.0 | 0.0 | 0.0 |
| 788-006D | 2050- 2060 | 7.1 | 4.4 | 2.4 | 2.4 | 1.4 | 0.3 | 2.4 | 5.1 | 8.5 | 13.9 | 18.6 | 11.9 | 9.8 | 2.7 | 2.4 | 1.4 | 3.1 | 0.3 | 1.4 | 0.3 | 0.3 | 0.0 | 0.0 |
| 788-008D | 2350- 2360 | 2.5 | 2.5 | 4.1 | 11.0 | 3.6 | 1.3 | 5.9 | 4.4 | 7.1 | 5.6 | 10.5 | 2.9 | 9.6 | 3.8 | 10.2 | 2.5 | 10.2 | 0.1 | 2.0 | 0.1 | 0.2 | 0.0 | 0.0 |
| 788-010D | 2650- 2660 | 0.8 | 0.6 | 0.8 | 14.1 | 0.8 | 0.3 | 2.0 | 2.8 | 5.7 | 8.2 | 15.5 | 8.2 | 11.0 | 8.8 | 7.3 | 3.6 | 6.4 | 0.2 | 2.5 | 0.2 | 0.3 | 0.0 | 0.0 |
| 788-013D | 3100- 3110 | 1.8 | 0.9 | 5.5 | 42.9 | 5.7 | 0.5 | 6.2 | 2.5 | 8.0 | 2.3 | 7.1 | 0.9 | 0.0 | 0.0 | 0.0 | 0.0 | 11.6 | 0.2 | 3.4 | 0.2 | 0.2 | 0.0 | 0.0 |
| 788-016D | 3550- 3560 | 1.1 | 1.1 | 3.0 | 23.3 | 2.7 | 1.4 | 6.3 | 3.3 | 5.5 | 5.5 | 11.8 | 11.0 | 11.2 | 0.0 | 0.0 | 0.0 | 9.3 | 0.3 | 2.7 | 0.3 | 0.3 | 0.0 | 0.0 |
| 788-019D | 4000- 4010 | 0.6 | 0.2 | 2.1 | 19.1 | 2.1 | 0.6 | 4.1 | 2.9 | 6.6 | 7.0 | 13.8 | 8.0 | 14.2 | 0.0 | 0.0 | 0.0 | 13.8 | 0.2 | 4.1 | 0.2 | 0.4 | 0.0 | 0.0 |
| 788-021D | 4300- 4310 | 0.6 | 0.5 | 1.3 | 3.9 | 0.8 | 0.3 | 2.5 | 4.4 | 8.4 | 12.0 | 15.3 | 9.5 | 12.3 | 13.4 | 5.4 | 2.1 | 5.4 | 0.3 | 1.4 | 0.2 | 0.2 | 0.0 | 0.0 |
| 788-022D | 4450- 4460 | 1.3 | 2.3 | 8.6 | 35.2 | 12.6 | 1.3 | 5.3 | 2.3 | 5.3 | 3.0 | 14.3 | 1.7 | 4.3 | 0.0 | 0.0 | 0.0 | 1.3 | 0.3 | 0.7 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-025D | 4900- 4910 | 0.5 | 0.5 | 4.5 | 54.6 | 5.0 | 0.8 | 2.8 | 1.3 | 4.3 | 1.3 | 21.1 | 0.8 | 1.8 | 0.0 | 0.0 | 0.0 | 0.5 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-027D | 5200- 5210 | 0.4 | 0.5 | 8.6 | 39.7 | 18.6 | 1.1 | 4.0 | 3.1 | 4.6 | 4.2 | 7.9 | 2.9 | 2.7 | 0.0 | 0.0 | 0.5 | 0.5 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-029D | 5450- 5560 | 0.8 | 1.0 | 15.1 | 31.7 | 6.2 | 2.1 | 6.5 | 3.4 | 6.8 | 4.2 | 16.4 | 2.3 | 1.8 | 0.0 | 0.0 | 0.8 | 0.5 | 0.3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-030D | 5650- 5660 | 0.5 | 0.3 | 6.8 | 21.4 | 4.8 | 2.2 | 7.3 | 6.5 | 8.8 | 8.2 | 19.0 | 4.6 | 6.5 | 0.0 | 0.0 | 0.6 | 1.7 | 0.3 | 0.5 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-032D | 5900- 5950 | 0.1 | 0.2 | 3.3 | 10.1 | 8.1 | 3.2 | 13.7 | 11.5 | 10.1 | 7.6 | 15.4 | 5.6 | 6.8 | 0.0 | 0.0 | 0.0 | 2.6 | 0.5 | 0.8 | 0.1 | 0.2 | 0.0 | 0.0 |
| 788-034D | 6250- 6260 | 0.1 | 0.2 | 1.4 | 3.6 | 3.6 | 1.4 | 7.1 | 6.6 | 8.3 | 6.4 | 17.3 | 6.0 | 11.8 | 0.0 | 0.0 | 0.0 | 15.9 | 1.8 | 7.6 | 0.1 | 0.8 | 0.0 | 0.0 |
| 788-036D | 6600- 6610 | 5.2 | 7.2 | 9.9 | 11.4 | 9.8 | 2.0 | 10.3 | 8.7 | 8.3 | 6.8 | 8.1 | 3.8 | 4.6 | 0.0 | 0.0 | 0.0 | 2.5 | 0.4 | 1.0 | 0.1 | 0.1 | 0.0 | 0.0 |
| 788-038D | 6850- 6860 | 1.1 | 1.3 | 9.5 | 22.5 | 3.6 | 2.0 | 5.6 | 4.7 | 6.8 | 7.1 | 12.1 | 5.4 | 8.5 | 0.0 | 0.0 | 0.0 | 6.0 | 0.6 | 2.7 | 0.1 | 0.3 | 0.0 | 0.0 |
| 788-040D | 7150- 7160 | 1.9 | 1.6 | 25.9 | 35.6 | 10.3 | 1.6 | 4.6 | 3.1 | 4.0 | 3.4 | 4.5 | 1.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.1 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |
| 788-041D | 7300- 7310 | 0.3 | 0.5 | 12.1 | 20.8 | 5.9 | 2.2 | 4.9 | 4.3 | 7.5 | 7.6 | 12.7 | 5.4 | 8.5 | 0.0 | 0.0 | 0.0 | 4.9 | 0.1 | 1.8 | 0.1 | 0.3 | 0.0 | 0.0 |
| 788-042D | 7500- 7510 | 1.8 | 1.4 | 36.3 | 38.2 | 4.2 | 1.7 | 3.3 | 2.5 | 3.5 | 2.4 | 3.1 | 1.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-044D | 7750- 7760 | 0.6 | 1.1 | 46.1 | 25.9 | 4.2 | 1.3 | 3.5 | 2.8 | 4.0 | 3.3 | 4.4 | 1.8 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 0.2 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 788-046D | 8050- 8060 | 1.7 | 2.4 | 14.8 | 32.0 | 5.6 | 4.1 | 7.1 | 5.3 | 6.7 | 5.8 | 7.3 | 3.9 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.3 | 0.8 | 0.2 | 0.2 | 0.0 | 0.0 |
| 788-048D | 8350- 8360 | 0.3 | 1.5 | 9.3 | 27.6 | 8.8 | 4.9 | 10.4 | 7.1 | 6.7 | 6.1 | 8.4 | 4.7 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.5 | 1.2 | 0.3 | 0.2 | 0.0 | 0.0 |
| 788-050D | 8650- 8660 | 0.2 | 0.2 | 3.6 | 7.7 | 1.2 | 0.8 | 2.6 | 2.1 | 7.1 | 9.2 | 16.6 | 11.2 | 13.0 | 6.7 | 7.6 | 4.1 | 3.8 | 0.5 | 1.5 | 0.2 | 0.2 | 0.0 | 0.0 |
| 788-052D | 8950- 8960 | 1.0 | 1.6 | 12.7 | 26.1 | 4.1 | 4.7 | 4.9 | 4.3 | 5.3 | 5.5 | 8.0 | 3.3 | 0.0 | 0.0 | 0.0 | 0.0 | 5.7 | 3.1 | 5.8 | 2.5 | 1.6 | 0.0 | 0.0 |
| 788-054D | 9240- 9250 | 0.3 | 1.2 | 5.1 | 21.2 | 4.8 | 3.5 | 7.2 | 6.8 | 9.7 | 8.7 | 12.0 | 6.5 | 8.8 | 0.0 | 0.0 | 0.0 | 2.6 | 0.3 | 1.0 | 0.1 | 0.3 | 0.0 | 0.0 |
| 788-056D | 9540- 9550 | 2.6 | 2.4 | 5.0 | 22.5 | 4.6 | 2.6 | 4.8 | 4.8 | 6.5 | 7.1 | 8.1 | 6.6 | 6.9 | 4.0 | 4.9 | 3.2 | 2.1 | 0.3 | 0.8 | 0.1 | 0.1 | 0.0 | 0.0 |
| 788-057D | 9700- 9710 | 0.5 | 1.0 | 4.8 | 18.6 | 3.5 | 2.1 | 5.2 | 5.6 | 7.4 | 7.9 | 9.5 | 7.2 | 7.7 | 4.5 | 5.9 | 4.2 | 3.0 | 0.4 | 0.8 | 0.1 | 0.1 | 0.0 | 0.0 |
| 788-060D | 10140-10150 | 0.5 | 1.0 | 3.9 | 15.8 | 5.0 | 3.7 | 7.1 | 7.2 | 7.7 | 7.6 | 8.4 | 5.9 | 7.6 | 5.0 | 6.1 | 3.3 | 2.8 | 0.6 | 0.8 | 0.1 | 0.1 | 0.0 | 0.0 |
| 788-061D | 10300-10310 | 3.4 | 3.3 | 6.5 | 21.5 | 5.0 | 3.0 | 5.1 | 5.6 | 6.9 | 7.6 | 8.0 | 6.8 | 6.0 | 3.2 | 3.2 | 2.7 | 0.9 | 0.2 | 0.5 | 0.2 | 0.1 | 0.2 | 0.0 |
| 788-062D | 10440-10450 | 0.4 | 1.1 | 3.0 | 10.8 | 5.5 | 2.5 | 8.2 | 8.3 | 9.0 | 8.8 | 9.9 | 7.7 | 7.8 | 4.9 | 5.4 | 3.3 | 2.3 | 0.4 | 0.6 | 0.1 | 0.1 | 0.0 | 0.0 |
| 788-064D | 10740-10750 | 0.6 | 0.5 | 1.4 | 4.6 | 2.5 | 1.4 | 4.8 | 6.4 | 8.5 | 9.5 | 11.4 | 9.1 | 9.9 | 6.8 | 8.9 | 5.3 | 4.7 | 1.3 | 2.0 | 0.2 | 0.2 | 0.0 | 0.0 |

* In feet

Table 6

Visual Kerogen Assessment Worksheet




| | GeoChem No. | DEPTH | REMARKS |
|---|---|---|---|
| | 788-004D | 1760' | W;-;H-C |
| | 788-006D | 2060' | W;Am-H;C |
| + | 788-008D | 2360' | W;Am;H (C) |
| + | 788-010D | 2660' | W;H;Am-C |
| | 788-013D | 3110' | W;H;Am-C |
| | 788-016D | 3560' | W;Am;H (C) |
| + | 788-019D | 4010' | W;Am-H;C |
| + | 788-021D | 4310' | W;H;Am-C |
| | 788-022D | 4460' | W;H;Am-C |
| | 788-025D | 4910' | W;Am;H (C) |
| | 788-027D | 5210' | W;Am;H (C) |
| | 788-029D | 5560' | W;H;Am-C |
| + | 788-030D | 5560' | W;H;Am-C |
| + | 788-032D | 5950' | W;H;Am-C |
| + | 788-034D | 6260' | W;H;Am-C |
| + | 788-036D | 6610' | W;H;Am (C) |
| + | 788-038D | 6860' | W;H-C;Am |
| | 788-040D | 7160' | W;H;C |
| | 788-041D | 7310' | W;H;Am-C |
| | 788-042D | 7510' | W;H;C |
| | 788-044D | 7760' | W;H;Am-C |
| | 788-046D | 8060' | W;Am-H;C |
| + | 788-048D | 8360' | W;H-C;Am |
| + | 788-050D | 8660' | W;H;Am (C) |
| + | 788-052D | 8960' | W;H;Am-C |
| + | 788-054D | 9250' | W;H;Am-C |
| + | 788-056D | 9550' | W;H;Am-C |
| + | 788-057D | 9710' | W;H;Am-C |
| | 788-060D | 10150' | W;H;Am-C |
| | 788-061D | 10310' | W;H;C |
| | 788-062D | 10450' | Am-W;H;C |
| + | 788-064D | 10750' | W;H;C (Am) |

Table 7

Vitrinite Reflectance Summary

| GeoChem Sample Number | Depth (feet) | Number of Readings | Minimum Reflectance (% Ro) | Maximum Reflectance (% Ro) | Average Reflectance (% Ro) |
|---|---|---|---|---|---|
| 788-004D | 1750-1760 | * | - | - | - |
| 788-010D | 2650-2660 | 14 | 0.17 | 0.87 | 0.40 |
| 788-013D | 3100-3110 | 40 | 0.17 | 0.34 | 0.24 |
| 788-016D | 3550-3560 | 40 | 0.16 | 0.36 | 0.24 |
| 788-019D | 4000-4010 | 27 | 0.15 | 0.67 | 0.28 |
| 788-022D | 4450-4460 | 40 | 0.20 | 0.35 | 0.27 |
| 788-025D | 4900-4910 | 40 | 0.27 | 0.42 | 0.32 |
| 788-029D | 5450-5560 | 41 | 0.24 | 0.47 | 0.35 |
| 788-032D | 5900-5950 | 37 | 0.25 | 0.47 | 0.37 |
| 788-036D | 6600-6610 | 40 | 0.19 | 0.54 | 0.40 |
| 788-040D | 7150-7160 | 40 | 0.48 | 0.63 | 0.55 |
| 788-042D | 7500-7510 | 40 | 0.43 | 0.66 | 0.54 |
| 788-044D | 7750-7760 | 40 | 0.21 | 0.63 | 0.52 |
| 788-048D | 8350-8360 | 40 | 0.38 | 0.68 | 0.55 |
| 788-052D | 8950-8960 | 40 | 0.23 | 0.67 | 0.48 |
| 788-056D | 9540-9550 | 40 | 0.50 | 0.78 | 0.67 |
| 788-058D | 9840-9850 | 40 | 0.29 | 0.71 | 0.55 |
| 788-061D | 10300-10310 | 40 | 0.39 | 0.83 | 0.65 |

Note:

* Insuffient kerogen return to prepare plug.

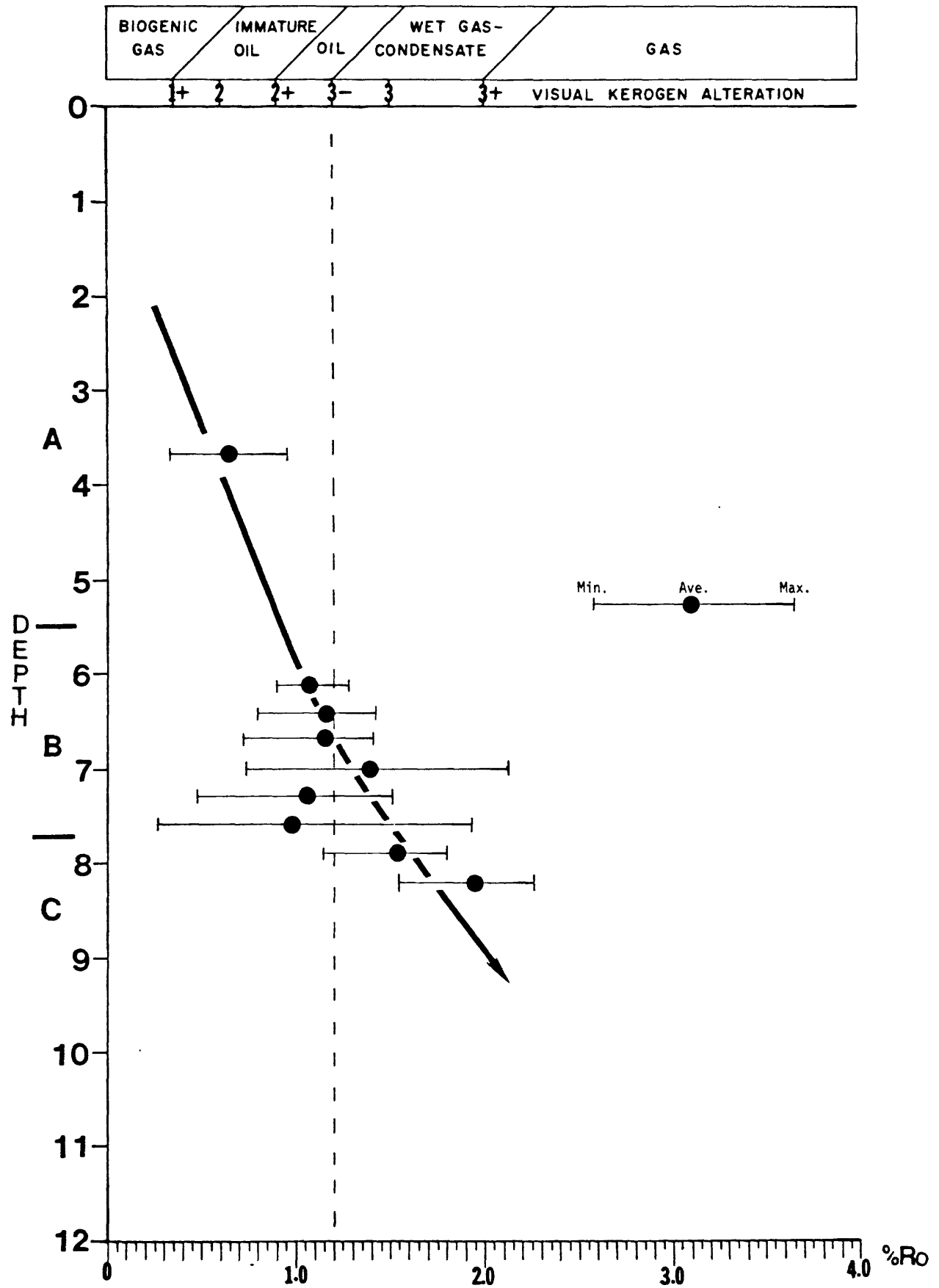
# APPENDIX 2

Geochemical Data for Pan

American Hoodoo Lake Unit No. 2

# PAN AM - SOCAL - HOODOO LAKE NO. 2

## VITRINITE REFLECTANCE DATA

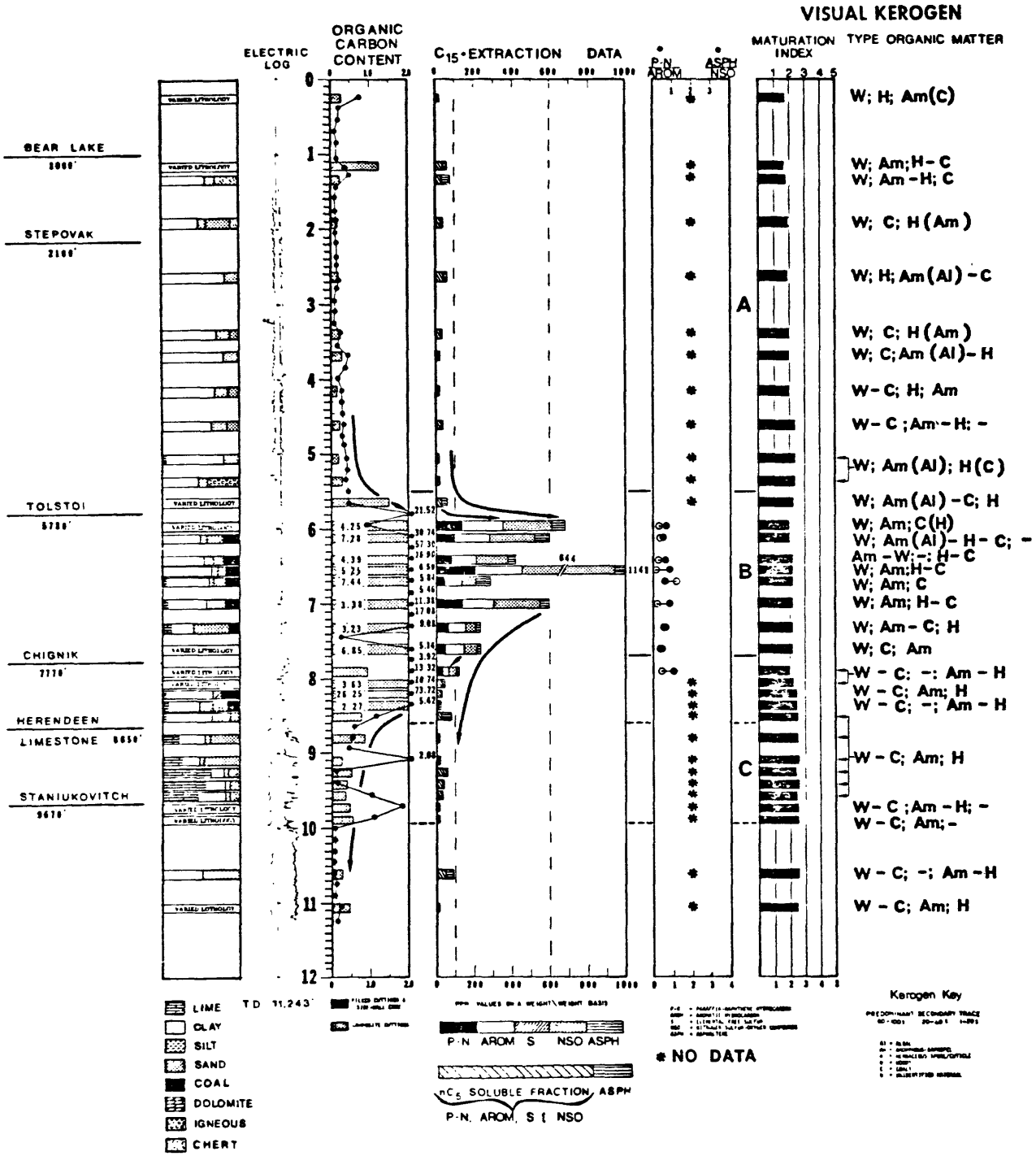



"Figure prepared by Geo Chem Labs., In

# PAN AM - Socal USA HOODOO LAKE UNIT #2 WELL

## SUMMARY OF ORGANIC ANALYSES

### SOURCE CHARACTER






" Figure prepared by Geo Chem Labs., Inc."

Table 8

Organic Carbon and Lithology Screen Analyses

| GeoChem Sample Number | Well Depth Interval | Description | Percent Organic Carbon |
|---|---|---|---|
| 787-001 | 227'- 240' | Silty claystone, light gray. | 0.76 |
| 787-002 | 390'- 420' | Composite, reworked material. | 0.21 |
| 787-003 | 540'- 570' | Composite, reworked material. | 0.19 |
| 787-004 | 690'- 720' | Composite, sand and reworked. | 0.10 |
| 787-005 | 840'- 870' | Composite, sand and reworked. | 0.14; 0.10 R |
| 787-006 | 1050'- 1080' | Composite, sand and reworked. | 0.14 |
| 787-007 | 1170'- 1200' | Silty claystone, light olive gray. | 0.37 |
| 787-008 | 1290'- 1320' | Claystone, light gray. | 0.49 |
| 787-009 | 1440'- 1470' | Composite, clay, carbonate, sand, s.s., reworked. | 0.14 |
| 787-010 | 1590'- 1620' | Composite, clay, carbonate, sand, ss. reworked. | 0.11; 0.13 R |
| 787-011 | 1740'- 1770' | Composite, claystone, limestone, ss. sand, rewkd. | 0.11 |
| 787-012 | 1890'- 1920' | Claystone, very sandy w/glauconite | 0.14 |
| 787-013 | 2040'- 2070' | Sandstone, very clayey, light olive gray. | 0.11 |
| 787-014 | 2190'- 2220' | Composite, sandstone, claystone, siderite. | 0.16 |
| 787-015 | 2340'- 2370' | Sandstone, very clayey, light olive gray. | 0.15; 0.20 R |
| 787-016 | 2490'- 2520' | Composite, sandstone, claystone, siderite. | 0.14 |
| 787-017 | 2640'- 2670' | Sandstone, very argillaceous, light olive gray. | 0.22 |
| 787-018 | 2790'- 2820' | comp., lmst, sandstone, calcite, siderite. | 0.16 |
| 787-019 | 2940'- 2970' | Comp. siltstone, s.s., lt. olive gray, tr. calc. | 0.09 |
| 787-020 | 3090'- 3120' | Comp. siltstone, s.s., lt. olive gray, tr. calc. | 0.10; 0.09 R |
| 787-021 | 3240'- 3270' | Comp. siltstone, s.s., lt. olive gray, tr. calc. | 0.08 |
| 787-022 | 3390'- 3420' | Sandstone. | 0.24 |
| 787-023 | 3540'- 3570' | Composite, sandstone, siderite, trace calcite. | 0.16 |
| 787-024 | 3690'- 3720' | Medium dark gray siltstone. | 0.45 |
| 787-025 | 3840'- 3870' | Medium dark gray siltstone. | 0.38; 0.39 R |
| 787-026 | 3990'- 4020' | Greenish gray silty shale | 0.18 |
| 787-027 | 4140'- 4160' | Silty shale. | 0.27 |
| 787-028 | 4300'- 4320' | Silty shale, medium dark gray. | 0.29 |
| 787-029 | 4440'- 4460' | Silty shale, medium dark gray. | 0.30 |
| 787-030 | 4600'- 4620' | Silty shale, medium dark gray. | 0.32; 0.34 R |
| 787-031 | 4740'- 4760' | Silty shale, medium dark gray. | 0.29 |
| 787-032 | 4880'- 4900' | Slightly silty shale, medium dark gray. | 0.34 |
| 787-033 | 5040'- 5060' | Silty shale, medium dark gray. | 0.39 |
| 787-034 | 5200'- 5220' | Silty shale, medium dark gray. | 0.42 |
| 787-035 | 5340'- 5360' | Slightly silty shale, medium dark gray. | 0.38; 0.42 R |
| 787-036 | 5500'- 5520' | Shale, medium dark gray. | 0.45 |
| 787-037 | 5640'- 5660' | Shale, medium dark gray. | 0.47 |

Table 8

Organic Carbon and Lithology Screen Analyses

| GeoChem Sample Number | Well Depth Interval | Description | Percent Organic Carbon |
|---|---|---|---|
| 787-038 | 5800'- 5820' | Silty coal. | 21.52 |
| 787-039 | 5940'- 5960' | Siltstone, medium gray. | 0.90 |
| 787-040 | 6100'- 6120' | Silty coal. | 30.74;29.96 R |
| 787-041 | 6240'- 6260' | Coal. | 57.30 |
| 787-042 | 6400'- 6420' | Silty coal. | 16.90 |
| 787-043 | 6540'- 6560' | Silty shale, black, carbonaceous. | 6.58 |
| 787-044 | 6700'- 6720' | Silty shale, black, carbonaceous. | 5.84 |
| 787-045 | 6840'- 6860' | Silty shale, black, carbonaceous. | 5.46; 5.38 R |
| 787-046 | 7000'- 7020' | Shale, black, carbonaceous. | 11.38 |
| 787-047 | 7140'- 7160' | Shale, black, carbonaceous. | 17.08 |
| 787-048 | 7300'- 7320' | Shale, black, carbonaceous. | 9.08 |
| 787-049 | 7440'- 7460' | Sandstone | 0.25 |
| 787-050 | 7600'- 7610' | Shale, black, carbonaceous. | 5.14; 5.22 R |
| 787-051 | 7750'- 7760' | Shale, black. | 3.92 |
| 787-052 | 7900'- 7910' | Shale, black, carbonaceous. | 13.32 |
| 787-053 | 8050'- 8060' | Shale, black, carbonaceous. | 10.74 |
| 787-054 | 8200'- 8210' | Coal. | 73.72 |
| 787-055 | 8350'- 8360' | Shale, black, slightly carbonaceous. | 5.42; 5.30 R |
| 787-056 | 8500'- 8510' | Shale, slightly silty, grayish black. | 1.17 |
| 787-057 | 8660'- 8670' | Shale, medium dark gray. | 0.59 |
| 787-058 | 8800'- 8810' | Shale, slightly silty, dark gray. | 0.54 |
| 787-059 | 8950'- 8960' | Shale, slightly silty, dark gray. | 0.46 |
| 787-060 | 9100'- 9110' | Shale, slightly silty, dark gray. | 2.08; 2.07 R |
| 787-061 | 9250'- 9260' | Limestone. | 0.12 |
| 787-062 | 9400'- 9410' | Limestone. | 0.13 |
| 787-063 | 9550'- 9560' | Shale, silty, dark gray. | 1.03 |
| 787-064 | 9700'- 9710' | Shale, silty, dark gray. | 1.85 |
| 787-065 | 9860'- 9870' | Shale, silty, dark gray. | 1.11; 1.10 R |
| 787-066 | 10000'-10010' | Sandstone. | 0.08 |
| 787-067 | 10150'-10160' | Tuffaceous sandstone. | 0.06 |
| 787-068 | 10300'-10310' | Tuffaceous sandstone. | 0.08 |
| 787-069 | 10450'-10460' | Sandstone | 0.05 |
| 787-070 | 10600'-10610' | Shale, silty, medium dark gray. | 0.05; 0.06 R |
| 787-071 | 10750'-10760' | Sandstone. | 0.11 |
| 787-072 | 10900'-10910' | Intrusives, igneous. | 0.06 |
| 787-073 | 11050'-11060' | Composite, intrusives, igneous. | 0.21 |
| 787-074 | 11240'-11243' | Composite, intrusives, igneous. | 0.13 |

Table 9

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-001D | 270' | Varied lithology consisting of shale, reworked shale, chert,and unconsloidated sand. | | 0.29 |
| 787-007D -A | 1260' | Varied lithology consisting of shale, reworked shale, chert, and unconsolidated sand. | | 1.27 |
| 787-008D | 1410' | | | 0.22 |
| -A | | 70% Shale, noncalcareous, silty, blocky, moderately hard, light gray. | N7 | |
| -B | | 30% Reworked chert and siliceous shale. Trace of sand grains. | | |
| 787-012D | 1950' | | | 0.15 |
| -A | | 50% Shale, noncalcareous, silty, blocky, moderately hard, light gray. | N7 | |
| -B | | 40% Sandstone, argillaceous cement, very fine to fine grain, subrounded to sub-angular, frosted to clear, fair porosity, no show. | | |
| -C | | 10% Reworked chert and siliceous shale. | | |
| 787-017D | 2670' | | | 0.19; 0.19 R |
| -A | | 60% Shale, noncalcareous, very silty, blocky, moderately hard, olive gray. | 5Y4/1 | |
| -B | | 30% Shale, noncalcareous, blocky, moderately hard, greenish gray. | 5G6/1 | |
| -C | | 10% Bentonite. | | |
| 787-022D | 3420' | | | 0.22 |
| -A | | 50% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 40% Shale, noncalcareous, silty, very sandy, fine grain, subrounded, frosted; blocky, moderately hard, dark gray. | N4 | |
| -C | | 10% Bentonite. | | |

## Table 9

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-024D | 3720' | | | 0.28 |
| -A | | 70% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 30% Shale, noncalcareous, silty, very sandy; fine grain, subrounded, frosted; blocky, moderately hard, medium dark gray. | N4 | |
| 787-027D | 4180' | | | 0.14 |
| -A | | 50% Shale, noncalcareous, silty, very sandy; fine grain, subrounded, frosted; blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 40% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| -C | | 10% Bentonite. | | |
| 787-030D | 4640' | | | 0.21 |
| -A | | 60% Shale, noncalcareous, silty, very sandy; fine grain, subrounded, frosted; blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 40% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| 787-033D | 5060' | | | 0.20; 0.17 R |
| -A | | 60% Shale, slightly calcareous, silty, blocky, hard, medium light gray. | | |
| -B | | 40% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| 787-035D | | | | |
| -A | 5380' | 60% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | 0.29 |
| -B | | 40% Igneous,? diorite, gabbro. Mud additives associated. | | |
| 787-037D | 5680' | | | 1.48 |
| | | Varied lithology consisting of shale, siltstone, sandstone, weathered igneous, coal and mud additive. | | |

## Table 9

### Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-039D | 5980' | Varied lithology consisting of shale, carbonaceous shale, coal, sandstone and siltstone. | | 4.25 |
| 787-040D | 6140' | | | 7.28 |
| -A | | 50% Shale, noncalcareous, silty, blocky, moderately hard, medium dark gray. | N4 | |
| -B | | 30% Sandstone, silica cement, very argillaceous, very fine to fine grain, subangular to subrounded, clear to frosted, fair porosity, no show. | | |
| -C | | 20% Coal. | | |
| 787-042D | 6440' | | | 4.39; 4.44 R |
| -A | | 60% Shale, noncalcareous, silty, blocky, hard, medium dark gray. | N4 | |
| -B | | 20% Sandstone, silica cement, very argillaceous, fine grain, subangular to subrounded, clear to frosted, fair porosity, no show. | | |
| -C | | 20% Coal. | | |
| 787-043D | 6560' | | | 5.25 |
| -A | | 60% Shale, noncalcareous, very carbonaceous, grading into a coal, blocky, hard, dark gray to black. | N3 to N1 | |
| -B | | 30% Shale, noncalcareous, very silty, blocky, hard, medium dark gray. | N4 | |
| -C | | 10% Sandstone, carbonate cement, fine grain, subrounded to subangular, frosted to clear, good porosity, no show. | | |
| 787-044D | 6740' | | | 7.44 |
| -A | | 60% Shale, same as 787-043D-A. | | |
| -B | | 20% Shale, same as 787-043D-B. | | |
| -C | | 20% Sandstone, same as 787-043D-C. | | |

Table 9

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-046D | 7040' | | | 3.38 |
| -A | | 60% Shale, noncalcareous, very carbonaceous, grading into a coal, blocky, hard, dark gray to black. | N3 to N1 | |
| -B | | 40% Sandstone, carbonate cement, argillaceous, very fine to fine grain, subrounded to subangular, frosted to clear, fair porosity, no show. Mud additives associated. | | |
| 787-048D | 7360' | | | 3.23 |
| -A | | 60% Sandstone, carbonate cement, very fine to fine grain, subrounded to subangular, frosted to clear, fair porosity, no show. | | |
| -B | | 40% Shale, noncalcareous, very carbonaceous, grading into a coal, blocky, hard, dark gray to black. Mud additives associated. | N3 to N1 | |
| 787-050D | 7640' | Varied lithology consisting of shale, coal, siltstone, sandstone and mud additives. | | 6.85; 6.92 R |
| 787-052D | 7920' | Varied lithology consisting of shale, siliceous shale, sandstone, siltstone, igneous and mud additives. | | 0.92 |
| 787-053D | 8070' | Varied lithology consisting of shale, siliceous shale, sandstone, coal, igneous and mud additives. | | 3.63 |
| 787-054D | 8220' | | | 26.25 |
| -A | | 80% Shale, noncalcareous, very carbonaceous, grading into a coal, blocky, hard, dark gray to black. | N3 to N1 | |
| -B | | 20% Sandstone, carbonate cement, argillaceous, fine grain, subrounded to subangular, frosted to clear, fair porosity, no show. Mud additives associated. | | |

Table 9

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-055 | 8370' | | | 2.27 |
| -A | | 50% Shale, same as 787-054D-A. | | |
| -B | | 30% Sandstone, same as 787-054D-B. | | |
| -C | | 20% Igneous. | | |
| | | Mud additives associated. | | |
| 787-056D | 8520' | | | 0.76; 0.78 R |
| -A | | 80% Shale, noncalcareous, very silty, blocky, hard, dark gray. | N3 | |
| -B | | 20% Sandstone, carbonate cement, very argillaceous, fine grain, subrounded to subangular, frosted to clear, no show. | | |
| | | Mud additives associated. | | |
| 787-058D | 8820' | | | 0.85 |
| -A | | 50% Sandstone, carbonate cement, very fine to fine grain, subrounded to subangular, frosted to clear, good porosity, no show. | | |
| -B | | 40% Shale, slightly calcareous, silty, blocky, hard, dark gray. | N3 | |
| -C | | 10% Calcite. | | |
| | | Mud additives associated. | | |
| 787-060D | 9130' | | | 0.26 |
| -A | | 60% Sandstone, carbonate and silica cement, limy, fine grain, subrounded to subangular, frosted to clear, fair porosity, no show. | | |
| -B | | 30% Shale, slightly calcareous, silty, blocky, hard, dark gray. | N3 | |
| -C | | 10% Calcite. | | |
| | | Mud additives associated. | | |

Table 9

Organic Carbon Analyses and Gross Lithological Description

| GeoChem Sample Number | Well Interval | Gross Lithological Description | GSA Color Code | Total Organic Carbon (% of Rock) |
|---|---|---|---|---|
| 787-061D | 9270' | | | 0.51 |
| -A | | 80% Limestone, chalk, sandy; very fine to fine grain, subrounded to subangular, frosted to clear; good porosity, no show, very light gray. | N8 | |
| -B | | 20% Shale, noncalcareous, silty, blocky, hard, dark gray. Mud additives associated. | N3 | |
| 787-062D | 9420' | | | 0.40 |
| -A | | 70% Limestone, same as 787-061D-A. | | |
| -B | | 30% Shale, same as 787-061D-B. Mud additives associated. | | |
| 787-063D | 9570' | | | 0.35; 0.32 R |
| -A | | 70% Limestone, chalk, argillaceous, very fine to fine grain, subrounded to subangular, frosted to clear, blocky,moderately hard, light gray. | N7 | |
| -B | | 30% Shale, slightly calcareous, silty, blocky, hard, dark gray. Mud additives associated. | N3 | |
| 787-064D | 9720' | Varied lithology consisting of weathered igneous, shale, sandstone, and mud additives. | | 0.48 |
| 787-065D | 9890' | Varied lithology consisting of igneous, shale, sandstone, and mud additives. | | 0.55 |
| 787-070D | 10610' | 60% Shale, noncalcareous, very silty, blocky, hard, dark gray. | N3 | 0.27 |
| -B | | 40% Siltstone, noncalcareous, argillaceous, hard, little porosity, no show, light gray. | N7 | |
| 787-073D | 11060' | Varied lithology consisting of igneous, shale, sandstone and mud additives. | | 0.46 |

Table 10

Summary of Organic Carbon and Visual Kerogen Analysis

| GeoChem Sample Number | Well Depth Interval | Organic Carbon (% of Rock) | Visual Kerogen Type | Visual Kerogen Alteration (1-5 Scale) |
|---|---|---|---|---|
| 787-001D | 227- 270 | 0.29 | W;H;Am (C) | 2- |
| 787-007D | 1080- 1260 | 1.27 | W;Am;H-C | 1+ to 2- (2)* |
| 787-008D | 1260- 1410 | 0.22 | W;Am-H;C | 2- to 2 (1) |
| 787-012D | 1890- 1950 | 0.15 | W;C;H (Am) | 2- to 2 (1) |
| 787-017D | 2610- 2670 | 0.19; 0.19R | W;H;Am (Al)-C | 2- to 2 (1) |
| 787-022D | 3360- 3420 | 0.22 | W;C;H (Am) | 2 |
| 787-024D | 3660- 3720 | 0.28 | W;C;Am (Al)-H | 2 (1+ to 2-)* |
| 787-027D | 4140- 4180 | 0.14 | W-C;H;Am | 2 (1)* |
| 787-030D | 4580- 4640 | 0.21 | W-C;Am-H;- | 2 to 2+ (1+ to 2-)* |
| 787-033D | 5020- 5060 | 0.20; 0.17R | W;Am (Al);H (C) | 2 to 2+ (1+ to 2-)* |
| 787-035D | 5320- 5380 | 0.29 | W;Am (Al);H (C) | 2 to 2+ (1+ to 2-)* |
| 787-037D | 5620- 5680 | 1.48 | W;Am (Al)-C;H | 2 to 2+ (1+ to 2-)* |
| 787-039D | 5940- 5980 | 4.25 | W;Am;C (H) | 2 |
| 787-040D | 6080- 6140 | 7.28 | W;Am(Al)-H-C;- | 2 (1+ to 2-)* |
| 787-042D | 6380- 6440 | 4.39; 4.44R | Am-W;-;H-C | 2 to 2+ |
| 787-043D | 6520- 6560 | 5.25 | W;Am;H-C | 2 to 2+ |
| 787-044D | 6640- 6740 | 7.44 | W;Am;C | 2 to 2+ |
| 787-046D | 6960- 7040 | 3.38 | W;Am;H-C | 2 to 2+ |
| 787-048D | 7240- 7360 | 3.23 | W;Am-C;H | 2 to 2+ |
| 787-050D | 7570- 7640 | 6.85; 6.92R | W;C;Am | 2 to 2+ |
| 787-052D | 7870- 7920 | 0.91 | W-C;-;Am-H | 2 |
| 787-053D | 8050- 8070 | 3.63 | W-C;-;Am-H | 2 to 2+ |
| 787-054D | 8190- 8220 | 26.25 | W-C;Am;H | 2 to 2+ |
| 787-055D | 8350- 8370 | 2.27 | W-C;-;Am-H | 2 to 2+ (2- to 2)* |
| 787-056D | 8490- 8520 | 0.76; 0.78R | W-C;Am;H | 2+ |
| 787-058D | 8790- 8820 | 0.85 | W-C;Am;H | 2+ |
| 787-060D | 9080- 9130 | 0.26 | W-C;Am;H | 2+ to 3- (2- to 2)* |
| 787-061D | 9250- 9270 | 0.51 | W-C;Am;H | 2 to 2+ (2- to 2)* |
| 787-062D | 9390- 9420 | 0.40 | W-C;Am;H | 2+ to 3- (2-)* |
| 787-063D | 9540- 9570 | 0.35; 0.32R | W-C;Am;H | 2 to 2+ |
| 787-064D | 9700- 9720 | 0.48 | W-C;Am-H;- | 2+ to 3- (1)* |
| 787-065D | 9860- 9890 | 0.55 | W-C;Am;- | 2+ to 3- |
| 787-070D | 10590-10610 | 0.27 | W-C;-;Am-H | 2+ to 3- (1+)* |
| 787-073D | 11040-11060 | 0.46 | W-C;Am;H | 2 to 2+ |

Table 11

Summary of C15+ Soxhlet Extraction, Deasphaltening and Liquid Chromatography

A. Weights of Extracts and Chromatographic Fractions

| GeoChem Sample Number | Well Interval* | Weight of Rock Extd. (grams) | Total Extract (grams) | Precipitated Asphaltenes (grams) | N-C5 Soluble (grams) | Sulfur (grams) | Paraffins-Naphthenes (grams) | Aromatics (grams) | Eluted NSO'S (grams) | Noneluted NSO'S (grams) |
|---|---|---|---|---|---|---|---|---|---|---|
| 787-001D | 227- 270 | 80.0 | 0.0014 | 0.0008 | 0.0006 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-007D | 1080- 1260 | 60.0 | 0.0035 | 0.0014 | 0.0021 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-008D | 1260- 1410 | 55.0 | 0.0040 | 0.0024 | 0.0016 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-012D | 1890- 1950 | 80.0 | 0.0031 | 0.0011 | 0.0020 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-017D | 2610- 2670 | 75.0 | 0.0045 | 0.0015 | 0.0030 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-022D | 3360- 3420 | 70.0 | 0.0024 | 0.0009 | 0.0015 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-024D | 3660- 3720 | 70.0 | 0.0015 | 0.0009 | 0.0006 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-027D | 4140- 4180 | 75.0 | 0.0014 | 0.0001 | 0.0013 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-030D | 4580- 4640 | 85.0 | 0.0030 | 0.0010 | 0.0020 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-033D | 5020- 5060 | 70.0 | 0.0011 | 0.0001 | 0.0010 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-035D | 5320- 5380 | 85.0 | 0.0017 | 0.0005 | 0.0012 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-037D | 5620- 5680 | 65.0 | 0.0036 | 0.0020 | 0.0016 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-039D | 5940- 5980 | 75.0 | 0.0508 | 0.0053 | 0.0455 | N.D. | 0.0102 | 0.0160 | 0.0071 | 0.0122 |
| 787-040D | 6080- 6140 | 75.0 | 0.0446 | 0.0058 | 0.0388 | N.D. | 0.0072 | 0.0136 | 0.0071 | 0.0109 |
| 787-042D | 6380- 6440 | 95.0 | 0.0393 | 0.0041 | 0.0352 | N.D. | 0.0077 | 0.0118 | 0.0061 | 0.0096 |
| 787-043D | 6520- 6560 | 80.0 | 0.0918 | 0.0044 | 0.0874 | N.D. | 0.0164 | 0.0195 | 0.0095 | 0.0420 |
| 787-044D | 6640- 6740 | 60.0 | 0.0170 | 0.0048 | 0.0122 | N.D. | 0.0028 | 0.0052 | 0.0039 | 0.0003 |
| 787-046D | 6960- 7040 | 65.0 | 0.0384 | 0.0032 | 0.0352 | N.D. | 0.0090 | 0.0103 | 0.0060 | 0.0099 |
| 787-048D | 7240- 7360 | 60.0 | 0.0136 | 0.0016 | 0.0120 | N.D. | 0.0035 | 0.0055 | 0.0027 | 0.0003 |
| 787-050D | 7570- 7640 | 75.0 | 0.0172 | 0.0015 | 0.0157 | N.D. | 0.0034 | 0.0074 | 0.0045 | 0.0004 |
| 787-052D | 7870- 7920 | 95.0 | 0.0115 | 0.0016 | 0.0099 | N.D. | 0.0031 | 0.0030 | 0.0033 | 0.0005 |
| 787-053D | 8050- 8070 | 85.0 | 0.0036 | 0.0016 | 0.0020 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-054D | 8190- 8220 | 75.0 | 0.0020 | 0.0006 | 0.0014 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-055D | 8350- 8370 | 70.0 | 0.0014 | 0.0010 | 0.0004 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-056D | 8490- 8520 | 85.0 | 0.0065 | 0.0043 | 0.0022 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-058D | 8790- 8820 | 80.0 | 0.0011 | 0.0007 | 0.0004 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-060D | 9080- 9130 | 75.0 | 0.0013 | 0.0005 | 0.0008 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-061D | 9250- 9270 | 85.0 | 0.0050 | 0.0008 | 0.0042 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-062D | 9390- 9420 | 80.0 | 0.0029 | 0.0003 | 0.0026 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-063D | 9540- 9570 | 80.0 | 0.0023 | 0.0007 | 0.0016 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-064D | 9700- 9720 | 80.0 | 0.0011 | 0.0002 | 0.0009 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-065D | 9860- 9890 | 85.0 | 0.0014 | 0.0008 | 0.0006 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-070D | 10590-10610 | 80.0 | 0.0069 | 0.0032 | 0.0037 | N.D. | N.D. | N.D. | N.D. | N.D. |
| 787-073D | 11040-11060 | 85.0 | 0.0012 | 0.0005 | 0.0007 | N.D. | N.D. | N.D. | N.D. | N.D. |

* In feet

Table 11

B. Concentration of Extracted Materials in Rock

| GeoChem Sample Number | Well Interval* | Total Extract (ppm) | Hydrocarbons: Paraffin-Naphthene (ppm) | Hydrocarbons: Aromatic (ppm) | Hydrocarbons: Total (ppm) | Sulfur (ppm) | Nonhydrocarbons: Precipitd. Asphaltene (ppm) | Nonhydrocarbons: Eluted NSO'S (ppm) | Nonhydrocarbons: Noneluted NSO'S (ppm) | Nonhydrocarbons: Total (ppm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 787-001D | 227- 270 | 18 | - | - | - | - | 10 | - | - | - |
| 787-007D | 1080- 1260 | 58 | - | - | - | - | 23 | - | - | - |
| 787-008D | 1260- 1410 | 73 | - | - | - | - | 44 | - | - | - |
| 787-012D | 1890- 1950 | 39 | - | - | - | - | 14 | - | - | - |
| 787-017D | 2610- 2670 | 60 | - | - | - | - | 20 | - | - | - |
| 787-022D | 3360- 3420 | 34 | - | - | - | - | 13 | - | - | - |
| 787-024D | 3660- 3720 | 21 | - | - | - | - | 13 | - | - | - |
| 787-027D | 4140- 4180 | 19 | - | - | - | - | 1 | - | - | - |
| 787-030D | 4580- 4640 | 35 | - | - | - | - | 12 | - | - | - |
| 787-033D | 5020- 5060 | 16 | - | - | - | - | 1 | - | - | - |
| 787-035D | 5320- 5380 | 20 | - | - | - | - | 6 | - | - | - |
| 787-037D | 5620- 5680 | 55 | - | - | - | - | 31 | - | - | - |
| 787-039D | 5940- 5980 | 677 | 136 | 213 | 349 | - | 71 | 95 | 163 | 328 |
| 787-040D | 6080- 6140 | 595 | 96 | 181 | 277 | - | 77 | 95 | 145 | 317 |
| 787-042D | 6380- 6440 | 414 | 81 | 124 | 205 | - | 43 | 64 | 101 | 208 |
| 787-043D | 6520- 6560 | 1148 | 205 | 244 | 449 | - | 55 | 119 | 525 | 699 |
| 787-044D | 6640- 6740 | 283 | 47 | 87 | 133 | - | 80 | 65 | 5 | 150 |
| 787-046D | 6960- 7040 | 591 | 138 | 158 | 297 | - | 49 | 92 | 152 | 294 |
| 787-048D | 7240- 7360 | 227 | 58 | 92 | 150 | - | 27 | 45 | 5 | 77 |
| 787-050D | 7570- 7640 | 229 | 45 | 99 | 144 | - | 20 | 60 | 5 | 85 |
| 787-052D | 7870- 7920 | 121 | 33 | 32 | 64 | - | 17 | 35 | 5 | 57 |
| 787-053D | 8050- 8070 | 42 | - | - | - | - | 19 | - | - | - |
| 787-054D | 8190- 8220 | 27 | - | - | - | - | 8 | - | - | - |
| 787-055D | 8350- 8370 | 20 | - | - | - | - | 14 | - | - | - |
| 787-056D | 8490- 8520 | 76 | - | - | - | - | 51 | - | - | - |
| 787-058D | 8790- 8820 | 14 | - | - | - | - | 9 | - | - | - |
| 787-060D | 9080- 9130 | 17 | - | - | - | - | 7 | - | - | - |
| 787-061D | 9250- 9270 | 59 | - | - | - | - | 9 | - | - | - |
| 787-062D | 9390- 9420 | 36 | - | - | - | - | 4 | - | - | - |
| 787-063D | 9540- 9570 | 29 | - | - | - | - | 9 | - | - | - |
| 787-064D | 9700- 9720 | 14 | - | - | - | - | 3 | - | - | - |
| 787-065D | 9860- 9890 | 16 | - | - | - | - | 9 | - | - | - |
| 787-070D | 10590-10610 | 86 | - | - | - | - | 40 | - | - | - |
| 787-073D | 11040-11060 | 14 | - | - | - | - | 6 | - | - | - |

* In feet

PPM values expressed on a weight/weight basis

Table 11 (Continued)

C. Composition of Extracts

| GeoChem Sample Number | Well Interval * | Hydrocarbons: Paraffin-Naphthene % | Hydrocarbons: Aromatic % | Hydrocarbons: PN/Arom | Hydrocarbons: Sulfur % | Nonhydrocarbons: Eluted NSO'S % | Nonhydrocarbons: Noneluted NSO'S % | Nonhydrocarbons: Precipitd. Asphaltene % | Nonhydrocarbons: Asph/NSO | HC'S % | HC/Non HC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 787-001D | 227- 270 | - | - | - | - | - | - | 57.1 | - | - | - |
| 787-007D | 1080- 1260 | - | - | - | - | - | - | 40.0 | - | - | - |
| 787-008D | 1260- 1410 | - | - | - | - | - | - | 60.0 | - | - | - |
| 787-012D | 1890- 1950 | - | - | - | - | - | - | 35.5 | - | - | - |
| 787-017D | 2610- 2670 | - | - | - | - | - | - | 33.3 | - | - | - |
| 787-022D | 3360- 3420 | - | - | - | - | - | - | 37.5 | - | - | - |
| 787-024D | 3660- 3720 | - | - | - | - | - | - | 60.0 | - | - | - |
| 787-027D | 4140- 4180 | - | - | - | - | - | - | 7.1 | - | - | - |
| 787-030D | 4580- 4640 | - | - | - | - | - | - | 33.3 | - | - | - |
| 787-033D | 5020- 5060 | - | - | - | - | - | - | 9.1 | - | - | - |
| 787-035D | 5320- 5380 | - | - | - | - | - | - | 29.4 | - | - | - |
| 787-037D | 5620- 5680 | - | - | - | - | - | - | 55.6 | - | - | - |
| 787-039D | 5940- 5980 | 20.1 | 31.5 | 0.64 | - | 14.0 | 24.0 | 10.4 | 0.27 | 51.6 | 1.07 |
| 787-040D | 6080- 6140 | 16.1 | 30.5 | 0.53 | - | 15.9 | 24.4 | 13.0 | 0.32 | 46.6 | 0.87 |
| 787-042D | 6380- 6440 | 19.6 | 30.0 | 0.65 | - | 15.5 | 24.4 | 10.4 | 0.26 | 49.6 | 0.98 |
| 787-043D | 6520- 6560 | 17.9 | 21.2 | 0.84 | - | 10.3 | 45.8 | 4.8 | 0.09 | 39.1 | 0.64 |
| 787-044D | 6640- 6740 | 16.5 | 30.6 | 0.54 | - | 22.9 | 1.8 | 28.2 | 1.14 | 47.1 | 0.89 |
| 787-046D | 6960- 7040 | 23.4 | 26.8 | 0.87 | - | 15.6 | 25.8 | 8.3 | 0.20 | 50.3 | 1.01 |
| 787-048D | 7240- 7360 | 25.7 | 40.4 | 0.64 | - | 19.9 | 2.2 | 11.8 | 0.53 | 66.2 | 1.96 |
| 787-050D | 7570- 7640 | 19.8 | 43.0 | 0.46 | - | 26.2 | 2.3 | 8.7 | 0.31 | 62.8 | 1.69 |
| 787-052D | 7870- 7920 | 30.0 | 26.1 | 1.03 | - | 28.7 | 4.3 | 13.9 | 0.42 | 53.0 | 1.13 |
| 787-053D | 8050- 8070 | - | - | - | - | - | - | 44.4 | - | - | - |
| 787-054D | 8190- 8220 | - | - | - | - | - | - | 30.0 | - | - | - |
| 787-055D | 8350- 8370 | - | - | - | - | - | - | 71.4 | - | - | - |
| 787-056D | 8490- 8520 | - | - | - | - | - | - | 66.2 | - | - | - |
| 787-058D | 8790- 8820 | - | - | - | - | - | - | 63.6 | - | - | - |
| 787-060D | 9080- 9130 | - | - | - | - | - | - | 38.5 | - | - | - |
| 787-061D | 9250- 9270 | - | - | - | - | - | - | 16.0 | - | - | - |
| 787-062D | 9390- 9420 | - | - | - | - | - | - | 10.3 | - | - | - |
| 787-063D | 9540- 9570 | - | - | - | - | - | - | 30.4 | - | - | - |
| 787-064D | 9700- 9720 | - | - | - | - | - | - | 18.2 | - | - | - |
| 787-065D | 9860- 9890 | - | - | - | - | - | - | 57.1 | - | - | - |
| 787-070D | 10590-10610 | - | - | - | - | - | - | 46.4 | - | - | - |
| 787-073D | 11040-11060 | - | - | - | - | - | - | 41.7 | - | - | - |

* In feet

Table 12-A

Saturate Hydrocarbon Analyses

Summary of Paraffin-Naphthene Distribution

| GeoChem Sample Number | Well Interval* | % Paraffin | % Isoprenoid | % Naphthene | C-P Index A | C-P Index B | ip19/ip20 |
|---|---|---|---|---|---|---|---|
| 787-001D | 227- 270 | 12.7 | 2.3 | 85.1 | 1.31 | - | 1.30 |
| 787-007D | 1080- 1260 | 10.0 | 1.2 | 88.8 | 1.15 | - | 0.55 |
| 787-008D | 1260- 1410 | 8.5 | 1.1 | 90.5 | 1.25 | - | 0.74 |
| 787-012D | 1890- 1950 | 6.6 | 0.6 | 92.9 | 1.23 | 1.79 | 0.47 |
| 787-017D | 2610- 2670 | 5.9 | 1.1 | 93.0 | 1.25 | 2.10 | 1.46 |
| 787-022D | 3360- 3420 | 6.0 | 1.0 | 93.0 | 1.18 | 1.59 | 1.23 |
| 787-024D | 3660- 3720 | 9.2 | 1.1 | 89.7 | 1.12 | 1.61 | 0.84 |
| 787-027D | 4140- 4180 | 9.3 | 1.9 | 88.8 | 1.08 | 1.22 | 0.90 |
| 787-030D | 4580- 4640 | 6.9 | 1.2 | 91.9 | 1.11 | 1.59 | 0.90 |
| 787-033D | 5020- 5060 | 8.6 | 1.3 | 90.0 | 1.10 | 1.31 | 1.74 |
| 787-035D | 5320- 5380 | 11.2 | 2.3 | 86.5 | 1.07 | 1.27 | 1.34 |
| 787-037D | 5620- 5680 | 30.8 | 5.1 | 64.1 | 1.09 | 1.29 | 4.65 |
| 787-039D | 5940- 5980 | 38.6 | 6.3 | 55.1 | 1.07 | - | 7.74 |
| 787-040D | 6080- 6140 | 31.7 | 9.4 | 58.8 | 1.08 | - | 13.31 |
| 787-042D | 6380- 6440 | 33.7 | 3.8 | 62.5 | 1.10 | - | 6.00 |
| 787-043D | 6520- 6560 | 48.3 | 4.7 | 47.0 | 1.09 | - | 5.79 |
| 787-044D | 6640- 6740 | 39.1 | 3.4 | 57.5 | 1.07 | 1.28 | 4.09 |
| 787-046D | 6960- 7040 | 43.6 | 3.5 | 52.9 | 1.07 | - | 4.28 |
| 787-048D | 7240- 7360 | 34.8 | 3.5 | 61.7 | 1.07 | - | 3.37 |
| 787-050D | 7570- 7640 | 32.0 | 3.2 | 64.9 | 1.08 | - | 3.39 |
| 787-052D | 7870- 7920 | 12.9 | 1.9 | 85.3 | 1.16 | 1.35 | 1.40 |
| 787-053D | 8050- 8070 | 7.6 | 0.8 | 91.6 | 1.12 | 1.34 | 0.49 |
| 787-054D | 8190- 8220 | 12.4 | 1.8 | 85.8 | 1.08 | 1.40 | 1.15 |
| 787-055D | 8350- 8370 | 6.7 | 0.6 | 92.7 | 1.08 | 1.16 | 0.23 |
| 787-056D | 8490- 8520 | 11.7 | 1.8 | 86.6 | 1.07 | - | 0.76 |
| 787-058D | 8790- 8820 | 14.1 | 1.2 | 84.7 | 1.06 | - | 0.58 |
| 787-060D | 9080- 9130 | 9.1 | 1.1 | 89.8 | 1.08 | 1.43 | 0.58 |
| 787-061D | 9250- 9270 | 9.2 | 1.4 | 89.4 | 1.18 | 1.37 | 0.90 |
| 787-062D | 9390- 9420 | 12.1 | 1.9 | 86.0 | 1.20 | - | 0.55 |
| 787-063D | 9540- 9570 | 8.3 | 1.4 | 90.2 | 1.08 | 1.31 | 0.74 |
| 787-064D | 9700- 9720 | 6.0 | 0.5 | 93.5 | 1.11 | 1.36 | 0.15 |
| 787-065D | 9860- 9890 | 6.0 | 0.4 | 93.6 | 1.09 | 1.38 | 0.09 |
| 787-070D | 10590-10610 | 9.3 | 1.2 | 89.5 | 1.04 | - | 0.63 |
| 787-073D | 11040-11060 | 9.9 | 1.6 | 88.5 | 1.09 | 1.30 | 0.51 |

* In feet

Table 12-B

Saturate Hydrocarbon Analyses

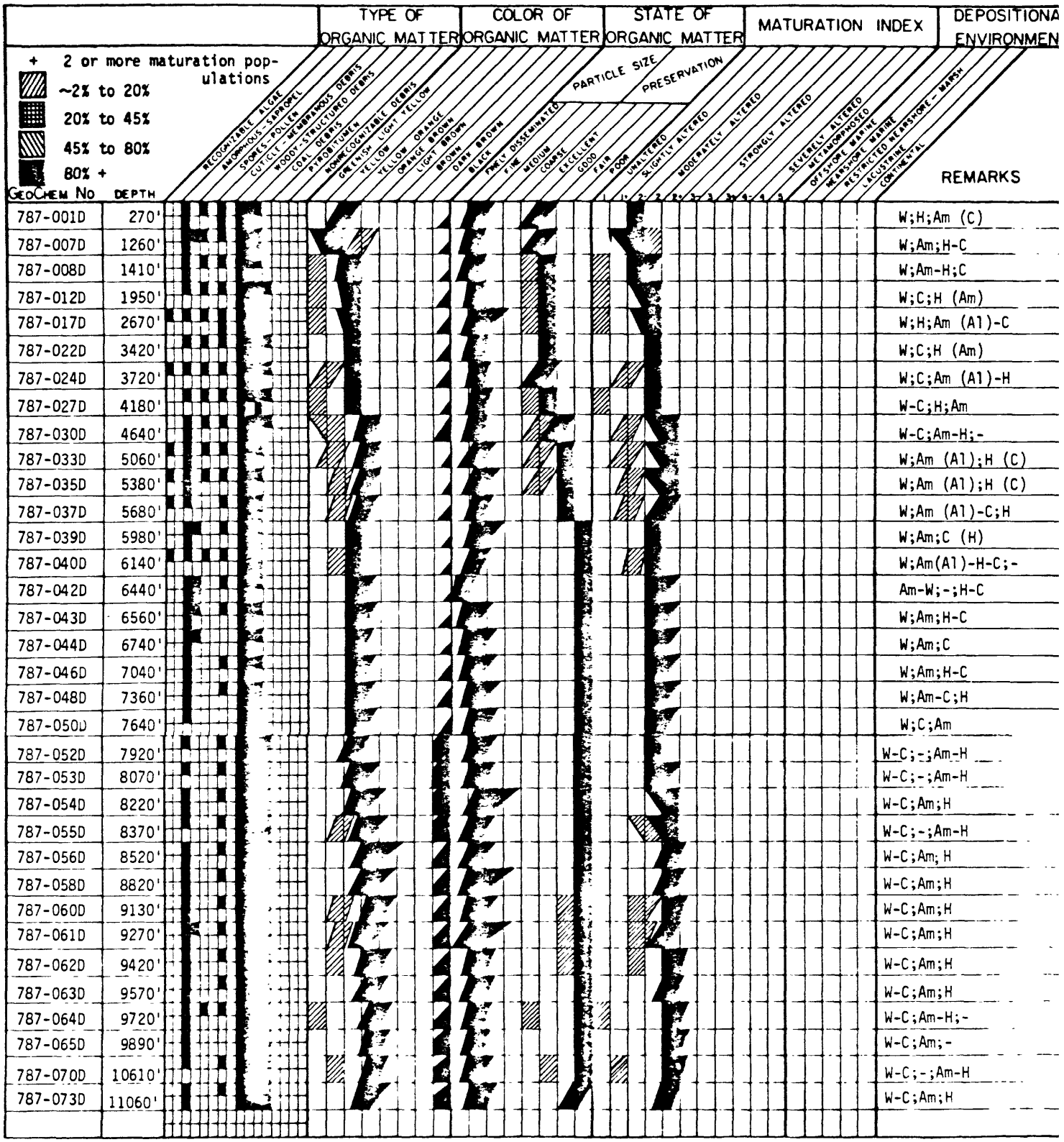
Normalized Paraffin Distribution

| GeoChem Sample Number | Well Interval* | % nC15 | % nC16 | % nC17 | % ip19 | % nC18 | % ip20 | % nC19 | % nC20 | % nC21 | % nC22 | % nC23 | % nC24 | % nC25 | % nC26 | % nC27 | % nC28 | % nC29 | % nC30 | % nC31 | % nC32 | % nC33 | % nC34 | % nC35 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 787-001D | 227- 270 | 0.9 | 4.6 | 12.5 | 8.6 | 14.8 | 6.6 | 15.0 | 13.6 | 11.2 | 6.3 | 3.3 | 1.3 | 0.6 | 0.2 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-007D | 1080- 1260 | 0.3 | 0.2 | 5.6 | 3.9 | 14.2 | 7.1 | 17.2 | 15.5 | 13.0 | 9.3 | 6.6 | 3.7 | 1.9 | 0.8 | 0.3 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-008D | 1260- 1410 | 0.1 | 0.4 | 6.8 | 4.8 | 14.0 | 6.4 | 17.1 | 16.0 | 14.1 | 9.2 | 5.8 | 2.5 | 1.5 | 0.6 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-012D | 1890- 1950 | 0.3 | 0.2 | 2.8 | 2.5 | 12.2 | 5.3 | 16.5 | 16.6 | 15.1 | 11.3 | 7.2 | 3.1 | 3.0 | 1.1 | 0.8 | 0.3 | 0.6 | 0.3 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 |
| 787-017D | 2610- 2670 | 0.1 | 3.0 | 10.2 | 9.6 | 10.8 | 6.6 | 10.9 | 11.6 | 9.3 | 7.5 | 6.9 | 4.0 | 3.4 | 1.4 | 1.9 | 0.4 | 1.0 | 0.3 | 0.7 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-022D | 3360- 3420 | 0.1 | 1.7 | 7.9 | 7.6 | 10.8 | 6.2 | 10.8 | 9.2 | 8.5 | 7.8 | 7.8 | 5.9 | 6.3 | 3.1 | 2.6 | 1.2 | 1.1 | 0.5 | 0.8 | 0.2 | 0.0 | 0.0 | 0.0 |
| 787-024D | 3660- 3720 | 0.1 | 0.1 | 3.8 | 4.9 | 9.8 | 5.8 | 11.4 | 10.3 | 9.8 | 10.2 | 9.8 | 6.9 | 6.0 | 3.5 | 3.0 | 1.2 | 1.8 | 0.4 | 0.9 | 0.1 | 0.1 | 0.0 | 0.0 |
| 787-027D | 4140- 4180 | 0.1 | 1.7 | 9.1 | 8.1 | 15.0 | 8.9 | 15.6 | 12.8 | 9.1 | 7.6 | 5.8 | 2.9 | 1.4 | 0.6 | 0.3 | 0.1 | 0.1 | 0.3 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-030D | 4580- 4640 | 0.2 | 2.7 | 9.2 | 6.9 | 13.7 | 7.8 | 14.1 | 11.8 | 9.4 | 8.2 | 6.3 | 3.6 | 2.6 | 1.0 | 0.6 | 0.3 | 0.5 | 0.3 | 0.5 | 0.2 | 0.2 | 0.0 | 0.0 |
| 787-033D | 5020- 5060 | 0.5 | 3.4 | 9.0 | 8.5 | 11.2 | 4.9 | 11.4 | 10.3 | 8.9 | 8.0 | 7.1 | 5.1 | 4.7 | 3.0 | 1.8 | 0.6 | 0.6 | 0.5 | 0.4 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-035D | 5320- 5380 | 0.2 | 2.0 | 10.5 | 9.9 | 14.4 | 7.4 | 13.1 | 10.7 | 8.7 | 7.5 | 5.9 | 3.8 | 2.5 | 1.2 | 0.7 | 0.4 | 0.3 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-037D | 5620- 5680 | 0.6 | 2.4 | 6.0 | 11.7 | 7.2 | 2.5 | 8.2 | 8.5 | 9.2 | 9.6 | 9.2 | 7.6 | 6.6 | 4.2 | 3.3 | 1.6 | 1.0 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 |
| 787-039D | 5940- 5980 | 4.6 | 4.9 | 14.3 | 12.5 | 8.1 | 1.6 | 8.7 | 8.8 | 8.7 | 8.3 | 7.0 | 5.2 | 3.7 | 2.0 | 1.0 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-040D | 6080- 6140 | 2.2 | 3.2 | 19.5 | 21.3 | 7.9 | 1.6 | 8.6 | 8.7 | 8.1 | 6.9 | 5.3 | 3.4 | 1.8 | 0.7 | 0.4 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-042D | 6380- 6440 | 6.0 | 6.9 | 13.7 | 8.8 | 9.9 | 1.5 | 10.3 | 10.2 | 9.3 | 8.1 | 6.3 | 4.1 | 2.6 | 1.2 | 0.6 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-043D | 6520- 6560 | 7.5 | 9.1 | 11.2 | 7.5 | 11.1 | 1.3 | 11.0 | 10.3 | 9.1 | 7.6 | 5.7 | 3.7 | 2.5 | 1.2 | 0.7 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-044D | 6640- 6740 | 2.1 | 5.3 | 9.0 | 6.5 | 10.5 | 1.6 | 11.3 | 11.0 | 10.4 | 9.4 | 7.7 | 5.6 | 4.0 | 2.3 | 1.6 | 0.7 | 0.5 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-046D | 6960- 7040 | 3.1 | 5.5 | 9.0 | 6.0 | 10.5 | 1.4 | 11.3 | 11.0 | 10.6 | 9.7 | 7.9 | 5.7 | 4.0 | 2.1 | 1.2 | 0.4 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-048D | 7240- 7360 | 5.1 | 7.1 | 9.4 | 7.0 | 10.3 | 2.1 | 11.0 | 10.5 | 9.9 | 8.9 | 7.0 | 5.0 | 3.4 | 1.8 | 1.0 | 0.4 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-050D | 7570- 7640 | 4.4 | 6.9 | 10.4 | 6.9 | 11.6 | 2.0 | 12.1 | 11.7 | 10.4 | 8.9 | 6.6 | 4.2 | 2.3 | 0.9 | 0.4 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-052D | 7870- 7920 | 2.0 | 7.1 | 12.9 | 7.4 | 14.7 | 5.3 | 14.2 | 11.5 | 8.2 | 5.8 | 3.8 | 2.0 | 2.0 | 1.1 | 0.7 | 0.4 | 0.4 | 0.2 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-053D | 8050- 8070 | 1.0 | 0.6 | 5.0 | 3.1 | 10.9 | 6.3 | 13.8 | 14.1 | 12.8 | 10.6 | 7.8 | 4.9 | 3.5 | 1.8 | 1.7 | 0.8 | 0.7 | 0.4 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-054D | 8190- 8220 | 1.0 | 6.9 | 11.7 | 6.6 | 12.3 | 5.7 | 13.0 | 11.3 | 8.9 | 7.2 | 5.8 | 4.1 | 2.7 | 1.3 | 0.6 | 0.3 | 0.3 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-055D | 8350- 8370 | 0.2 | 0.2 | 1.8 | 1.5 | 10.3 | 6.8 | 16.7 | 17.1 | 15.4 | 13.0 | 8.1 | 4.0 | 1.8 | 0.7 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.2 | 0.0 | 0.0 | 0.0 |
| 787-056D | 8490- 8520 | 0.5 | 2.8 | 8.7 | 5.7 | 12.9 | 7.4 | 14.0 | 11.7 | 10.2 | 9.0 | 8.1 | 5.4 | 2.3 | 0.8 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-058D | 8790- 8820 | 0.3 | 0.1 | 3.6 | 2.9 | 10.3 | 5.1 | 13.7 | 12.6 | 11.5 | 10.5 | 9.4 | 7.4 | 5.5 | 3.3 | 1.9 | 0.9 | 0.5 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-060D | 9080- 9130 | 0.1 | 0.7 | 6.2 | 4.1 | 12.5 | 7.0 | 15.6 | 13.6 | 11.1 | 9.6 | 7.7 | 4.8 | 2.8 | 1.2 | 0.8 | 0.5 | 0.7 | 0.3 | 0.5 | 0.2 | 0.1 | 0.0 | 0.0 |
| 787-061D | 9250- 9270 | 0.3 | 1.8 | 8.7 | 6.3 | 15.0 | 7.0 | 17.8 | 15.9 | 10.7 | 7.0 | 3.8 | 1.9 | 1.3 | 0.4 | 0.4 | 0.1 | 0.3 | 0.4 | 0.4 | 0.3 | 0.0 | 0.0 | 0.0 |
| 787-062D | 9390- 9420 | 0.3 | 1.1 | 8.3 | 4.7 | 16.2 | 8.7 | 19.3 | 16.7 | 11.6 | 7.2 | 3.4 | 1.3 | 0.5 | 0.2 | 0.2 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-063D | 9540- 9570 | 0.1 | 1.3 | 7.4 | 6.3 | 13.0 | 8.5 | 15.9 | 17.2 | 11.1 | 8.0 | 5.0 | 2.7 | 1.2 | 0.5 | 0.4 | 0.3 | 0.5 | 0.3 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |
| 787-064D | 9700- 9720 | 0.5 | 0.2 | 1.1 | 0.9 | 9.6 | 6.2 | 16.7 | 17.0 | 14.9 | 11.9 | 7.8 | 4.4 | 3.4 | 1.8 | 0.9 | 0.5 | 0.9 | 0.5 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 |
| 787-065D | 9860- 9890 | 0.2 | 0.2 | 0.2 | 0.5 | 8.7 | 5.5 | 19.0 | 19.5 | 15.4 | 12.5 | 7.9 | 3.8 | 2.2 | 1.2 | 1.0 | 0.5 | 0.7 | 0.2 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 |
| 787-070D | 10590-10610 | 0.1 | 1.1 | 6.2 | 4.3 | 10.0 | 6.7 | 10.5 | 8.8 | 9.1 | 12.1 | 13.5 | 9.4 | 4.8 | 1.7 | 0.7 | 0.1 | 0.4 | 0.1 | 0.4 | 0.0 | 0.0 | 0.0 | 0.0 |
| 787-073D | 11040-11060 | 0.1 | 0.4 | 5.9 | 4.6 | 15.0 | 9.1 | 17.7 | 16.0 | 10.8 | 8.2 | 5.7 | 2.9 | 1.5 | 0.7 | 0.4 | 0.3 | 0.3 | 0.1 | 0.3 | 0.1 | 0.0 | 0.0 | 0.0 |

* In feet

Table 13

Visual Kerogen Assessment Worksheet




| | GeoChem No | Depth | Remarks |
|---|---|---|---|
| | 787-001D | 270' | W;H;Am (C) |
| + | 787-007D | 1260' | W;Am;H-C |
| + | 787-008D | 1410' | W;Am-H;C |
| + | 787-012D | 1950' | W;C;H (Am) |
| + | 787-017D | 2670' | W;H;Am (Al)-C |
| | 787-022D | 3420' | W;C;H (Am) |
| + | 787-024D | 3720' | W;C;Am (Al)-H |
| + | 787-027D | 4180' | W-C;H;Am |
| + | 787-030D | 4640' | W-C;Am-H;- |
| + | 787-033D | 5060' | W;Am (Al);H (C) |
| + | 787-035D | 5380' | W;Am (Al);H (C) |
| + | 787-037D | 5680' | W;Am (Al)-C;H |
| | 787-039D | 5980' | W;Am;C (H) |
| + | 787-040D | 6140' | W;Am(Al)-H-C;- |
| | 787-042D | 6440' | Am-W;-;H-C |
| | 787-043D | 6560' | W;Am;H-C |
| | 787-044D | 6740' | W;Am;C |
| | 787-046D | 7040' | W;Am;H-C |
| | 787-048D | 7360' | W;Am-C;H |
| | 787-050D | 7640' | W;C;Am |
| | 787-052D | 7920' | W-C;-;Am-H |
| | 787-053D | 8070' | W-C;-;Am-H |
| | 787-054D | 8220' | W-C;Am;H |
| + | 787-055D | 8370' | W-C;-;Am-H |
| | 787-056D | 8520' | W-C;Am;H |
| | 787-058D | 8820' | W-C;Am;H |
| + | 787-060D | 9130' | W-C;Am;H |
| + | 787-061D | 9270' | W-C;Am;H |
| + | 787-062D | 9420' | W-C;Am;H |
| | 787-063D | 9570' | W-C;Am;H |
| + | 787-064D | 9720' | W-C;Am-H;- |
| | 787-065D | 9890' | W-C;Am;- |
| + | 787-070D | 10610' | W-C;-;Am-H |
| | 787-073D | 11060' | W-C;Am;H |
| | | | |

* Mineral charcoal in sampl

Table 14

Vitrinite Reflectance Summary

| GeoChem Sample Number | Depth (feet) | Number of Readings | Minimum Reflectance (% Ro) | Maximum Reflectance (% Ro) | Average Reflectance (% Ro |
|---|---|---|---|---|---|
| 787-008D | 1260-1410 | * | - | - | - |
| 787-024D | 3660-3720 | 40 | 0.33 | 0.96 | 0.65 |
| 787-030D | 4580-4640 | * | - | - | - |
| 787-035D | 5320-5380 | * | - | - | - |
| 787-040D | 6080-6140 | 40 | 0.90 | 1.29 | 1.09 |
| 787-042D | 6380-6440 | 44 | 0.80 | 1.42 | 1.18 |
| 787-044D | 6640-6740 | 40 | 0.74 | 1.41 | 1.17 |
| 787-046D | 6960-7040 | 43 | 0.74 | 2.14 | 1.40 |
| | Population 1 | 2 | 0.74 | 0.96 | 0.85 |
| | Population 2 | 16 | 1.14 | 1.54 | 1.34 |
| | Population 3 | 25 | 1.63 | 2.14 | 1.89 |
| 787-048D | 7240-7360 | 40 | 0.49 | 1.52 | 1.07 |
| 787-050D | 7570-7640 | 47 | 0.27 | 1.94 | 0.99 |
| | Population 1 | 4 | 0.27 | 0.42 | 0.35 |
| | Population 2 | 11 | 0.69 | 0.99 | 0.87 |
| | Population 3 | 32 | 1.00 | 1.94 | 1.52 |
| 787-052D | 7870-7920 | 28 | 1.15 | 1.80 | 1.56 |
| 787-054D | 8190-8220 | 41 | 1.56 | 2.26 | 1.95 |
| 787-056D | 8490-8520 | * | - | - | - |
| 787-060D | 9080-9130 | * | - | - | - |
| 787-063D | 9540-9570 | * | - | - | - |
| 787-065D | 9860-9890 | * | - | - | - |

Note:

* Insuffient kerogen return to prepare plug.

APPENDIX 3

Analytical Data on Maturity of Coal Samples

Alaska Peninsula Coals

| Item | Depth Fm. Interval (ft.) | Organic Carbon wt. % | Pyrolytic HC yield wt. % | Volatile HC content ppm | Pyrol. HC Org. Carbon % | Tmax °C |
|---|---|---|---|---|---|---|
| Pan Am Hoodoo Lake No. 1 | | | | | | |
| 1 | 1,220-50 | 54.6 | 9.34 | n.d.* | 17.1 | 399 |
| 2 | 1,940-70 | 58.4 | 7.35 | " | 12.6 | 395 |
| 3 | 3,440-70 | 47.0 | 5.17 | " | 11.0 | 391 |
| 4 | 4,430-90 | 58.8 | 6.82 | " | 11.6 | 393 |
| 5 | 5,840-70 | 51.3 | 2.84 | " | 5.54 | 455 |
| 6 | 7,460-90 | 36.8 | 4.30 | " | 11.7 | 458 |
| 7 | 8,030-40 | 59.3 | 10.37 | " | 17.5 | 453 |
| Pan Am Hoodoo Lake No. 2 | | | | | | |
| 8 | 5,620-40 | 40.1 | 6.96 | 4,230 | 17.4 | 490 |
| 9 | 6,780-6,800 | 49.1 | 5.76 | 7,500 | 11.7 | 509 |
| 10 | 7,580-90 | 76.6 | 7.79 | 5,250 | 10.17 | 511 |
| Pan Am David River No. 1-A | | | | | | |
| 11 | 4,220-50 | 43.2 | 9.59 | 5,260 | 22.2 | 455 |
| 12 | 7,220-30 | 63.0 | 14.97 | 9,090 | 23.4 | 453 |
| 13 | 8,490-8500 | 13.4 | 0.39 | 200 | 2.9 | 481 |
| 14 | 9,660-70 | 59.4 | 7.95 | 9,870 | 13.4 | 506 |
| 15 | 10,240-40 | 13.8 | 2.66 | 1,830 | 19.3 | 478 |
| 16 | 12,240-50 | 0.25 | | | | |
| Cities Service Painter Creek No. 1 | | | | | | |
| 17 | 1,018-19 | 29.1 | 4.41 | 830 | 15.2 | 489 |

APPENDIX 3 (continued)

| Item | Depth Fm. Interval (ft.) | Organic Carbon wt. % | Pyrolytic HC yield wt. % | Volatile HC content ppm | Pyrol. HC Org. Carbon % | Tmax °C |
|---|---|---|---|---|---|---|
| AMOCO Cathedral River No. 1 | | | | | | |
| 18 | 9,400-10 | 7.5 | 4.76 | 17,380 | 63.5 | 471 |
| 19 | 12,200-10 | 5.7 | 2.45 | 1,690 | (40.3) | 461 |
| 20 | 14,100-10 | 1.5 | 0.34 | 110 | | 467 |

*n.d. = no data

Data supplied by George Claypool, U.S. Geological Survey, Denver, Colorado.

## APPENDIX 4

### Thin Sections

All thin sections are grain mounts of representative grains selected from bags of washed cuttings except core chips denoted by C after depth.

Cities Service Painter Creek No. 1

| | |
|---|---|
| 500-530 | SS & SLST., Volcaniclastic. |
| 1035-1036 | Cgl. with clasts of vfg basalt and andesite. |
| 1037-1038 | SS, Volcanolithic subwacke, laumontite? vein filling. |
| 1310-1340 | Cgl. - With alt. basalt & andesite, granodiorite, stretched metachert. |
| 1700-1710 | SS - Qtz. & chert & aphanitic volcs.,SLST. |
| 2700-2710 | Cgl. - Alt. basalt, granodiorite, qtz-hbl. schist, epidote granulite. |
| 3940-3950 | Cgl. - as above. |
| 3980-3990 | Cgl. - as above. |
| 5340-5350 | Cgl. - alt. basalt & diabase, granodiorite & gabbro, volc. SS. |
| 6050-6060 | Cgl. - chert, qtzite, granodiorite, alt. mafics?, rare SS. |
| 6070-6080 | Cgl. - as above: higher % of alt. mafic volcs. |
| 7000-7010 | Cgl. - mafic volcs. alt. to Ab-Ep; granodiorite, jadeitized sed. rocks? |
| 7410-7420 | Cgl. - Alt. volcs.;chert, qtzite, lithic subwacke SS. |
| 7800-7810 | Cgl. - Alt. volcs. & granodiorite; jadeite granulite, chlorite-prehnite bearing porphyry. |

Gulf-Alaskaco Port Heiden No. 1

| | | |
|---|---|---|
| 11,833-34 | C | Lt. gray alt. dacite microbreccia or crs. sandy tuff. |
| 11,955-56 | C | Alt. vfg vesicular dacite porphyry. |
| 15,000-01 | C | Hbl. - qtz. diorite, med. grd., equigranular. |
| 15,014-15 | C | Hbl. - Biot. qtz. diorite, slightly altered. |

Gulf Sandy River Federal No. 1

| | | |
|---|---|---|
| 11,681-11,686 | C | SS - Qtz. - lithic arenite (liths. = chert, slst. & volc. porph.). |
| 12,100-13,105 | C | SS - Qtz. lithic subwacke, heulandite? cement. |
| 13,003-13,009 | C | SS - med. grd.feldspathic arenite, minor qtz. & volc. liths. |
| 13,009-13,015 | C | Mudstone, v. dark gray, sheared, w/calcite veins. |

Pan American Hoodoo Lake No. 1

| | |
|---|---|
| 1040-1070 | SS and SLST., tuffaceous matrix, angular plag., pumice and glass shards. |
| 3140-3170 | SS and SLST., as above but contains rare diatoms. |
| 4190-4220 | Loose sand grains; Qtz., chert, plag., qtzite, volc. porph., garnet, m'cline, biot., brn.- hbl., slst. |

Pan American David River No. 1A

| | |
|---|---|
| 3270-3480 | SLST. - Dark brown, rare rounded sand-size qtz. grains. |
| 4410-4740 | SLST. - As above, carbonaceous; rare med. grd. volc. lith. SS. |
| 6750-7100 | SS - silty, v.f.g. to med. grd.; some tuffaceous matrix. |
| 7220-7500 | SLST. - sandy, abundant carbonaceous laminae. |
| 7950-8000 | SS, f-med. grd., volc. liths.>Qtz.>chert, (volc. lith. arenite) |
| 9320-9330 | SS - Albitized, chloritized volcano-lithic arenite. |

Pan American David River No. 1A

| | |
|---|---|
| 10,680-10690 | SLST. - dark brown, laminated, carbonaceous. |
| 11,640-11,710 | SS - med. - crs. grd.; chert>plutonic liths.>qtz., $CO_3$ cement. |
| 11,740-11,750 | SLST. - lt. brn., carbonaceous>SS, feldspathic-volc. lith. wac |
| 11,880-11,890 | SS - crs. - v. crs. grd., Qtz.>plag.>chert>volc. liths. |
| 11,980-11,990 | SS - as above, recrystallized qtz. cement & abundant zeolites. |
| 12,120-12,130 | Sandy SLST - carbonaceous; probably volc. derived. |
| 12,210-12,220 | SS crs. - v.crs. grd., plag.>volc. liths>qtz., chloritic cemen |
| 12,870-12,880 | SLST. - and f. grd. SS; strongly sericitized. |
| 13,350-13,360 | Sandy SLST. - brownish green chlorite?, volc. derived. |
| 13,430-13,440 | SS, similar to 12,210-12,220. |

AMOCO Cathedral River No. 1

| | |
|---|---|
| 690-700 | Sandy SLST. - massive, quartzofeldspathic. |
| 2800-2810 | SS - med. grd., arkose w/grn. hbl. laumontite veins & cement. |
| 3700-3710 | Sandy SLST. - same as 690-700. |
| 4900-4910 | SLST. - gray, massive; SS-v.f.g., arkosic wacke and arenite. |
| 5500-5510 | SS - f. grd., feldspathic wacke, angular grains. |
| 7400-7410 | SS - f. grd., volc.-lithic feldspathic wacke, abund. hbl. & Cp |
| 7600-7610 | SS - same as 7400-7410; lithics altering to clay minerals. |
| 8600-8610 | Calcareous mudstn. - sandy, dark brown, carbonaceous. |
| 11,690-11,700 | Sandy mudstn. - carbonaceous laminae. |
| 13,300-13,310 | SS - volcanolithic subwacke & pebble cgl.; sparry $CO_3$ veins. |
| 14,290-14,300 | Mixed liths. - sandy calcarenite, lam. carbonaceous SLST., calcareous arkosic SS. |

Pan Am Hoodoo Lake No. 2

| | |
|---|---|
| 1980-2010 | SS - well sorted, med. grd., f'spathic-volc'lithic subwacke. |
| 4480-4680 | SS - mostly basaltic lithic frags., various grain sizes, subwacke texture. |
| 7510-7600 | SS - well sorted, f. grd., volcanolithic wacke & subwacke. |
| 8100-8200 | SS - volcaniclastic, with abund. $CO_3$ matrix, basalt, diabase. |
| 10,210-10,220 | Diabase & SS/med. to f. grd., qtz.-feldspar arenite, SLST. |
| 10,480-10,490 | Diabase, gabbro, rare sandy SLST., and arkose SS. |
| 11,240-11,243 | (T.D.) Tightly packed arkosic SS, SLST., diabase, rare basalt. |

Abbreviation Key

| | |
|---|---|
| Ab | albite |
| alt. | altered |
| biot. | biotite |
| c | core sample |
| cgl. | conglomerate |
| $CO_3$ | calcite |
| Cpx | clinopyroxene |
| crs. grd. | coarse grained |
| Ep. | epidote |
| hbl. | hornblende |
| liths. | lithic or rock fragments |
| m'cline | microcline |
| qtz. | quartz |
| qtzite | quartzite |
| sed. rxs. | sedimentary |
| SLST. | siltstone |
| SS | sandstone |
| vfg. | very fine grained |
| volc. SS | volcaniclastic sandstone |

## APPENDIX 5

### Paleontology

| Sample intervals (in feet) | Section-Township-Range (Seward Meridian) |
|---|---|
| **Cities Service Painter Creek No. 1** | **14-35S-51W** |
| 1800-1810 | Barren |
| 2280-2310 | Barren |
| **Gulf, Sandy River Federal No. 1** | **10-46S-70W** |
| 11,686-11,691 | Barren |
| **Pan Am, Hoodoo Lake No. 1** | **21-50S-76W** |
| 2590-2840 | Barren |
| 4010-4180 | Barren |
| **Pan Am, Hoodoo Lake No. 2** | **35-50S-76W** |
| 1519-1710 | Barren |
| 1710-1830 | Barren |
| 2100-2250 | BATHYSIPHON sp.<br>Sponge Spicules |
| 3690-3930 | ELPHIDIUM CALIFORNICUM Cook<br>GLOBOBULIMINA PACIFICA? Cushman |
| Age: | Probably Early Tertiary |
| 5400-5600 | Barren |
| 5800-6000 | Barren |
| 6600-6800 | Barren |
| 7510-7700 | Barren |
| 7680-7690 | ELPHIDIUM CALIFORNICUM Cook<br>Diatom (pyritized) |
| Age: | Probably Early Tertiary |
| 8350-8540 | Barren |
| 8650-8660 | Barren |
| 9480-9490 | Barren |
| 9900-9910 | Barren |
| 11,090-11,100 | Barren |
| **Pan Am David River No. 1-A** | **12-50S-80W** |
| 3270-3480 | Plant and wood debris<br>Bivalve fragments |
| 4410-4740 | Coaly |
| 6750-7100 | Coaly |
| 7270-7500 | Barren |
| 9000-9100 | Barren |
| 11,290-11,300 | Barren |
| 12,110-12,120 | Barren |
| 12,370-12,380 | Barren |
| 12,970-12,980 | Barren |
| 13,180-13,190 | Barren |
| 13,290-13,300 | Barren |
| 13,360-13,370 | Barren |
| 13,650-13,660 | Barren |

AMOCO Cathedral River No. 1 29-51S-83W

| | |
|---|---|
| 100-1000 | Barren |
| 1100-1930 | Barren |
| 3700-4700 | Barren |
| 6500-7400 | Barren |
| 8600-9600 | Barren |
| 9700-10,600 | Barren |
| 10,700-11,700 | Barren |
| 11,800-12,800 | Barren |
| 12,900-14,000 | Barren |
| 14,220-14,300 | Barren |

Palynomorphs

Cities Service Painter Creek No. 1

1800-1810

ALNUS
MOMIPITES

2280-2330

MOMIPITES
NYSSAEPOLLENITES

Age: Paleocene or Eocene

Gulf Sandy River Federal No. 1

11,686-11,691

LARIX/PSEUDOTSUGA
PICEA
PINUS
TSUGA
ALNUS
BETULA
PTEROCARYA

Age: Neogene, probably from Bear Lake Formation

Pan Am Hoodoo Lake No. 1

2590-2840 feet

LARIX/PSEUDOTSUGA
PICEA
PINUS
TSUGA
Taxodiaceae/Cupressaceae
ALNUS
BETULA
ULMUS/ZELKOVA
CENTROSPERMAE
LONICERA
Cyperaceae

4010-4180 feet

PICEA
PINUS
Taxiodiaceae/Cupressaceae
TSUGA
ALNUS
BETULA
PIEROCARYA
Cypearaceae

Pan Am David River 1-A (continued)

6750-7100 feet

PICEA
PINUS
Taxodiaceae/Cupressaceae
ALNUS
BETULA
FAGUS
cf. QUERCUS
PTEROCARYA
ILEX

9000-9100 feet - Pollen sparse

PINUS
TSUGA?
ALNUS
CARYA
cf. QUERCUS

Age: 3270-9100 feet Eocene? Tolstoi or possibly Stepovak Formation

11,290-11,300 feet

PICEA
ALNUS
CARYA
PTEROCARYA
MOMIPITES
TILIAEPOLLENITES
PISTILIPOLLENITES

Age: Early to middle Eocene

12,110-12,120 Barren
12,370-12,380 Barren
12,970-12,980 Barren
13,180-13,190 Barren
13,290-13,300 Barren
13,360-13,370 Barren
13,650-13,660 Barren

Pan Am Hoodoo Lake No. 1 (continued)

7460-7550 feet

PICEA
PINUS
TSUGA
ALNUS
BETULA
ILEX?
Ericales

8000-8030 feet

PICEA
PINUS
TSUGA
ALNUS
BETULA
Ericales

Age: Later half of Miocene

Pan Am Hoodoo Lake No. 2

7680-7690 feet
8530-8540
8650-8660
9480-9490
9850-9860
9900-9910
11,090-11,100

All barren, except for 7680-7690 that contained non-diagnostic rare palynomorphs.

Pan Am David River 1A

3270-3450 feet

PICEA
PINUS
Taxodiceae/Cupressaceae
ALNUS
cf. QUERCUS
PTEROCARYA
ULMUS/ZELKOVA
TILIA
HALESIA?

4410-4740 feet

PICEA
PINUS
Taxodiaceae/Cupressaceae
ALNUS
cf. QUERCUS
CARYA
ULMUS/ZELKOVA
Ericales