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PHYSICAL PARAMETERS OF POTENTIAL PETROLEUM RESERVOIR AND SOURCE ROCKS IN THE KAMISHAK-INISKIN-TUXEDNI REGION, LOWER COOK INLET, ALASKA

By W.M. Lyle and J.A. Morehouse

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ABSTRACT

Reconnaissance geological and geochemical work was added to previous work on the west side of the lower Cook Inlet. The following objectives were accomplished: potential reservoir and source rock samples were collected and analyzed; porosity and permeability of all samples analyzed are generally low owing to original tight packing and crushing of grains and zeolitization. The average of 58 samples was 2.43 percent porosity and 0.032 md permeability. Rocks of upper Jurassic age have very low porosities that improve slightly offshore. Thin Cretaceous and Tertiary age sandstone have slightly higher porosities and permeabilities in outcrop samples than the Jurassic age sandstones, but are still low.

Source-rock evaluations indicate a hydrocarbon range from 64 to 1,569 ppm. The average of 69 samples is 242 ppm.

A visual kerogen assessment indicates a submature to mature degree of basin age on the basis of thermal alteration index method.

Evidence seems to support the concept that source rocks, reservoir rocks, and large traps exist in part of the lower Cook Inlet area. Petroleum potential appears fair to good if reservoir rocks of better quality than observed in outcrop exist in the offshore subsurface.

INTRODUCTION

A stratigraphic field project was conducted in the lower Cook Inlet region during a 22-day period in June and July 1976 by the Alaska Division of Geological and Geophysical Surveys (DGGS) and the U.S. Geological Survey (USGS). The project was the result of discussions between the agencies after completion of a similar project conducted last year in the northern Gulf of Alaska.

The major objective of the project was to study the reservoir- and source-rock characteristics of those Tertiary and Mesozoic stratigraphic sections reported to have hydrocarbon potential.

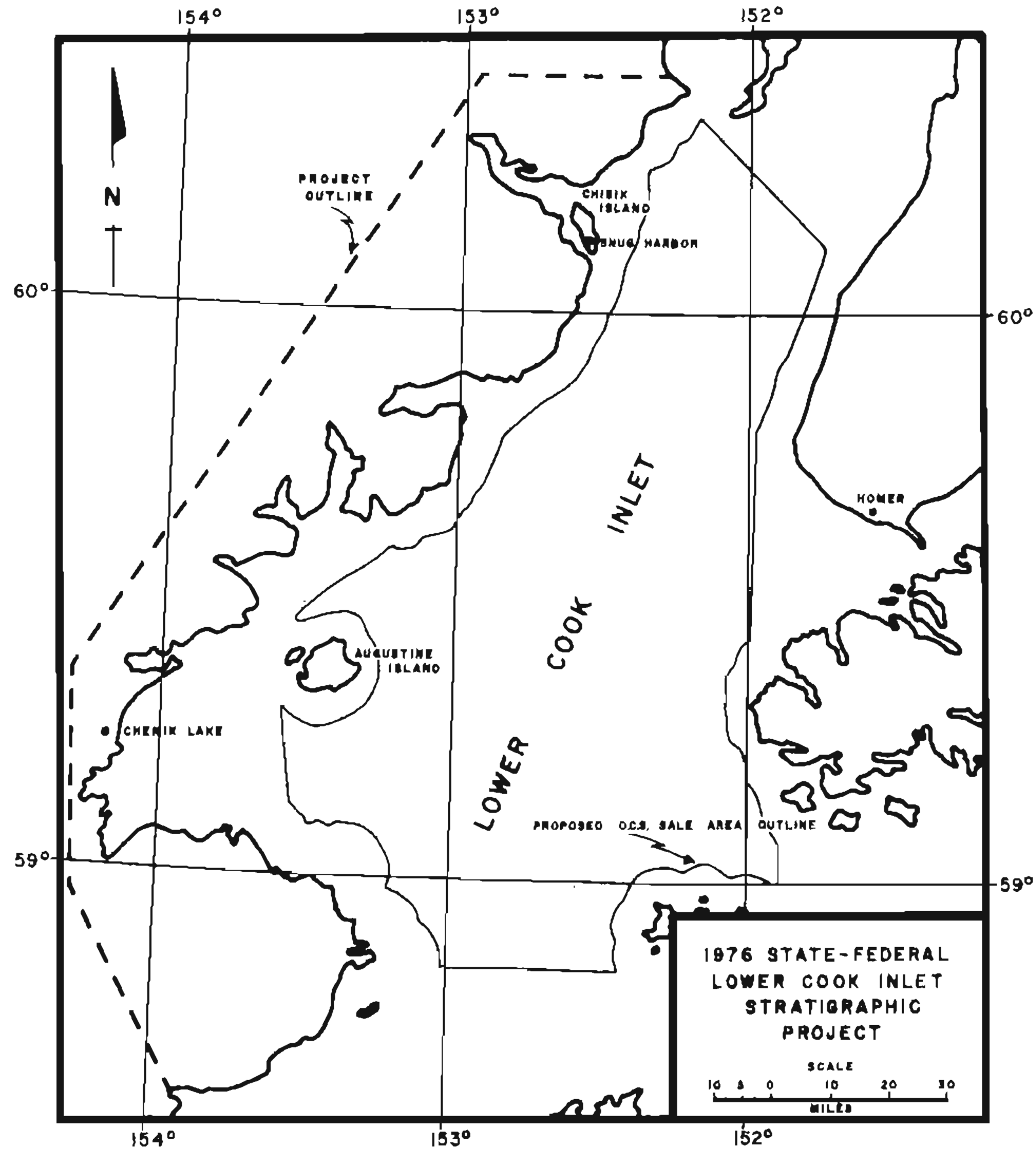
DGGS is charged with determining the state's resource potential for state lands, both onshore and offshore. The USGS is charged with regional geologic and resource framework studies of the Outer Continental Shelf (OCS) adjacent to State lands and evaluating resources of lease blocks in proposed federal oil and gas lease sales.

Field operations started at Chenik Lake (fig. 1) and then shifted to a cannery at Snug Harbor on Chisik Island. The Chenik Lake field crew consisted of I.W. Palmer (USGS), W.J. Lyle, and J.A. Morehouse (DGGS). L. Magoon and R. Egbert (USGS) provided support in the location of rock exposures in the field for study. On Chisik Island the crew consisted of Palmer, Wills, Lyle, and Morehouse. R.G. Schaff and D.L. McGee of DGGS visited the project for 2 days at the close of the field season.

Field operations were conducted using an FH-1100 turbine helicopter contracted from Arctic Air Service. Kachemak Air Service of Homer flew fixed-wing support for the crew. Weather was excellent with the exception of 2 marginal days.

ACKNOWLEDGMENTS

We wish to thank the Conservation Branch of the USGS for joint funding of this project. Also, we thank I.W. Palmer (joint party chief), J. Wills and J. Bolm of



154°
153°
152°
PROJECT OUTLINE
N
CHISIK ISLAND
SNUG HARBOR
60°
60°
COOK INLET
HOMER
AUGUSTINE ISLAND
CHENIK LAKE
LOWER
PROPOSED O.C.S. SALE AREA OUTLINE
59°
59°
1976 STATE-FEDERAL
LOWER COOK INLET
STRATIGRAPHIC
PROJECT
SCALE
10 5 0 10 20 30
MILES
154°
153°
152°

FIGURE 1

the Conservation Division and L. Magoon and R. Egbert of the Geologic Division for their participation and contributions.

The authors also wish to thank Mr. and Mrs. J.R. Fribrock of the Snug Harbor Packing Company for their hospitality and for making their cannery available to us. We gratefully acknowledge helicopter pilot Stewart Taft and his mechanic Darrel Monthieth, who helped make the operation successful and safe. We also acknowledge the following personnel for reviewing the manuscript: R.G. Schaff, D.L. McGee, and L.F. Larson of DGGS.

FIELD METHODS

Measurement of Stratigraphic Sections

Stratigraphic sections and traverses were measured primarily with Brunton compass and tape. Occasionally it was necessary to use the helicopter altimeter or photographs to determine thickness. All stratigraphic thicknesses are true thicknesses; they were corrected for dip and slope either in the field or at the base camp prior to rough drafting.

Lithologic Descriptions

Lithologic descriptions generally follow the accepted format listed below:

> Rock type, descriptive modifier, color (from GSA Rock Color Chart), grain size (either Wentworth grade name or in actual metric units), sorting, mineralogical constituents, statements concerning degree of induration, porosity, and sedimentary structures.

Abbreviations were commonly used to save time and space; notations such as "as above" were freely used if little obvious difference was noted. Unit descriptions usually include notations on bedding type, thickness, contacts and lateral variations.

SAMPLES

Samples from stratigraphic sections and spot sample locations were collected in 7- x 12-inch or 5- by 7-inch sample bags to provide material for laboratory analyses and for sample cuts for permanent library reference for both agencies. Whenever possible, the freshest material available was sampled by digging small pits in the outcrop. Several oriented sandstone samples were also collected.

A total of 10,954 feet of section was measured along the west side of the lower Cook Inlet. A total of 408 samples were processed: 88 for porosity and permeability, 69 for hydrocarbon analysis, 69 for basin maturity, 31 for paleontological age determination, 66 for micropaleontological age determinations, 45 for geochemical analysis, 9 for lithology, 6 for sandstone orientation, 6 for potassium-argon age determination and 19 for macrofossil age determination.

In the numbering system, the first digits are the sample number, followed by the initials of the collector and two numbers denoting the year (e.g., 2-WL-76). Some samples have a terminal letter that indicates that they were collected at or near the same location.

STRATIGRAPHY

General Statement

The lower Cook Inlet area is underlain by sedimentary rock sequences of Jurassic, Cretaceous, and Tertiary age and covered by a veneer of Pleistocene to Recent glacial and fluvial overburden (fig. 2). Metasedimentary rocks of Triassic age are locally exposed, and may underlie part or all of the lower Cook Inlet area. The basin is flanked by the Aleutian Range Batholith of Jurassic age on the west and Mesozoic metamorphics and metasediments of the Chugach - Kenai Mountain range and Barren Islands on the east. The lower Cook Inlet area is open to the north into upper Cook Inlet and to the south into Shelikof strait. Recent activity of Mts. Iliamna, Douglas, and St. Augustine have deposited varying thicknesses of extrusive rocks and volcanic debris over areas adjacent to these volcanoes.

The petroleum potential of the lower Cook Inlet area may have been recognized as early as 1853 (Detterman and Hartsock, 1966), when oil seeps were discovered on the Iniskin Peninsula. Several wells were drilled there between 1902 and 1960. Although encouraging shows of oil and gas were encountered in the Jurassic rocks penetrated by these wells, no commercial production was established.

All of the well-known oil- and gas-producing formations of the Kenai Group (Tertiary) in upper Cook Inlet are present in at least part of lower Cook Inlet. Encouraging oil shows were found in the Pennzoil Starichkof State #1 well drilled in 1967, and in a minor (presently shut-in) gas field found by the SOCAL North Fork 41-35 well, drilled in 1965. The latter well yielded a small quantity of oil.

Interest in the lower Cook Inlet area has been high for a number of years, and much detailed stratigraphic work has been done. However, most of these data are not available to the public.

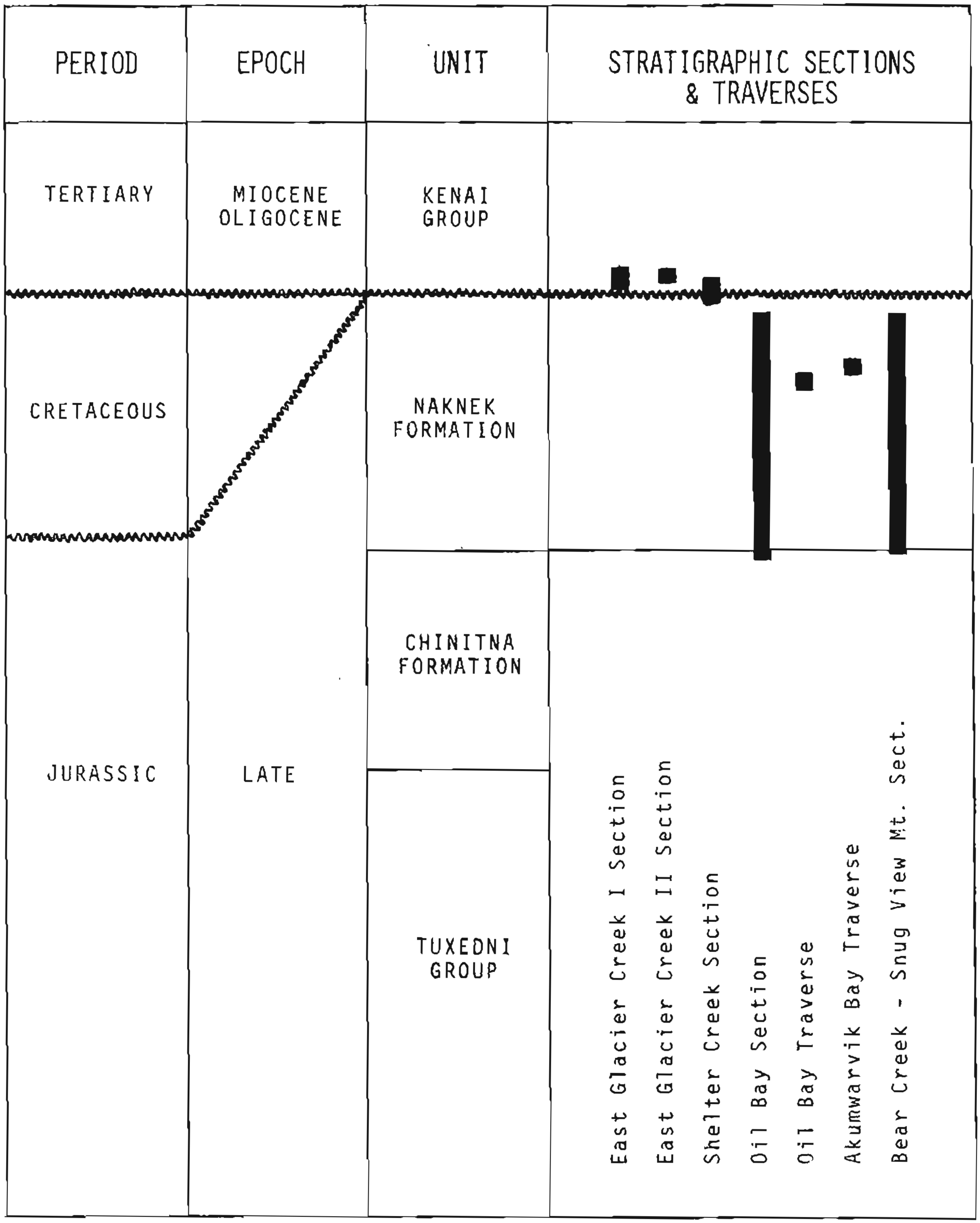
Stratigraphic nomenclature for the Jurassic system has been proposed by Detterman and Hartsock (1966) for part of the Cretaceous system by Keller and Reiser (1959), and for the Kenai Group by Calderwood and Fackler (1972).

Pre-Tertiary Rocks

1. Triassic System: The oldest rocks evident in the lower Cook Inlet area are an unnamed sequence of Triassic age consisting of metamorphosed limestone, chert, sandstone, shale, and basaltic flows (Detterman and Hartsock, 1966). Because of the varying degrees of alteration and deformation, the Triassic rocks are not considered to be a petroleum objective.

2. Jurassic System:

- Lower Jurassic: The lower Jurassic rocks of the lower Cook Inlet area are a sequence of volcanic agglomerates, breccias, and tuffs collectively called the Talkeetna Formation (Detterman and Hartsock, 1966). The rocks are widely distributed throughout the Cook Inlet basin and are encountered immediately below the Tertiary rocks in many of the wells in upper Cook Inlet. Because of their nonsedimentary origin, they are generally considered to be "economic basement" throughout the Cook Inlet basin. Maximum known thickness in the Iniskin - Tuxedni area is 1,021 m (3,350 feet) (Detterman and Hartsock, 1966).



Generalized Stratigraphic Column

FIGURE 2

- Middle Jurassic: Unconformably overlying the Talkeetna Formation is a sequence of graywacke and siltstone collectively known as the Tuxedni Group, which consists of the following formational units (from oldest to youngest): Red Glacier Formation (arkosic sandstone and siltstone), Gaikema Sandstone, Fitz Creek Siltstone, Cynthia Falls Sandstone, Twist Creek Siltstone, and the Bowser Formation (sandstone, siltstone, and conglomerate). The Tuxedni Group has a maximum composite thickness of at least 2,960 m (9,715 feet) (Detterman and Hartsock, 1966). These marine rocks are in part abundantly fossiliferous. The dominant sandstone type is graywacke, and probably exhibits relatively poor petroleum reservoir potential.

The oil seeps on the Iniskin Peninsula came from the Tuxedni Group---the same rocks that were penetrated by the drill there. The minor quantities of oil and gas recovered from these wells was apparently coming from fractures and/or fault zones, as no permeable reservoirs were discovered. The most obvious source for the petroleum is the siltstones of the Tuxedni Group.

- Upper Jurassic: Unconformably overlying the Tuxedni Group are up to 2,500 m (8,200 feet) of upper Jurassic marine siltstones, arkosic sandstones, and conglomerates known as the Chinitna Formation (Tonnie and Paveloff siltstone members) and the Naknek Formation (Chisik conglomerate - lower sandstone, Snug Harbor siltstone, and Pomeroy Arkose members) (Detterman and Hartsock, 1966). The Chinitna Formation siltstones are abundantly fossiliferous, the Naknek Formation less so. Naknek Formation sandstones contain a high percentage of angular quartz and feldspar, and are fine to coarse grained, commonly with a fine clay matrix and occasionally cemented by silica. The source for the Naknek sandstones and conglomerates was the Aleutian range quartz-diorite batholith to the west (Detterman and Hartsock, 1966).

The sandstones of the Naknek Formation are thought to offer the best petroleum reservoir potential of the Jurassic rocks in the lower Cook Inlet area. Where exposed at the surface, the sandstones generally appear extremely well indurated. However, friable and moderately porous sandstones from the Naknek Formation are found exposed on Augustine Island and at the mouth of Douglas River (Magoon and others, 1975). Wells drilled on Kalgin Island have encountered the Naknek Formation immediately below the Tertiary, but have not penetrated any promising reservoir rock. In wells drilled on the east side of the lower Cook Inlet area, Cretaceous rocks were encountered below the Tertiary; Jurassic rocks were not reached (with the exception of the tests drilled at Swanson River).

3. Cretaceous System:

- Lower Cretaceous: An unnamed sequence of lower Cretaceous sandstone and siltstone up to 215 m (675 feet) thick unconformably overlies the upper Jurassic Naknek Formation in the Kamishak Hills area and is expected to underlie the lower Cook Inlet area (Magoon and others, 1975). A basal sandstone unit 9 m (30 feet) to 15 m (50 feet) thick is prominent wherever the lower Cretaceous unit is seen and may offer good reservoir potential.

- Upper Cretaceous: The upper Cretaceous Kaguyak Formation unconformably overlies the lower Cretaceous unit and is composed of marine sandstone and siltstone (Keller and Reiser, 1959). This unit is about 1,370 m (4,495 feet) thick at Kaguyak Bay (Magoon and others, 1975). The unit does not outcrop north of the Kamishak Hills, except for one small exposure on the south flank of Augustine

Island. Wells drilled through the Tertiary on the lower Kenai Peninsula have penetrated as much as 1,737 m (5,700 feet) of upper Cretaceous siltstones and sandstones. Little promise of Cretaceous reservoir potential has been found in these wells.

It is reasonable to expect that large areas of these Cretaceous rocks underlie the lower Cook Inlet area. However, Cretaceous rocks are obviously absent along both the west side of the area, where the Tertiary is seen to overlap on the Jurassic Naknek Formation in surface outcrop, and to the north, where wells at Kalgin Island found the Naknek Formation to be immediately beneath the Tertiary. The nature and location of the Cretaceous truncation on the Jurassic and beneath the Tertiary will likely be determined only by seismology and exploratory drilling.

Tertiary Rocks

Following a period of considerable uplift and erosion of the Mesozoic rocks, a sequence of nonmarine sedimentary rocks up to 4,570 m (15,000 feet) thick was deposited in the lower Cook Inet area. These rocks range in age from Eocene through Pliocene and consist of siltstones, sandstones, and conglomerates with interbedded coal. These rocks yield major oil and gas production in the upper Cook Inlet area, and promising oil and gas "shows" have been found in them on the lower Kenai Peninsula.

Extensive drilling of the Tertiary rocks for more than 10 years has allowed the recognition of mappable subsurface units, and the stratigraphic nomenclature proposed by Calderwood and Fackler (1972) has found common usage.

The Tertiary rocks present in the lower Cook Inlet are collectively known as the Kenai Group, and consist of the following formational units (from oldest to youngest): the West Foreland Formation (tuffaceous siltstone, claystone, and scattered sandstone and conglomerate), the Hemlock Conglomerate (sandstone and conglomerate), the Tyonek Formation (siltstone, claystone, and sandstone with massive subbituminous coal beds), the Beluga Formation (claystone, siltstone and thin sandstone beds, and thin subbituminous coal beds), and the Sterling Formation (massive sandstone and conglomerate with occasional thin lignite beds) (Calderwood and Fackler, 1972). In upper Cook Inlet, the Hemlock Conglomerate and Tyonek Formation offer major oil production, and the Tyonek, Beluga, and Sterling Formations offer major dry-gas production.

To date, no major production has been established in the lower Cook Inlet area. All of the formations of the Kenai Group offer some potential in the lower Cook Inlet area with the possible exception of the Sterling Formation, which may be mostly absent in the offshore areas. The Kenai Group rocks thin southward from a maximum thickness of approximately 4,570 m (15,000 feet) south of Kalgin Island to an unknown thickness, possibly less than 1,220 m (4,000 feet), over the broad arch across lower Cook Inlet just north of Augustine Island. Projections of formation thicknesses into the offshore area would be uncertain at best without further well information.

East Glacier Creek Stratigraphic Section I

This stratigraphic section (pl. I) is located on the north shore of Chinitna Bay just east of the mouth of East Glacier Creek, in sec. 28, T. 3 S., R. 21 W., Seward Meridian. The rocks exposed here are Tertiary (Oligocene?) in age and are tentatively assigned to the West Foreland Formation. Thirty-eight m (125 feet) of sandstone, siltstone, and conglomerate were measured and sampled. This exposure is a nonmarine sequence and contains thin coal seams, fossil leaves, and one fossil tree (p. E-11, top) that was preserved in an upright position. The conglomerate is composed of pebble to cobble size subrounded to well-rounded clasts, and is sandstone-matrix supported. The sandstone is fine to medium grained, moderately friable, and contains numerous coal chips and coalified carbonaceous debris.

On the basis of limited samples, the maximum porosity in sandstone samples taken here is 13 percent; the average porosity, 10.7 percent. Maximum permeability is 1.69 md; the average permeability is 1 md. (This is based on three sample values each.)

East Glacier Creek Stratigraphic Section II

This stratigraphic section (pl. II) is located on the north shore of Chinitna Bay just west of the mouth of East Glacier Creek, in sec. 32, T. 3 S., R. 21 W., Seward Meridian. The rocks exposed here are Tertiary (Oligocene?) in age and are tentatively assigned to the West Foreland Formation. Although these rocks are of the same age and formation as those in East Glacier Creek stratigraphic section I, the exact stratigraphic relationship of the two sections to one another is not known, as the two are separated by the alluvial valley fill of the creek and are possibly offset by faulting. One hundred four m (341 feet) of sandstone, conglomerate, and siltstone were measured and sampled here (p. E-11, bottom). This is a nonmarine sequence and exhibits cross bedding and cut-and-fill features. The section is dominantly sandstone and conglomerate with interbedded siltstone. The section is complicated by normal faulting.

The sandstone occurs either as massive beds 2 m (6 feet) to 4 m (12 feet) thick or as interbedded lenses with the conglomerate; grain size varies from fine to pebbly. Some of the sandstone contains pinkish pods of tuffaceous material. The conglomerate is generally bedded. Clasts are pebble to boulder sized, and estimated to be 50 percent plutonic and 50 percent greenish to black metasediments. The conglomerate is matrix supported in a silty sandstone matrix. The siltstone is generally fractured, and contains reddish calcite(?) vein fillings. Soft-sediment deformation, commonly associated with pods of tuff, is evident. From laboratory analysis, maximum sandstone porosity is 1.5 percent and average porosity is 1 percent. Maximum permeability is 0.04 md, and the average permeability is 0.016 md.

Oil Bay Stratigraphic Section

The Oil Bay section (pl. III) was measured along the east shore of Oil Bay, on the Iniskin Peninsula, and is located in sections 12 and 13 of T. 6 S., R. 24 W., Seward Meridian and sections 18 and 19 of T. 6 S., R. 23 W., Seward Meridian. The rocks exposed there are the Chinitna and Naknek Formations, of upper Jurassic age. A total of 1,682 m (5,519 feet) of siltstone and sandstone was measured and sampled.

The base of the section (at the northeast end of Oil Bay) consists of 397 m (1,302 feet) of fossiliferous siltstone of the Chinitna Formation (p. E-7, top). The siltstone is commonly fractured, occasionally sandy, with scattered calcareous concretionary zones and ammonoid and belemnoid fossils.

The remaining 1,285 m (4,217 feet) of section measured and sampled were sandstones, siltstones, and conglomerates of the Naknek Formation. The sandstone beds are massive, very well indurated, and form spectacular cliffs (p. E-7, top). The siltstones are fractured and occasionally fossiliferous, and are similar to the siltstones of the underlying Chinitna Formation. Conglomerate is a minor constituent of this section and is interbedded with the sandstone units.

The Oil Bay section is one of the best exposures of the entire Naknek Formation sequence to be found in the lower Cook Inlet area. From laboratory analyses of the samples collected at Oil Bay, maximum sandstone porosity is 8.5 percent and average porosity is 1.5 percent. Maximum permeability is 2.15 md; average permeability is 0.13 md.

Shelter Creek Stratigraphic Section

This stratigraphic section (pl. IV) was measured along the ridge south of Shelter Creek, in sections 10 and 11 of T. 3 S., R. 21 W., Seward Meridian. Here the West Foreland Formation (Oligocene) is exposed as it overlaps Naknek Formation sandstones with a 7° angular unconformity. Both units dip southeastward at this location, the dip being 17° in the Tertiary and 24° in the Jurassic. Two hundred forty-three m (797 feet) of Tertiary conglomerate and sandstone were measured and sampled. Additional samples were taken from a stratigraphically lower position in a ravine draining north from the ridge to Shelter Creek, but that part of the section was not measured because of steep and unstable slopes.

Conglomerate is the dominant rock type in this section, with minor interbedded sandstone. The conglomerate generally weathers to a loose cobble pile. The clasts are generally well rounded and estimated to be 30 percent plutonic, 35 percent volcanic, and 35 percent metasediments. Where found unweathered, the conglomerate was clast supported in a silty sandstone matrix.

The sandstone is interbedded with the conglomerate. The thickest sandstone bed observed was 23 m (75 feet). The sandstone is coarse grained to pebbly, and occasionally well cross bedded.

Maximum porosity is 7.9 percent, average is 6.8 percent. Maximum permeability is 2.3 md, and average is 0.97 md (based on three samples).

Snug View Mountain - Bear Creek Ridge Stratigraphic Section

This stratigraphic section (pl. V) is located west of Snug Harbor, in sections 15 and 24, T. 1 S., R. 20 W., Seward Meridian. The rocks exposed here are Jurassic in age and are assigned to the Naknek Formation (Detterman and Hartsock, 1966) (p. E-5, bottom, E-6, top).

There were 12 sandstone units present in the section for a total sandstone thickness of 1,210 feet. The sandstones occur as massive beds 9.9 m (30 feet) to 99 m (300 feet) thick. The sandstones are dominantly fine grained and were deposited in a marginal open-marine environment. The remaining 654 m (2,146 feet) is dominantly mudstone and siltstone with some zones of fossils and concretions.

Porosities and permeabilities of the surface samples are low. Laboratory analysis indicates that the maximum porosity was 7.1 percent and maximum permeability was 0.27 md. The average sandstone porosity was 2.9 percent; average permeability was 0.076 md.

RESERVOIR CHARACTERISTICS

General Considerations

Examination of many stratigraphic sections from Cape Douglas to Tuxedni Bay indicates that sandstones with intergranular porosity and permeability will probably be the reservoir rock for any commercial accumulations of hydrocarbons in the lower Cook Inlet basin. Sandstone very locally suitable for reservoirs is contained in rocks that crop out onshore along the west side of lower Cook Inlet (p. E-1, top) and on Augustine Island (p. E-2, bottom); however, their offshore extent is not known. Well logs on the Kenai Peninsula indicate that some sandstones are present in the Mesozoic section. Therefore, it seems likely that sufficient sources of sand may have been available to form reservoirs within the lower Cook Inlet OCS area.

Reservoir Geometry and Size

The many different depositional environments discussed in other sections of this report attest to the high probability that potential reservoirs in the offshore area will have many different morphologies and sizes. Possible Jurassic reservoirs may range from lobate submarine fanglomerate or channel shapes such as the conglomerates on Nordyke Island (p. E-2, top) or their downdip sandy facies to marginal-marine linear clastic shoreline sand bodies such as that depicted in the Akumwarvik Bay traverse (pl. VI, p. E-1, bottom) or in the Oil Bay traverse (pl. VII, p. E-7, bottom and E-8, top). Such tabular sand bodies would be 50 to 1,000 times wider than the thickness (Krynine, 1957). These units form as linear bodies (beaches, spits, bars) oriented parallel to the paleoshoreline and in this case are probably oriented northeast-southwest parallel to the Cook Inlet trough.

The lower Cretaceous offshore may contain the same basal sandstone (30-50 feet thick) as is exposed at outcrops in the Kamishak Hills (Magoon, 1976). This subtidal to middle-shore facies unit would fit the tabular or blanket (sheet sand) model where the width is over 1,000 times the thickness.

Possible upper Cretaceous reservoirs may range from deepwater submarine fan-channel lobate (p. E-9, bottom) or shoestring deposits (Nelson, 1973) to turbidite sheets as discussed by Hand and Emery (1964). Possible Tertiary reservoirs may include delta plain or channel conglomerates (p. E-11, bottom and E-12, top) or their downdip sandy-delta-front lobate facies (Fisher, 1969). With such a wide variety of reservoir types exposed onshore, it seems very likely that many of these same sandstone geometries will occur in the lower Cook Inlet offshore area.

Reservoir Thickness

Jurassic Naknek Formation

The Oil Bay section was the most complete Jurassic Naknek section measured. There were nine sandstone units with a total thickness of 2,105 feet present. These sandstone beds ranged in thickness from 10 to 755 feet; the average thickness is about 234 feet. The sandstones are very low in porosity and permeability, and would be considered potential reservoir rock only if they change radically offshore.

Cretaceous Kaguyak Formation

There are not enough data to evaluate this area.

Tertiary West Forelands Formation

Three stratigraphic sections were measured in the West Foreland Formation. They are predominantly conglomerate and may not be diagnostic of the offshore subsurface geology. Sandstone bodies ranged from 10 to 190 feet thick. Ten sandstones were measured and sampled; their average thickness was 70 feet.

Reservoir Porosity and Permeability

Jurassic Rocks

Fifty-eight samples were processed for porosity and permeability determination. The samples were taken from all major sandstone bodies and are representative for surface samples. The porosities and permeabilities are consistently low. The maximum porosity was 10.9 percent and permeability was 17 md. These single maximum figures are not representative, as the next lower values were 6.7 percent and 10 md. The average of the 58 samples was 2.41 percent porosity and 0.032 md permeability. The reasons for the low readings are discussed in the section on petrography (p. H-1). It may be noteworthy that slightly higher porosities (5 and 10.9 percent) were present in samples from two sandstones on Augustine Island.

Cretaceous Rocks

There were not enough Cretaceous samples taken to give a representative sampling. The three samples taken yielded 2.4, 11.8, and 4.5 percent porosity and 0.02, 0.15, and 0.19 md permeability.

Tertiary Westforeland Formation

The sandstone and sandy conglomerate outcrops are very limited. Of 11 samples, the maximum porosity was 13 percent and the maximum permeability was 2.34 md; the average was 5.2 percent porosity and 0.55 md permeability.

Reservoir-Structural Spatial Relationships

There are only a few places in the study area that observations can be made on reservoirs and their relation to structures. In the Iniskin Peninsula area, sandstones of the Middle Jurassic Tuxedni Group and the upper Jurassic Chinitna Formation were observed on both the east and west flanks of both the Tonnie syncline and the Fitz Creek anticline, suggesting that the structure had no effect on deposition. Orientation of sandstones appear to be northeast-southwest.

The general northeast-southwest alignment of sandstones within the massive Pomeroy arkose member of the Naknek Formation suggests that most offshore Pomeroy equivalents should be oriented similarly in the greater part of the lower Cook Inlet. The sandstones would not be expected to occur preferentially in synclines or on anticlines because the structure probably postdates the deposition.

Jurassic sandstones in the Kamishak Bay area also appear not to be restricted to any particular part of a structure. Possible potential reservoir sandstones were observed in both anticlinal and synclinal position near the mouth of Douglas River (p. E-1, top).

As discussed previously, the Cretaceous sands may occur as either tabular deposits or as submarine fan-channel or lobate deposits. The sheet sands are oriented more or less parallel to the Cook Inlet trough and the fan, lobes, or channels are oriented normal to the Cook Inlet trough. These sandstones should also predate major structural growth in lower Cook Inlet.

The conglomerate exposures of Tertiary rocks in the Cape Douglas area and in the Shelter Creek area (p. E-12, top) suggest that similar channel, fluvial flood plain, or deltaic lobate deposits offshore are oriented normal to the existing Cook Inlet trough and most offshore structural trends. The sandy-facies equivalent of these conglomerates (p. E-11, bottom) are probably oriented parallel to the Cook Inlet trough. Deposition of all these sandstones should predate most lower Cook Inlet structures.

In summary, sandstones capable of being potential reservoirs---if porosity and permeability are preserved---should occur where originally deposited at all structural positions within the lower Cook Inlet, mainly because deposition predated major tectonic activity in that area.

HYDROCARBON SOURCE ROCKS

Sixty-nine samples were taken for source-rock evaluation. The relative amount of soluble hydrocarbon is considered to be indicative of the quality of the source rocks. In general, the parts-per-million (ppm) hydrocarbon readings were moderate. Sample values ranged from a low of 64 ppm hydrocarbon to a high of 1,569 ppm. The average of the 69 samples was 242 ppm. With the exception of one low reading (68 ppm) and two high readings (1,094 and 1,569), the sample values clustered around the average, indicating moderate source rock throughout the Jurassic section examined. The average hydrocarbon content in 791 samples of ancient sediments was 300 ppm (Hunt, 1961). The following tables are included to offer the reader a comparison of these data, other producing basins, and recent sediment values.

Table 1. Average noncarbonate carbon content, content of indigenous hydrocarbons boiling above 325°C., and hydrocarbon-noncarbonate carbon ratio of Recent sediments (after Blumer, 1958).[1]

Environment (location)	Average hydrocarbon content (ppm)
Soils	
(Texas)	60
Peats	
(Florida)	350
Fresh-Water Lake	
(Grand Lake, Louisiana)	41
Near-Shore Mud Flat	
(Sabine Pass, Texas)	23
Lagoonal	
(Laguna Madre, Texas)	20
Carbonate Muds	
(Florida)	20

Environment (location)	Average hydrocarbon content (ppm)
Interdeltaic	
(Louisiana)	20
Deltaic	
(Mississippi Delta)	80
Prodeltaic	
(Mississippi Delta)	80
Open Marine Shelf	
(Gulf of Mexico)	30
Deep Marine Basin	
(Chubasco Trench, Mexico)	23
(Channel Islands Area, California)	100
(Cariaco Trench, Venezuela)	140

[1] Philippi, G.T., 1965, On the depth, time and mechanism of petroleum generation: Geochem. et Cosmochem. Acta. vl. 29, p. 1021-1049.

Table 2. Noncarbonate carbon content, content of indigenous hydrocarbons boiling above 325°C., and hydrocarbon-noncarbonate carbon ratio of some ancient sediments.

Age and formation (location)	Average hydrocarbon content (ppm)
U. Mio.--Div. D & E	
(Ventura and Los Angeles Basins, California)	1,577
Mio.--Telissa	
(Sungei Taham Field, S. Sumatra)	896
Cret.--2nd White Specks	
(Alberta, Canada)	1,572
Cret.--Graneros	
(Northeast Colorado)	1,239
Cret.--LaLuna	
(La Paz Field, Venezuela, S.A.)	2,360
Cret.--LaLuna Equivalent	
(Casabe Field, Colombia, S.A.)	1,146
Perm--Leonard	
(Delaware Basin, Texas)	875
Miss.--Lodgepole	
(Eastern Montana)	267
Ord.--Winnipeg	
(Eastern Montana)	394

BASIN MATURITY

A total of 69 samples were processed for visual kerogen assessment by Geochem Laboratories, Inc. These samples were collected from widely separated areas and from all potential Mesozoic and Tertiary source rocks examined in the lower Cook Inlet area. There is essentially no difference in the type of organic matter present or in the degree of maturation in rocks ranging in age from upper Jurassic to Tertiary. The dominant thermal alteration rank of the majority of the samples ranges from +1 to +2, and is mainly -2 to +2. Only five samples have an alteration rank greater than +2. These range from +3 to -4 and are from the upper Cretaceous Kaguyak Formation and Tertiary rocks exposed in the area surrounding Mt. Douglas. The higher alteration rank of these five samples must indicate local thermal alteration due to igneous activity in the area. These alteration effects are probably not important in most of the offshore area.

Staplin (1969) has indicated that an alteration range of -2 to +2 should be indicative of the capability of the source rocks to generate either "wet" or "dry" associated hydrocarbons, depending on the type of hydrocarbon precursor kerogen.

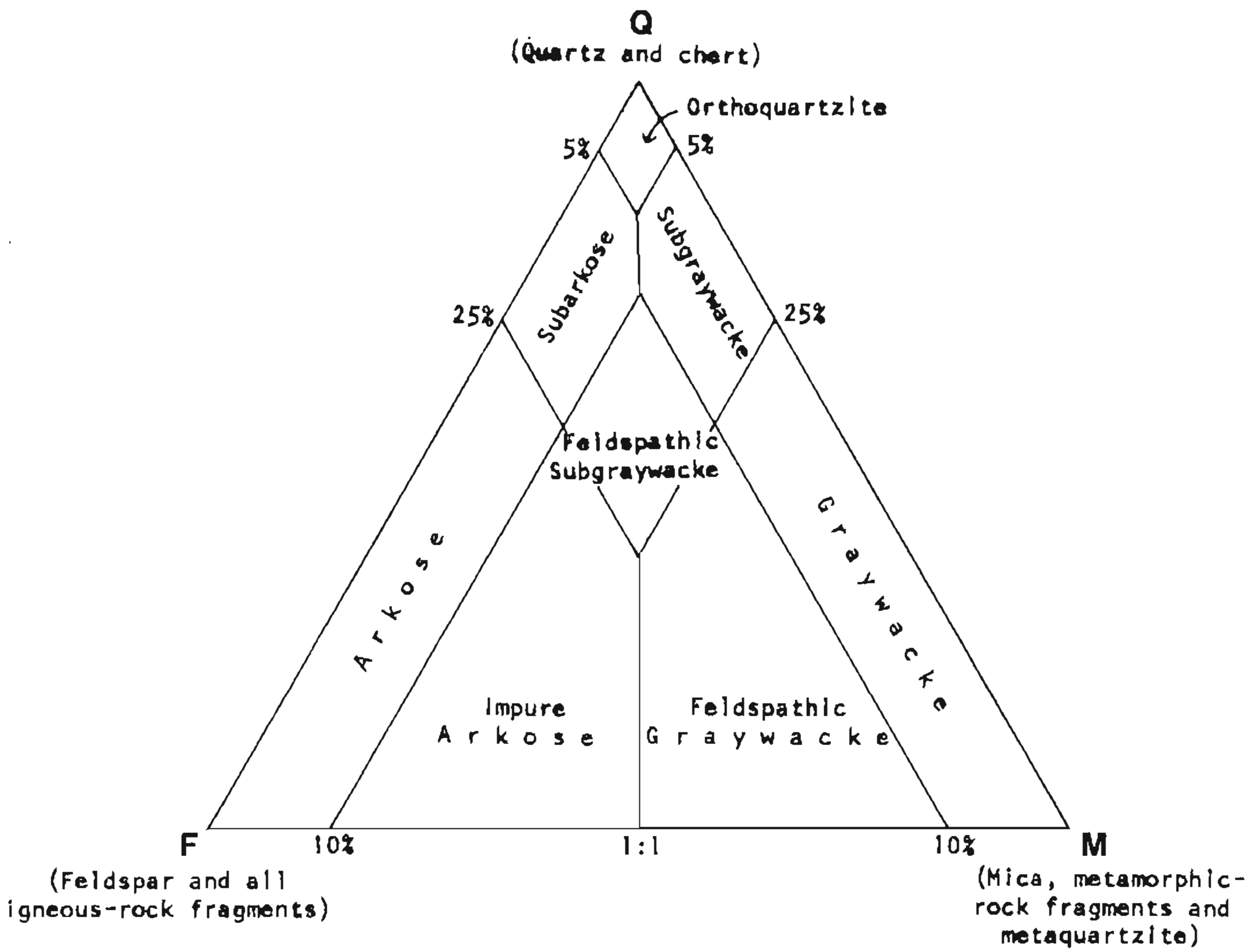
Analysis of the type of kerogen present in the 69 samples shows that the dominant type is herbaceous-spore/cuticle. Secondary and trace types of kerogen are coaly, amorphous-sapropel, and woody grains. The type of associated hydrocarbon indicated as most likely to occur is thus dry gas. However, 61 of the samples contain amorphous grains in either secondary or trace amounts which are indicative of the capability to generate "wet" hydrocarbons. These laboratory determinations appear in appendix D.

PETROGRAPHY OF POTENTIAL RESERVOIR SANDSTONES

Thirty-eight samples from stratigraphic columns and traverses in the lower Cook Inlet area were petrographically examined---10 from the West Foreland Formation of Tertiary age and 28 from the Chinitna and Naknek Formations of Jurassic age. These rocks were classified by composition of clasts and grain size (appendix H) according to Folk (1954; see figs. 3, 4). The modes used in compositional classification were estimated and are not reported in the appendix but the different compositions of clasts in each sample are present in order of their decreasing abundance.

All the samples contain intermediate plagioclase, quartz, and igneous rock fragments, and are accompanied in individual samples by various amounts of green or brown hornblende, brown biotite, potassium feldspar, magnetite, metamorphic rock fragments, chlorite, detrital clay, and carbonate. Accessory minerals include epidote, apatite, sphene, and muscovite. Plagioclase and igneous rock fragments are the most common types of clasts in all samples; most samples are compositionally arkoses, but some contain enough quartz or metamorphic rock fragments and mica to be classified as subarkoses or impure arkoses.

Plagioclase is commonly zoned and twinned according to the albite law, and pericline twins are not uncommon. Quartz commonly displays slight undulatory extinction, and polycrystalline grains are moderately abundant among larger clasts; bubble trains can be seen in numerous quartz clasts. Because these features are common for igneous plagioclase and quartz, a predominantly igneous provenance is indicated for the samples. Hornblende and biotite are common components of intermediate igneous rocks and are probably of igneous provenance.



The eight types of terrigenous sedimentary rocks, as defined by the mineral composition of the detrital silt-sand-gravel fraction, disregarding chemical cements and detrital clays. Not drawn to scale; limits indicated by the percentages shown at the edges of the triangle.

COMPOSITIONAL CLASSIFICATION OF SEDIMENTARY ROCKS (AFTER FOLK, 1954)

FIGURE 3

Terms Applied to Mixtures of Gravel, Sand, and Mud Delimited in Figure 1

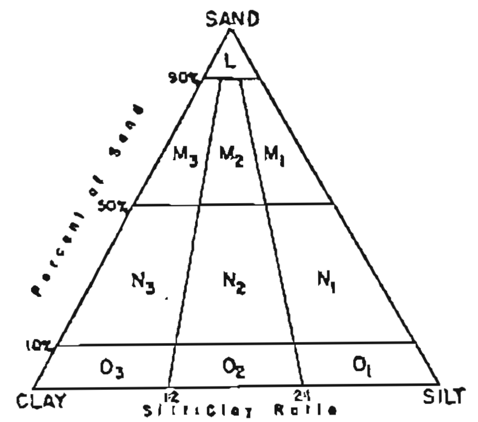
Major Textural Class	Examples of Usage
A. *Gravel*	Cobble gravel
Conglomerate	Granule conglomerate
B. Sandy *gravel*	Sandy pebble gravel
Sandy *conglomerate*	Sandy boulder conglomerate
C. *Muddy* sandy *gravel*	Muddy sandy granule gravel
Muddy sandy *conglomerate*	Clayey sandy pebble conglomerate
D. *Muddy gravel*	Silty boulder gravel
Muddy conglomerate	Muddy pebble conglomerate
E. *Gravelly sand*	Pebbly coarse sand
Conglomeratic sandstone	Granular very fine sandstone
F. *Gravelly muddy sand*	Pebbly silty fine sand
Conglomeratic muddy sandstone	Bouldery muddy coarse sandstone
G. *Gravelly mud*	Cobbly clay
Conglomeratic mudstone	Pebbly siltstone
H. Slightly *gravelly sand*	Slightly granular medium sand
Slightly *conglomeratic sandstone*	Slightly pebbly coarse sandstone
I. Slightly *gravelly muddy sand*	Slightly pebbly muddy medium sand
Slightly *conglomeratic muddy sandstone*	Slightly cobbly silty fine sandstone
J. Slightly *gravelly sandy mud*	Slightly granular fine sandy mud
Slightly *conglomeratic sandy mudstone*	Slightly pebbly coarse sandy claystone
K. Slightly *gravelly mud*	Slightly pebbly clay
Slightly *conglomeratic mudstone*	Slightly cobbly mudstone
L. *Sand* (specify sorting)	Well-sorted fine sand
Sandstone (specify sorting)	Poorly sorted medium sandstone
M. †*Muddy sand*	Well-sorted silty very fine sand
Muddy sandstone	Muddy coarse sandstone
N. †*Sandy mud*	Fine sandy clay
Sandy mudstone (specify structure)	Coarse sandy siltstone (if fissile, coarse sandy silt-shale)
O. †*Mud*	Silt
Mudstone (specify structure)	Mudstone (if fissile, mud-shale)

* Both unconsolidated and consolidated equivalents are shown in this table. It is suggested that the italicized terms be further specified as to their grain size, as shown in the examples.

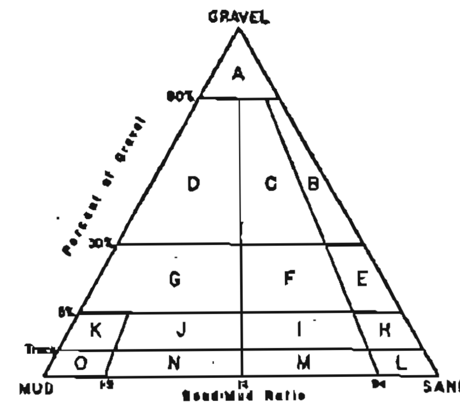
† Textural classes M, N, and O are expanded,

Classification of Fine-grained Rocks Based on Grain Size, Induration, and Structure

Textural Class	Unindurated	Indurated, Not Fissile	Indurated and Fissile
O1	Silt (>67 per cent silt)	Siltstone	Silt-shale
O2	Mud (intermediate)	Mudstone	Mud-shale
O3	Clay (>67 per cent clay)	Claystone	Clay-shale
N1	Sandy silt	Sandy siltstone	Sandy silt-shale
N2	Sandy mud	Sandy mudstone	Sandy mud-shale
N3	Sandy clay	Sandy claystone	Sandy clay-shale



Expansion of the bottom tier of fig. 1a (classes L, M, N, O) to show size terminology for specimens lacking gravel and for which the silt: clay ratio is determined. *L*, sand; *M1*, silty sand; *M2*, muddy sand; *M3*, clayey sand; *N1*, sandy silt; *N2*, sandy mud; *N3*, sandy clay; *O1*, silt; *O2*, mud; *O3*, clay.



The fifteen major textural groups as defined by the relative percentages of gravel (material coarser than 2 mm.), sand (material between 0.0625 and 2 mm.), and mud (silt plus clay material finer than 0.0625 mm.). Letters refer to textural names shown in table 1. Fields are defined by the percentage of gravel (shown on the left "leg" of the triangle) and the ratio of sand to mud (shown on the base). For expansion of the bottom, nongravelly tier into a sand-silt-clay triangle,

FIGURE 4. GRAIN-SIZE CLASSIFICATION OF SEDIMENTARY ROCKS (AFTER FOLK, 1954)

None of the clasts in any of the samples had weathering rinds, and it is likely that clasts were not weathered significantly during or after transport and deposition. Plagioclase ranges from fresh to moderately or greatly altered in all the samples, and this together with the common angularity of plagioclase clasts indicates that the samples are tectonic arkoses. In most samples, the plagioclase has been partly altered to kaolinite, which indicates normal weathering in the source area; however, some samples had various amounts of sericitized plagioclase indicative of deuteric alteration. One plagioclase sample was partly altered to zeolite, indicating hydrothermal activity in the source area.

There is commonly some magnetite associated with chlorite, and an origin from the alteration of biotite is suggested. There are many clasts of partly chloritized biotite, which supports such an origin for chlorite.

Calcareous (micritic) and noncalcareous brown detrital clays occur in some of the samples. Commonly, much of the micrite is recrystallized to sparry calcite, and the brown detrital clay appears to be a mixture of finely shredded biotite and chlorite.

Except for sample 177-IP-76, all samples are poorly sorted and have clasts arranged in a disordered fashion suggestive of sudden deposition. Sample 177-IP-76 is well sorted, and clasts in this sample are arranged with their long axes in a single plane; the rock of this sample has been reworked between the times of deposition and burial.

The samples from the West Foreland Formation are loosely to moderately packed, but those from the Naknek Formation are tightly packed with many grains broken in compaction. The thin sections used in this study were not impregnated with any colored medium to aid in the study of porosity; no visible porosity was observed in any of the samples, even those which were determined to have relatively large porosities by laboratory testing. What would otherwise have been pore space in the samples (amounting to considerable volume in some) was filled in with autochthonous zeolite which commonly displays a coxcomb texture. Because all the samples were collected along a trend of long-continued volcanism and the authigenic zeolite in the samples has probably been deposited by hydrothermal solutions associated with that volcanism, it is possible that rocks in the strata sampled might be free of autochthonous zeolite and contain proportionately more pore space in areas away from the volcanic trend.

STRUCTURE

The Cook Inlet basin is a northeast-trending intermontane trough bounded by the Bruin Bay fault system on the west and by the Border Ranges fault system on the east (Magoon and others, 1975). Within this trough, the major structural feature of the lower Cook Inlet is a broad, regional east-west-trending feature known as the Augustine-Seldovia arch.

Northeast-trending anticlinal and synclinal features and associated faulting have been identified in preliminary interpretations of seismic data by Fisher (1975), and in tentative shipboard interpretations of seismic data obtained by the USGS research vessel *Sea Sounder* in the summer of 1976 (Magoon and others, 1976). It is felt that these structural features will offer the most promising trap potential for future petroleum exploration in the lower Cook Inlet.

PETROLEUM POTENTIAL

Petroleum potential of the lower Cook Inlet area appears fair to good. Commercial accumulation of hydrocarbons requires (a) source rocks, (b) reservoir rocks, and (c) large traps. Evidence seems to support the concept that all three of these requirements are present in the lower Cook Inlet.

Basin maturity determinations indicate that potential source rocks are mature enough to have generated petroleum. Reservoir parameter determinations are generally low, and pore space has been limited by original tight packing and zeolitization. Large anticlinal structures are known from seismic data and there may be stratigraphic traps along the Augustine-Seldovia arch.

GEOCHEMICAL CONTROL

These data are available in appendix J.

CONCLUSIONS

We feel that the major objectives of this project were completed at a cost savings to both agencies. Reconnaissance geological and geochemical work was added to previous work on the west side of the lower Cook Inlet. Source-rock and potential reservoir-rock samples were collected and analyzed; basin maturity was determined from selected mudstones, siltstones, and shales; geochemical samples were taken for base-metal analysis; and samples were taken for age determination of certain plutons.

The results of these analyses show:

1. Porosities and permeabilities in outcrop samples are all generally low to very low.

2. A slight improvement was noted in upper Jurassic rocks in an easterly direction on Augustine Island.

3. Slightly higher porosities were noted in one sandstone unit in the Cretaceous and in the Tertiary rocks than in the Jurassic rocks.

4. Basin maturity was in the "wet" hydrocarbon and gas range for rocks ranging in age from upper Jurassic through Tertiary.

From these data we conclude that the petroleum potential in the lower Cook Inlet is fair to good, although it is considerably less attractive than the upper Cook Inlet.

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APPENDIX A

Porosity and Permeability Analyses

Map Number	Sample Number	Effective Porosity Percent	Permeability Millidarcies
34	43-JM-76	6.7	0.48
39	30-JM-76	2.9	0.03
46	26-JM-76	3.5	0.06
47	25-JM-76	1.2	< 0.01
48	119-IP-76	2.2	< 0.01
52	57-JM-76	3.6	0.02
53	56-JM-76	2.9	0.01
55	169-IP-76	6.5	0.07
63	177-IP-76	7.1	0.27
67	181 W 76	4.0	0.24
70	45-JM-76	1.4	< 0.01
74	49-JM-76	1.9	< 0.01
75	50-JM-76	2.3	0.01
76	51-JM-76	1.4	0.22(HF)
78	54-JM-76	1.5	< 0.01
80	55-JM-76	1.4	< 0.01
94	123 WL 76	0.2	< 0.01
101	173 WL 76	3.1	< 0.01
109	187 WL 76	2.9	< 0.01
139	138 WL 76	0.1	< 0.01
144	143 WL 76	0.2	< 0.01
146	145 WL 76	0.2	< 0.01
147	146 WL 76	1.6	< 0.01
148	147 WL 76	1.9	< 0.01
162	159 WL 76	0.2	< 0.01
163	160 WL 76	0.2	< 0.01
164	161 WL 76	0.5	< 0.01
165	162 WL 76	0.6	< 0.01
167	126-IP-76	1.0	< 0.01
168	125-IP-76	3.0	0.02
169	128-IP-76	1.2	< 0.01
170	129-IP-76	1.2	< 0.01
172	131-IP-76	0.6	< 0.01
173	132-IP-76	1.1	< 0.01
174	133-IP-76	1.8	< 0.01
176	135-IP-76	8.5	2.15
177	136-IP-76	4.0	0.25
182	141-IP-76	0.3	< 0.01
186	143 IFP 76	1.1	< 0.01
187	144-IP-76	1.9	0.01

Map Number	Sample Number	Effective Porosity Percent	Permeability Millidarcies
192	166 WL 76	6.2	0.03
196	172 WL 76	10.9	0.17
198	170 WL 76	5.0	0.10
205	60 WL 76	5.7	0.68
207	62 WL 76	5.5	0.01
210	64 WL 76	0.2	< 0.01
213	67B WL 76	10.3	13
214	67A WL 76	9.4	5.83
218	71 WL 76	6.9	0.02
219	72 WL 76	6.2	0.02
231	111 WL 76	0.2	< 0.01
232	110 WL 76	2.7	< 0.01
236	106 WL 76	6.8	0.08
237	105 WL 76	2.6	< 0.01
241	29 JCW 76	0.5	< 0.01
243	31 JCW 76	1.3	0.15
244	1 JW 76	2.6	0.03
247	4 JCW 76	7.9	0.48
248	5 JCW 76	7.7	2.34
249	6 JCW 76	4.8	0.09
257	25 JCW 76	5.2	0.31
264	110-IP-76	0.9	0.02
267	113-IP-76	1.0	< 0.01
271	117-IP-76	1.6	< 0.01
272	118-IP-76	1.7	< 0.01
273	13 JCW 76	0.7	0.04
276	16 JCW 76	1.3	< 0.01
277	17 JCW 76	1.5	< 0.01
278	18 JCW 76	1.2	< 0.01
279	19 JCW 76	0.3	< 0.01
281	105-IP-76	10.1	0.96
282	104-IP-76	9.0	0.37
289	106-IP-76	13.0	1.69
290B	122 WL 76	0.2	< 0.01
295	78 WL 76	11.8	0.15
296	79 WL 76	4.1	0.19
298	81 WL 76	7.4	0.12
301	84 WL 76	4.5	0.01
309	87-IP-76	8.0	0.57
313	91-IP-76	5.1	< 0.01

Map Number	Sample Number	Effective Porosity Percent	Permeability Millidarcies
317	19-JM-76	2.4	0.02
330	96 WL 76	3.1	< 0.01
331	97 WL 76	5.6	0.01
332	98 WL 76	1.8	< 0.01
333	99 WL 76	1.0	< 0.01
335	101 WL 76	2.1	< 0.01
337	81-IP-76	0.4	< 0.01
339	83-IP-76	1.0	0.01
342	85-IP-76	1.6	0.01

APPENDIX B

Paleontology Determinations[1]

Radiolarian assemblages similar to assemblages found in the subsurface of the Alaska Peninsula occur in several of these outcrop samples. These radiolaria are included in the sample-by-sample Foraminifera Report which appears below.

99-IP-76

Barren.

Age: Indeterminate
Environment: Indeterminate

103-IP-76

Barren. Coal (a).

Age: Indeterminate
Environment: Indeterminate

109-IP-76

Cenosphaera spp. (A), Dictyomitra sp. A (C), D. sp. B (R), D. spp. (C), Spongodiscus spp. (A), Spongurus sp. (C).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Marine

116-IP-76

Bathysiphon cf. alexanderi (R), Dentalina sp. (R), Hormosina ? sp. (R), Lenticulina sp. (R), Cenosphaera spp. (A), Dictyomitra sp. A (R), D. sp. B (F), D. spp. (C), Histiastrum sp. (R), Rhopalastrum sp. (R), Spongodiscus spp. (C), Spongurus sp. (C), Stylospongia sp. (R), pyrite (F), coal (F).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Marine

121-IP-76

Arenaceous sp. (R), Dentalina sp. (R), Globobulimina ? sp. (R), Cenosphaera spp. (A), Dictyomitra sp. A (R), D. spp. (C), Spongodiscus spp. (C), Spongurus sp. (F), Inoceramus prisms (R), coal (F).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Outer Neritic to Bathyal

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1 Performed by Anderson, Warren and Associates, consulting micropaleontologists, San Diego, California, August 1976.

124-IP-76

Cenosphaera spp. (F), Dictyomitra spp. (R), pyrite (F), coal (R).

Age: Probable Cretaceous or older
Environment: Marine

138-IP-76

Barren.

Age: Indeterminate
Environment: Indeterminate

141-IP-76

Arenaceous spp. (F), Bathysiphon ? sp. (R), Dentalina sp. (R), Globobulimina ? sp. (R), Haplophragmoides cf. excavata (C), H. spp. (F), Trochammina cf. sablei (F), Cenosphaera spp. (A), Dictyomitra sp. A (R), D. sp. B (F), D. spp. (C), Spongodiscus spp. (C), Spongurus sp. (C).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Outer Neritic to Bathyal

171-IFP-76

Ammodiscus ? sp. (R), Bathysiphon sanctaecrucis (R), Haplophragmoides spp. (R), Trochammina ? sp. (R).

Age: Indeterminate
Environment: Neritic ?

174-IP-76

Bathysiphon ? sp. (R), Haplophragmoides sp. (R), Cenosphaera spp. (C), Dictyomitra spp. (R), Spongodiscus spp. (F), pyrite (R).

Age: Probable Cretaceous or older
Environment: Marine

179-IFP-76

Haplophragmoides ? sp. (R), Cenosphaera spp. (F), Dictyomitra sp. (R), Spongodiscus spp. (F), Spongurus spp. (C).

Age: Probable Cretaceous or older
Environment: Marine

182-IFP-76

Haplophragmoides sp. (R), Cenosphaera spp. (F), Dictyomitra spp. (C), Spongurus spp. (F).

Age: Probable Cretaceous or older
Environment: Marine

<u>59-WL-76</u>

Shell fragments (R), Inoceramus prisms (F).

Age: Jurassic - Cretaceous
Environment: Marine

<u>63-WL-76</u>

Barren.

Age: Indeterminate
Environment: Indeterminate

<u>66-WL-76</u>

Barren.

Age: Indeterminate
Environment: Indeterminate

<u>67-WL-76</u>

Barren.

Age: Indeterminate
Environment: Indeterminate

<u>68-WL-76</u>

Dictyomitra sp. (R), pyrite (F).

Age: Indeterminate
Environment: Possible Marine

<u>70-WL-76</u>

Barren. Sponge spicules (R), pyrite (F).

Age: Indeterminate
Environment: Indeterminate

<u>76-WL-76</u>

Lagena ? sp. (R), Nodosaria cf. dolliformis (R), Lenticulina spp. (F), L. aff. wisselmanni (R), Osangularia ? sp. (R), Dictyomitra sp. (R), echinoid remains (R), Inoceramus prisms (FL), glauconite (A), vein calcite (C).

Age: Probable Cretaceous (Neocomian)
Environment: Neritic

80-WL-76

Barren. Inoceramus prisms (A).

Age: Jurassic - Cretaceous
Environment: Marine

83-WL-76

Gavelinella sp. (R), Spongurus sp. (R), radiolaria (R), shell fragments (F), Ditrupa cornu ? (R), Inoceramus prisms (C).

Age: Probable Cretaceous
Environment: Marine

85-WL-76

Haplophragmoides sp. (R).

Age: Indeterminate
Environment: Possible Marine

89-WL-76

Glomospira cf. gordialis (R), Pelosina sp. (R), Cenosphaera spp. (A), Lithocampe cf. sp. A (F), Spongurus spp. (A), Spongodiscus spp. (A), Dictyomitra cf. sp. A (F), D. spp. (F), Inoceramus prisms (R), Cyrtocapsa ? sp. (R).

Age: Jurassic to Early Cretaceous (Neocomian)
Environment: Open Marine

91-WL-76

Cenosphaera spp. (C), Spongurus spp. (C), Inoceramus prisms (R).

Age: Probable Jurassic to Cretaceous
Environment: Open Marine

100-WL-76

Inoceramus prisms (FL).

Age: Jurassic to Cretaceous
Environment: Marine

103-WL-76

Cenosphaera spp. (R), Cyrtocapsa ? sp. (R), Inoceramus prisms (R).

Age: Probable Jurassic to Cretaceous
Environment: Marine

108-WL-76

Haplophragmoides spp. (R).

Age:	Indeterminate
Environment:	Probable Marine

114-WL-76

Inoceramus prisms (R).

Age:	Probable Jurassic - Cretaceous
Environment:	Possible Marine

116-WL-76

Cenosphaera spp. (F), Spongurus spp. (R), Inoceramus prisms (R), pyrite (F).

Age:	Probable Jurassic - Cretaceous
Environment:	Open Marine

119-WL-76

Dictyomitra sp. (R), Spongurus spp. (F), Cenosphaera spp. (F), Inoceramus prisms (F), pyrite (F).

Age:	Jurassic - Cretaceous
Environment:	Open Marine

125-WL-76

Lenticulina sp. (R), Cyrtocapsa ? sp. (R), Cenosphaera spp. (C), Crucella cf. sp. B (R), Spongodiscus sp. (F), Dictyomitra cf. sp. B (R), pyrite (F).

Age:	Jurassic
Environment:	Open Marine

130-WML-76

Dictyomitra sp. B (R), D. spp. (C), Lenticulina spp. (R), Reophax ? sp. ()R, Crucella cf. sp. B (A), Patulibracchium cf. sp. A (F), Spongodiscus spp. (A), Cenosphaera spp. (A), shell fragments (R), Rhopalastrum sp. (R), R. sp. A (R), pyrite (C), pyrite sticks (C), Spongolonche sp. (R).

Age:	Jurassic
Environment:	Open Marine

133-WL-76

Bathysiphon sp. (R), Dictyomitra spp. (C), D. cf. sp. A (R), Stichomitra sp. (R), Spongurus spp. (A), Spongodiscus spp. (C), Crucella cf. sp. B (R), Trochammina sp. (R), Cenosphaera spp. (A), Patulibracchium sp. (R), pyrite (C), pyrite sticks (F).

Age:	Jurassic - Early Cretaceous (Neocomian)
Environment:	Open Marine

136-WML-76

Ammobaculites cf. vetusta (R), Arenaceous sp. (R), Cenosphaera spp. (F), Spongodiscus sp. A (R), Spongurus sp. (R), Patulibracchium sp. (R), Dictyomitra sp. (R), Spongolonche sp. A (R), pyrite (F), Rhopalastrum sp. A (R).

Age: Jurassic
Environment: Open Marine

140-WL-76

Arenaceous spp. (R), Epistomina ? sp. (R), Haplophragmoides sp. (R), Lenticulina cf. toarcense (R), Trochammina cf. sablei (R), Cenosphaera spp. (R), Inoceramus prisms (R), pyrite (F).

Age: Probable Jurassic
Environment: Neritic ?

143-WL-76

Spongodiscus sp. (R), Cenosphaera spp. (R).

Age: Indeterminate
Environment: Possible Marine

152-WL-76

Astacolus pediacus (R), Haplophragmoides sp. (R), Trochammina sp. (R), Verneuilinoides sp. (R), Cenosphaera spp. (R), pyrite (F).

Age: Probable Jurassic
Environment: Neritic ?

166-WL-76

Lenticulina prima (R), Cyrtocapsa ? sp. (R), Cenosphaera spp. (C).

Age: Probable Jurassic
Environment: Marine

177-WL-76

Haplophragmoides spp. (R), Cenosphaera spp. (R), pyrite (F).

Age: Indeterminate
Environment: Marine

179-WL-76

Gaudryina sp. (R), Gaudryinella sp. (R), Lenticulina sp. (R), Saccammina sp. (R), Cenosphaera spp. (F), Inoceramus prisms (R).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Neritic ?

182-WL-76

Spongodiscus spp. (F), Cyrtocapsa sp. A (R), Lithocampe sp. (F), Cenosphaera spp. (A), Crucella sp. (R), Dictyomitra sp. (F). echinoid remains (R), Inoceramus prisms (R), pyrite (C), vein calcite (F).

Age: Jurassic
Environment: Open Marine

3-JW-76

Barren.

Age: Indeterminate
Environment: Indeterminate

8-JCW-76

Barren. Coal (C).

Age: Indeterminate
Environment: Indeterminate

10-JCW-76

Barren. Coal (VA).

Age: Indeterminate
Environment: Indeterminate

12-JCW-76

Barren. Coal (A).

Age: Indeterminate
Environment: Indeterminate

14-JCW-76

Barren.

Age: Indeterminate
Environment: Indeterminate

21-JCW-76

Haplophragmoides ? sp. (R), Lenticulina sp. (R), Lingulina sp. (R), Trochammina ? sp. (R), pyrite (C), Cenosphaera spp. (C), Dictyomitra spp. (R), Spongodiscus spp. (R), Spongurus sp. (F).

Age: Probable Cretaceous or older
Environment: Middle Neritic to Bathyal

27-JCW-76

Barren.

Age: Indeterminate
Environment: Indeterminate

28-JM-76

Barren. Pyrite (F), pyrite sticks (R).

Age: Indeterminate
Environment: Indeterminate

32-JM-76

Barren. Pyrite (F), coal (F).

Age: Indeterminate
Environment: Indeterminate

35-JM-76

Haplophragmoides cf. excavata (R), H. spp. (F), Trochammina cf. albertensis (R), T. spp. (F), pelecypods (R), pyrite (C), Cenosphaera spp. (C), Dictyomitra spp. (R), Spongodiscus spp. (C), Spongurus sp. (F).

Age: Probable Cretaceous or older
Environment: Marine

38-JM-76

Barren. Coal (lignite) (C).

Age: Indeterminate
Environment: Indeterminate

46-JM-76

Bathysiphon sp. (R), Eoguttulina sp. (R), Haplophragmoides spp. (F), Spumellaria (VA), Cenosphaera spp. (A), Dictyomitra sp. A (R), D. sp. B (F), D. spp. (C), Spongodiscus spp. (A), Spongurus sp. (C).

Age: Jurassic - Early Cretaceous (Neocomian)
Environment: Open Marine

52-JM-76

Trochammina sp. (R), Cenosphaera spp. (A), Dictyomitra spp. (R), Spongodiscus spp. (C), Spongurus sp. (F).

Age: Probable Cretaceous or older
Environment: Marine

53-JM-76

Barren.

Age:	Indeterminate
Environment:	Indeterminate

APPENDIX C

Concentration of Extracted Materials in Rock

Map Number	Sample Number	Hydrocarbons: Total Extract (ppm)	Hydrocarbons: Percent Organic Carbon	Nonhydrocarbons: Precipitated Asphaltene (ppm)
11	162-IP-76	434	0.51	349
28	37-JM-76	410	0.27	348
36	31-JM-76	251	0.13	197
40	34-JM-76	117	0.10	97
43	27-JM-76	248	0.12	185
49	120-IP-76	185	0.08	141
51	122-IP-76	164	0.07; 0.06R	131
54	168-IFP-76	147	0.12	107
56	170-IFP-76	157	0.08; 0.06R	126
58	172-IP-76	172	0.07	125
59	173-IP-76	101	0.18	98
62	176-IP-76	97	0.08	92
64	178-IFP-76	82	0.08; 0.09R	80
67	181-IFP-76	105	0.12	79
73	48-JM-76	147	0.13	116
87	20-JCW-76	227	0.12; 0.10R	174
90	23-JCW-76	154	0.09	131
95	178-WL-76	656	0.38	378
99	176-WL-76	106	0.11	58
105	183-WL-76	350	0.20	223
110	188-WL-76	200	0.24	165
126	124-WL-76	341	0.17; 0.16R	235
130	129-WML-76	295	0.20	208
133	132-WL-76	218	0.12	168
135	134-WML-76	352	0.24; 0.18R	274
136	135-WL-76	257	0.21	157
140	139-WL-76	160	0.12	131
142	141-WML-76	171	0.10	139
143	142-WL-76	202	0.10	179
152	151-WL-76	185	0.01; 0.09R	163
154	123-IP-76	153	0.08	127
156	153-WL-76	176	0.19	138
158	155-WL-76	177	0.15	138
159	156-WL-76	189	0.15	141
160	157-WL-76	351	0.21	299
166	127-IP-76	264	0.04	210
171	130-IP-76	236	0.11	149
178	137-IP-76	85	0.09; 0.08R	73
181	140-IP-76	108	0.12	75
185	142A-IFP-76	175	0.15	133

Map Number	Sample Number	Hydrocarbons: Total Extract (ppm)	Hydrocarbons: Percent Organic Carbon	Nonhydrocarbons: Precipitated Asphaltene (ppm)
191	165-WL-76	251	0.11; 0.11R	234
216	69-WL-76	1094	0.24	202
221	121-WL-76	311	0.11	240
224	118-WL-76	145	0.08	101
227	115-WL-76	122	0.11	104
229	113-WL-76	192	0.05	143
235	107-WL-76	183	0.06; 0.06R	138
240	102-WL-76	160	0.06	114
254	11-JCW-76	269	0.16	196
258	26-JCW-76	282	0.09	216
261	107-IP-76	237	0.09	160
265	111-IP-76	124	0.04	82
268	114-IP-76	222	0.06	164
273	13-JCW-76	348	0.16	302
284	102-IP-76	130	0.16; 0.21R	100
288	98-IP-76	158	0.14	114
292	75-WL-76	195	0.13	142
303	86-WL-76	176	0.25	123
305	88-WL-76	190	0.14; 0.12R	138
311	89-IP-76	303	0.51	238
314	92-IP-76	173	0.69; 0.71R	70
322	95-IP-76	64	0.68	49
326	92-WL-76	1569	0.42	96
329	95-WL-76	503	0.26	96
335B	79-IP-76	193	0.64	164
341	84-IP-76	102	0.46	79
344	77-IP-76	151	0.21	97
345	76-IP-76	150	0.25; 0.27R	67
349	72-IP-76	125	0.21	71

APPENDIX D

Summary of Visual Kerogen Assessment[1]

Map Number	Sample Number	Visual Kerogen: Organic Matter Type	Visual Kerogen: Alteration Rank
11	162-IP-76	H; -; W-C	1+ to 2-
28	37-JM-76	H; C; -	1+ to 2-
36	31-JM-76	H; Am; C	1+ to 2-
40	34-JM-76	H; Am; C	1+ to 2-
43	27-JM-76	H; Am; C	1+ to 2-
49	120-IP-76	H; -; Am-C	1+ to 2-
51	122-IP-76	H; C; Am	2- to 2
54	168-IFP-76	H; Am; C	1+ to 2-
56	170-IFP-76	H; Am; C	2-
58	172-IP-76	H; Am; C	1+ to 2-
59	173-IP-76	H; Am; C	1+ to 2-
62	176-IP-76	H; Am; C	1+ to 2-
64	178-IFP-76	H; C; Am	1+ to 2-
67	181-IFP-76	H; Am; C	1+ to 2-
73	48-JM-76	H; Am; C	1+ to 2-
87	20-JCW-76	H; C; Am	2- to 2
90	23-JCW-76	H; Am; C	1+ to 2-
95	178-WL-76	H; Am-C; -	2 to 2+
99	176-WL-76	H; Am-C; -	2
105	183-WL-76	H; Am; C	1+ to 2-
110	188-WL-76	H; C; Am	2-
126	124-WL-76	H; -; Am-C	2-
130	129-WML-76	H; Am; C	1+ to 2-
133	132-WL-76	H; -; C	1+ to 2-
135	134-WML-76	H; Am; C	2- to 2
136	135-WL-76	H; -; Am-C	1+ to 2-
140	139-WL-76	H; C; Am	2- to 2
142	141-WML-76	H; -; Am-C	2- to 2
143	142-WL-76	H; Am-C; -	2- to 2
152	151-WL-76	H; C; Am	2- to 2

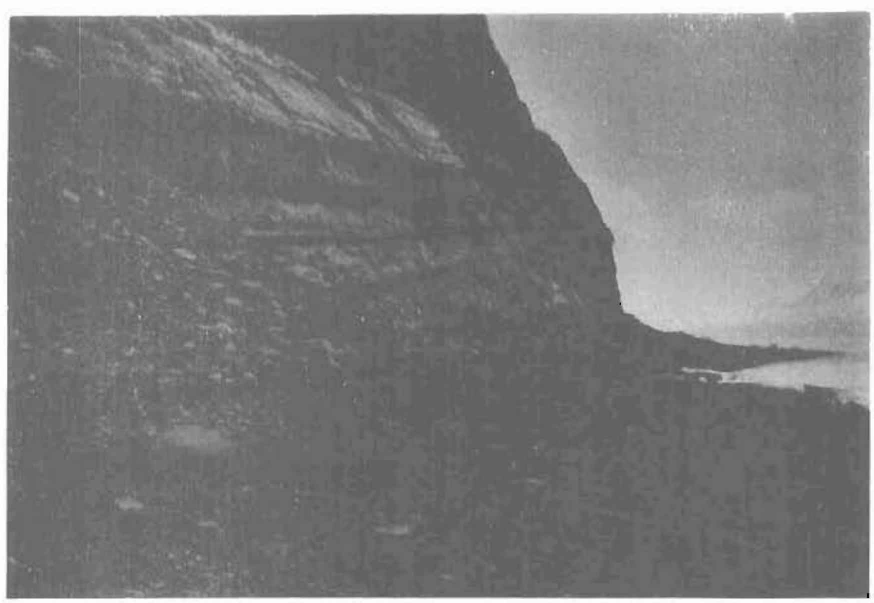
[1] Kerogen Key:

Predominant; Secondary; Trace
60-100% 20-40% 1-20%

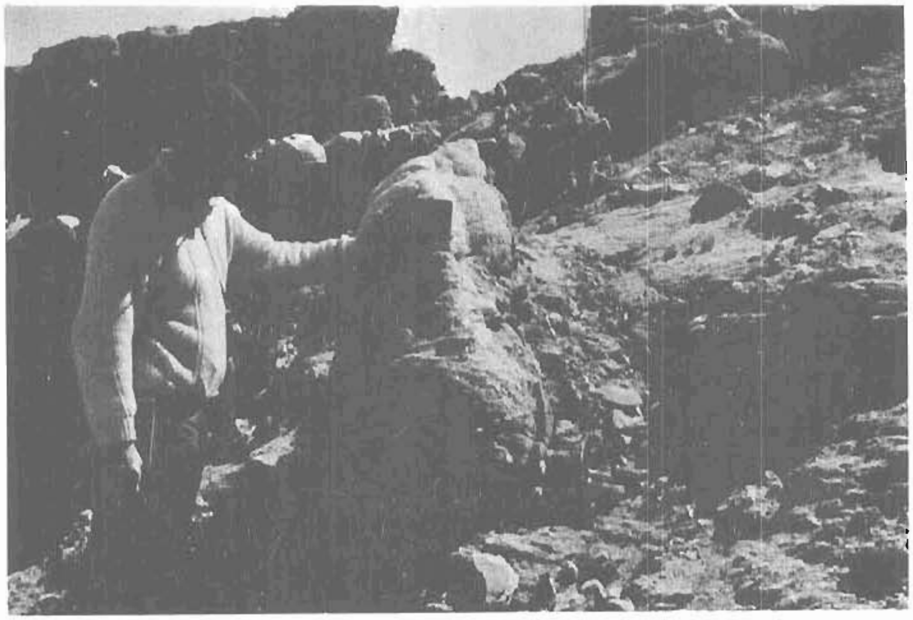
Al = Algal
Am = Amorphous-Sapropel
H = Herbaceous-Spore/Cuticle
W = Woody
C = Coaly
U = Unidentified Material

Map Number	Sample Number	Visual Kerogen: Organic Matter Type	Visual Kerogen: Alteration Rank
154	123-IP-76	H; Am; C	2- to 2
156	153-WL-76	H; C; Am-W	1+ to 2-
158	155-WL-76	H; C; -	2-
159	156-WL-76	H; Am-C; -	2-
160	157-WL-76	H; C; Am	2-
166	127-IP-76	H; -; C	1+ to 2-
171	130-IP-76	H; Am; C	1+ to 2-
178	137-IP-76	H-C; -; Am	2-
181	140-IP-76	H; Am-C; -	1+ to 2-
185	142A-IFP-76	H; C; Am	2-
191	165-WL-76	H; C; Am	2-
216	69-WL-76	H; -; -	1+ to 2-
221	121-WL-76	H; Am; C	1+ to 2-
224	118-WL-76	H; C; Am	1 to 1+
227	115-WL-76	H; Am; C	2- to 2
229	113-WL-76	H; Am; C	1+ to 2-
235	107-WL-76	H; C; Am	1+ to 2-
240	102-WL-76	H; Am; C	1+ to 2-
254	11-JCW-76	H; -; Am-W	2- to 2
258	26-JCW-76	H; -; C	2- to 2
261	107-IP-76	H; Am; C	1+ to 2-
265	111-IP-76	H; Am; C	1+ to 2-
268	114-IP-76	H; C; Am	2-
273	13-JCW-76	H; C; Am	1+ to 2-
284	102-IP-76	H; C; Am	2
288	98-IP-76	H-C; Am; -	2 to 2+
292	75-WL-76	H; -; Am-C	1 to 1+
303	86-WL-76	Am-H; -; C	1+
305	88-WL-76	H; Am; C	1+ to 2-
311	89-IP-76	H-C; W; -	3+
314	92-IP-76	C; Am; H-W	4-
322	95-IP-76	H-C; W; Am	3+
326	92-WL-76	Am; H; W-C	2 to 2+
329	95-WL-76	Am; H-C; W	2 to 2+
335B	79-IP-76	H-C; W; Am	3+ to 4-
341	84-IP-76	H-C; -; Am-W	3+ to 4-
344	77-IP-76	H-C; -; Am	2 to 2+
345	76-IP-76	H-C; Am; -	2 to 2+
349	72-IP-76	H-C; Am; -	2 to 2+

Upper Jurassic Naknek Formation massive sandstone exposed on a small island in the Akumwarvik Bay - Douglas River area. Rock has petroliferous odor on fresh break.

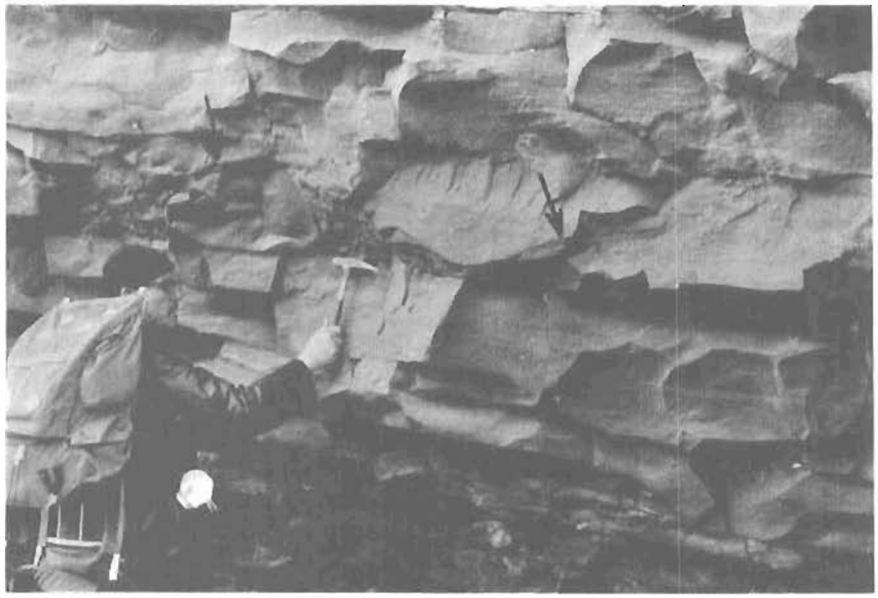


Upper Jurassic Naknek Formation sandstones exposed along Akumwarvik Bay.



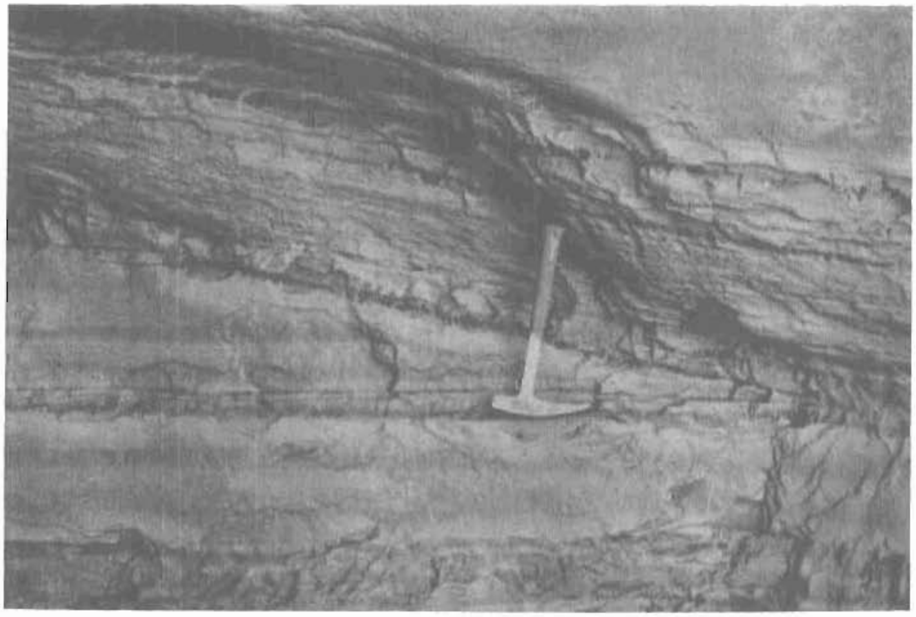
Upper Jurassic matrix-supported conglomerate exposed on Nordyke Island. Many cut-and-fill features are evident where the conglomerate has cut out a graded bedded sequence. The conglomerate is probably a submarine channel or fanglomerate deposit. The distal sandstone facies may be preserved in the lower Cook Inlet OCS area.

Upper Jurassic Naknek Formation sandstone exposed on south flank of Augustine Volcano. Sandstone exhibits large cross-bed sets and soft-sediment-deformation "swirls".

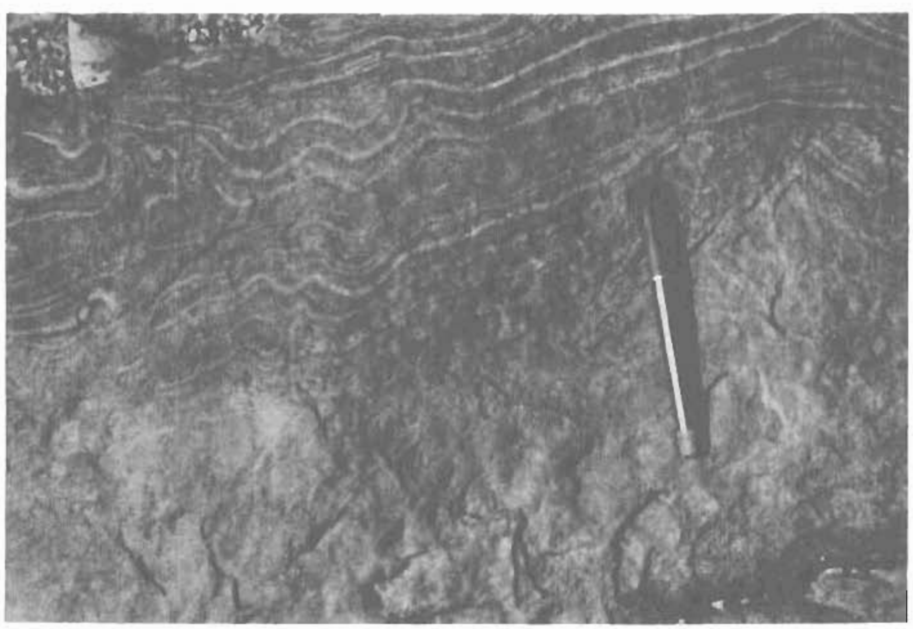


Flame structures and other soft-sediment deformation are common in Naknek Formation rocks exposed along north side of Chinitna Bay near Clam Cove.

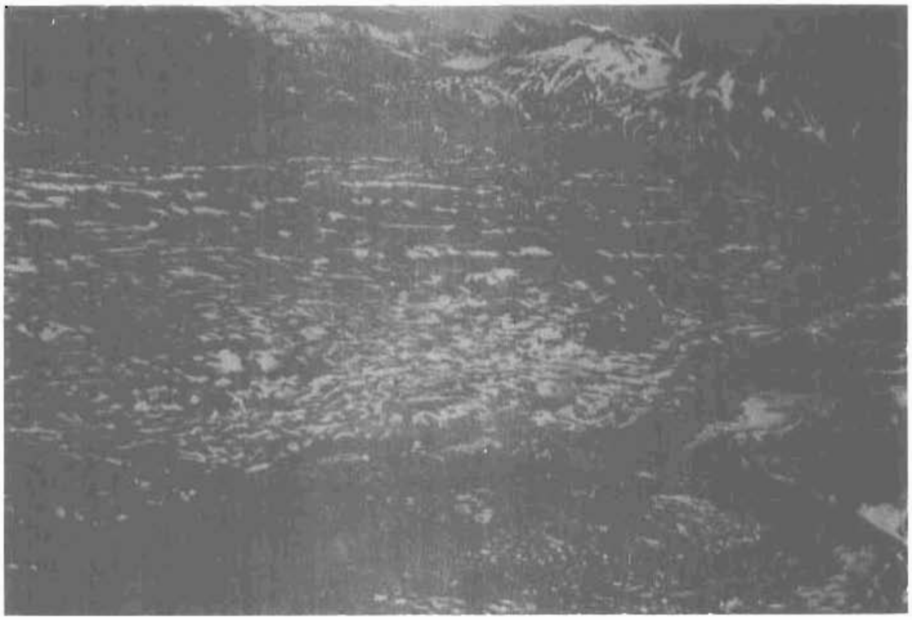
Soft-sediment deformation Jurassic Naknek Formation, north side of Chinitna Bay.



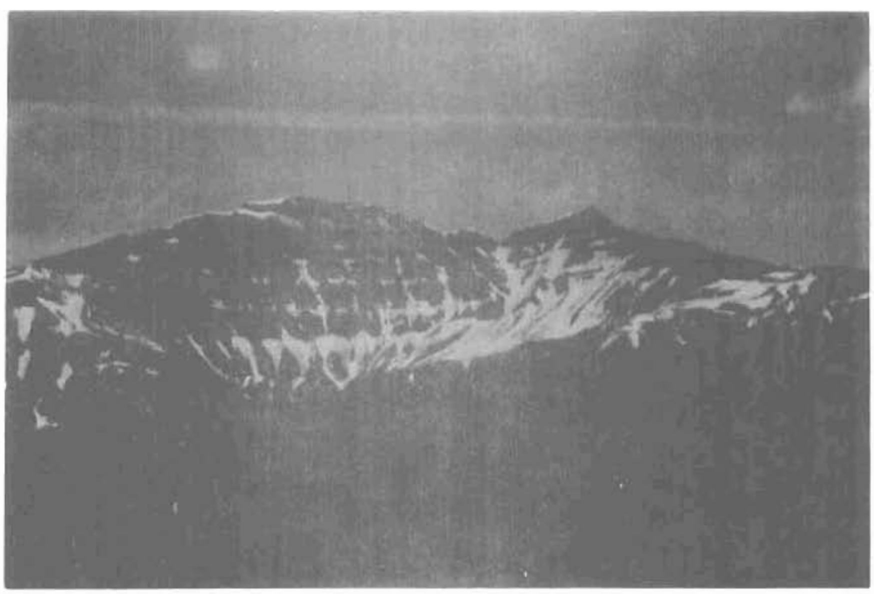
Channel cut-and-fill features, Jurassic Naknek Formation on the north side of Chinitna Bay.



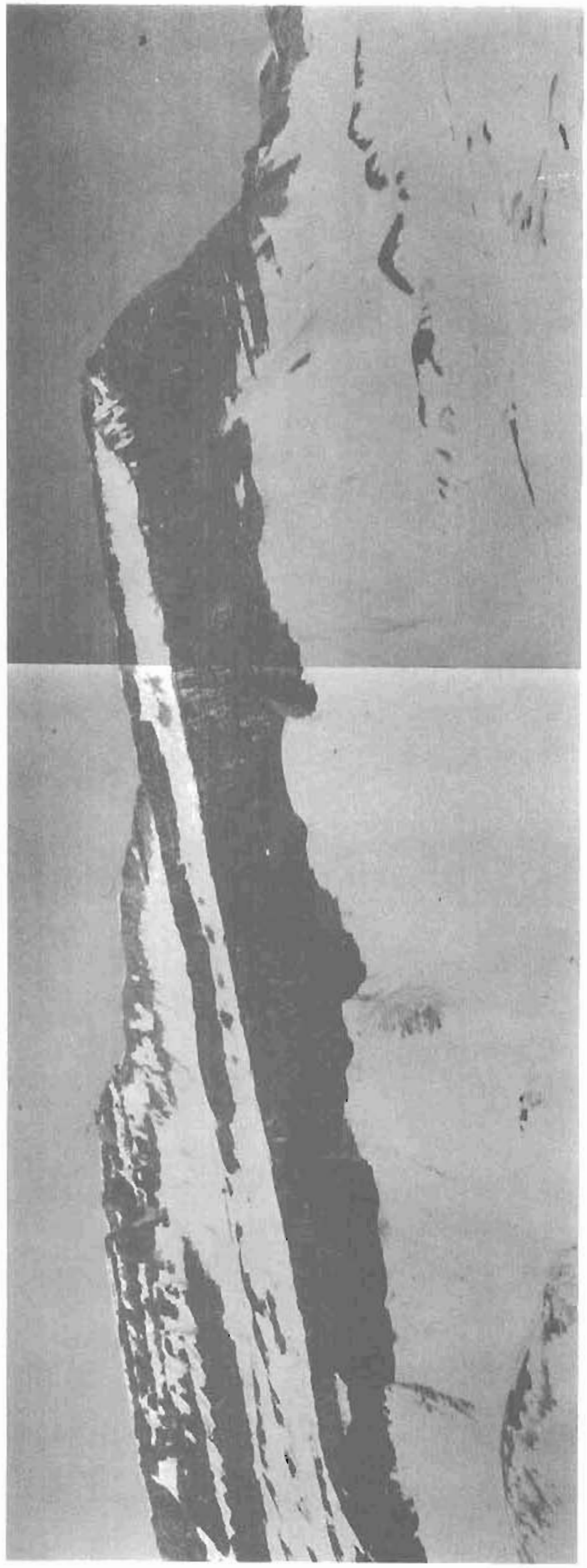
Soft-sediment deformation, Jurassic Naknek Formation on north side of Chinitna Bay.



Red Glacier, north side of Chinitna Bay.

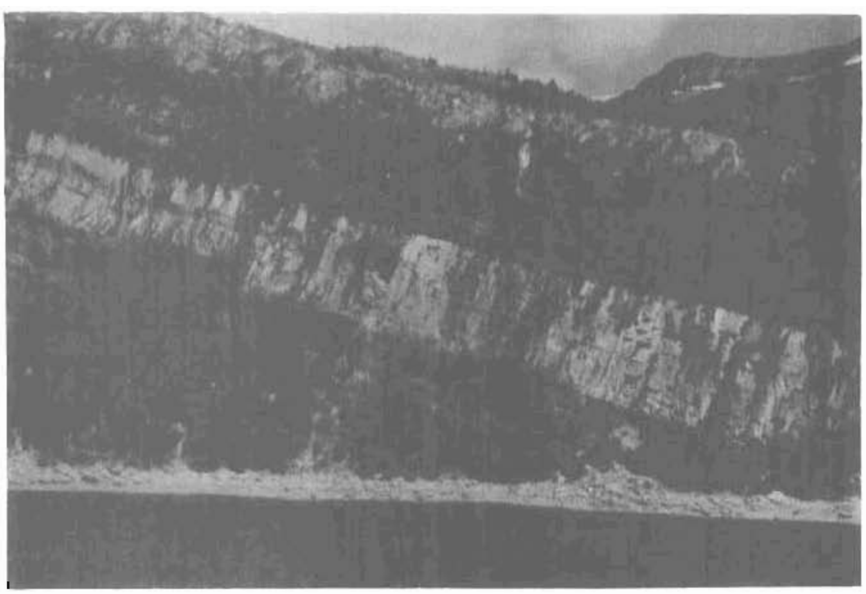


Basal part of the Snug View Mountain - Bear Creek Ridge stratigraphic section.

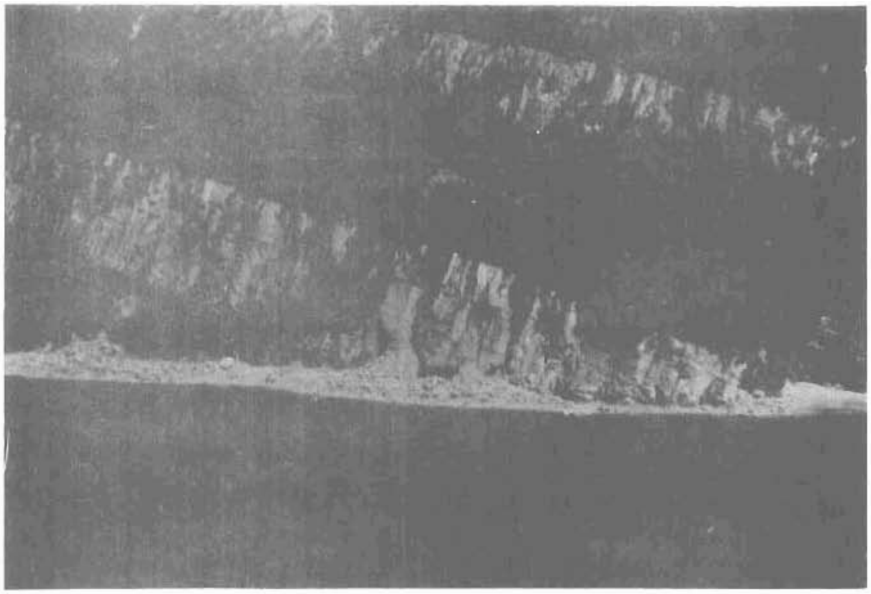


Upper part of Snug View Mountain - Bear Creek Ridge measured section, west of Snug Harbor.

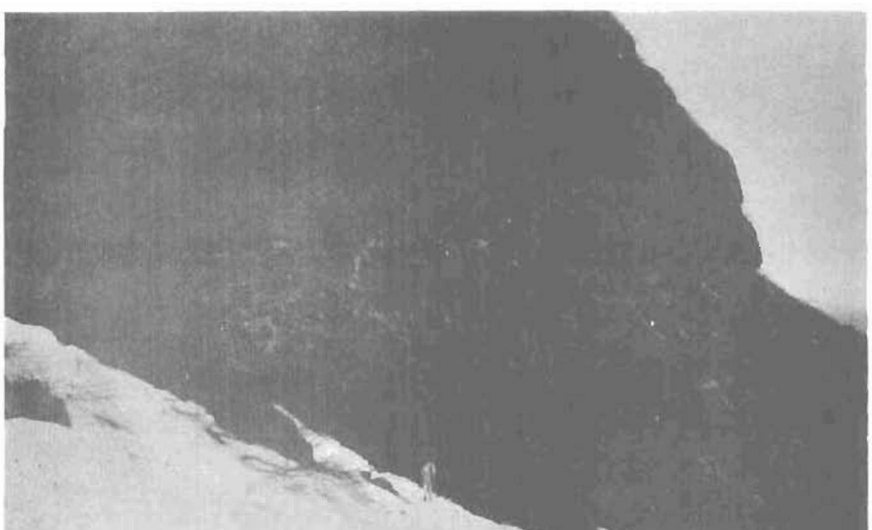
Basal part of Oil Bay stratigraphic section.



North end of Oil Bay traverse sandstone.

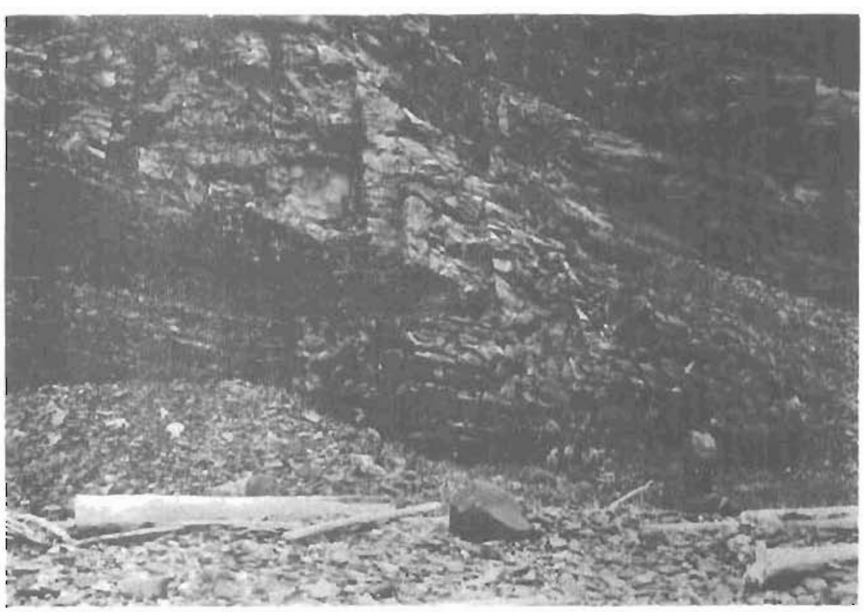


South end of Oil Bay traverse sandstone.

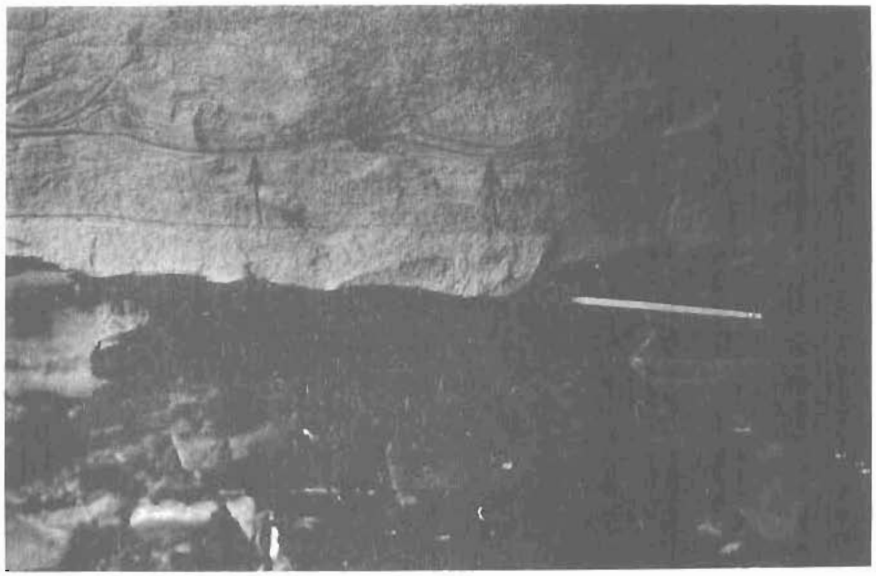


Contact between the Tertiary West Foreland Formation conglomerate and the underlying upper Cretaceous Kaguyak Formation, exposed north of Mt. Douglas at section 13, T. 14 S., R. 26 W., Seward Meridian. The sandstone facies of these massive conglomerates may be preserved in the offshore lower Cook Inlet area.

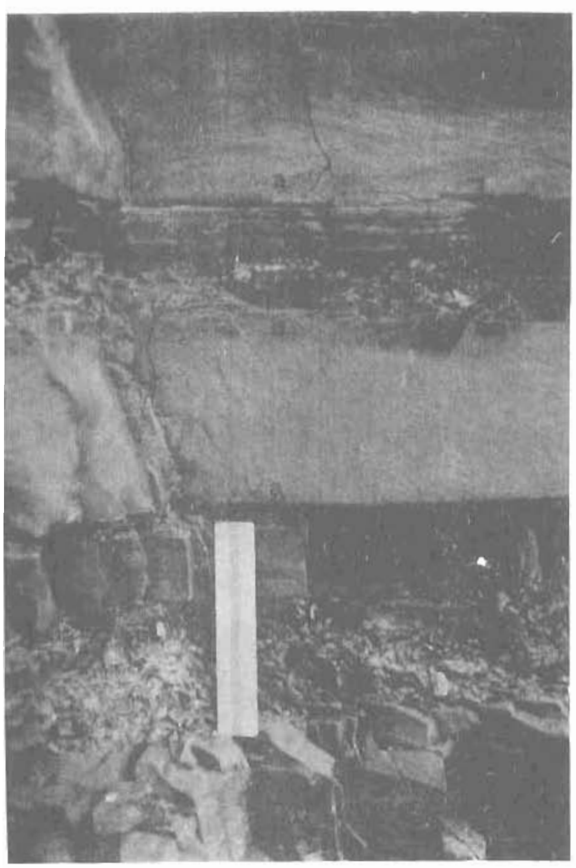
Upper Cretaceous Kaguyak Formation deep-water turbidite sequence exposed along north side of Kaguyak Bay.



Upper Cretaceous Kaguyak Formation submarine fan-channel sandstone that truncates turbidite sequence at Kaguyak Bay.



"Dish-structure" dewatering and consolidation features observed in the Kaguyak Formation turbidite and grain-flow sequence at Kaguyak Bay.



Incomplete Bouma-sequence turbidite facies observed in Upper Cretaceous Kaguyak Formation outcrop along Kaguyak Bay. From bottom to top: graded sequence "a" is present, lower interval of parallel lamination "b" possibly present, ripple lamination "c" is present, parallel lamination "d" is present and pelitic interval "e" is missing.

East Glacier Creek stratigraphic section I (Tertiary West Foreland Formation) exposed along north side of Chinitna Bay. Fossilized tree in growth position has been truncated by overlying conglomerate.

East Glacier Creek stratigraphic section II exposed along the north side of Chinitna Bay at section 32, T. 3 S., R. 21 W., Seward Meridian.

Tertiary West Foreland Formation conglomerates exposed in the Shelter Creek stratigraphic section. The sandstone facies of these conglomerates should underlie the lower Cook Inlet OCS area.

Basal conglomerate of West Foreland Formation exposed in the Shelter Creek stratigraphic section.

APPENDIX F

Selected Spot-Sample-Location Observations

Most field observations are incorporated into various parts of the report or illustrations; however, some observations made at spot sample locations do not appear in other parts of the report. Because some of these observations may be significant to those interested in the area, especially in regard to depositional environments, they are presented herein.

Nordyke Island

The island is largely composed of pebble and cobble conglomerate containing numerous sandstone interbeds. Many cut-and-fill structures are evident (p. E-2). In places, a graded bedded sequence of sandstones and siltstones has been cut out by the conglomerate, which may be a submarine fanglomerate. The conglomerate contains both plutonic and volcanic clasts and is supported by a sandstone matrix.

Akumwarvik Bay (east side)

Upper Jurassic Naknek sandstones and siltstones crop out in large cliff exposures (p. E-1) along the east side of Akumwarvik Bay. These rocks exhibit sedimentary features which include crossbeds in 0.5-1.0 meter sets, load casts, soft-sediment deformation, burrows, pelecypods, discontinuous coal seams and pods (maximum 1 cm thick), carbonaceous debris, and occasional graded beds. A marginal marine to middle shoreface depositional environment is suggested.

Section 15, T. 15 S., R. 29 W., Seward Meridian

A contact between the upper Jurassic and the basal sandstone of the lower Cretaceous was visited at this location. The lower Cretaceous sandstone, which varies between 9 and 15 m (30-50 feet) over much of the Kamishak Hills, exhibits large festoon crossbeds in 2-m sets and a high percentage of Inoceramus fragments and belemnoids. The sandstone is very fine grained and well indurated and commonly contains parting laminations 1-2 cm in diameter. A subtidal to middle shoreface depositional environment is suggested.

Kaguyak Bay (north side)

A deep-water turbidite sequence (p. E-9) of alternating sandstones and siltstones in beds 0.5-2.5 m thick crops out along the north side of Kaguyak Bay in prominent cliffs. Sedimentary structures observed in these rocks include ripup clasts or mudstone chips, shale-flame or injection structure, flaser bedding, load casts, flute casts (northeast orientation), microcrossbeds or current deposition foresets 1 cm thick, penecontemporaneous deformation, "dish" or dewatering structure (p. E-10), and graded bedding. Incomplete Bouma sequences are common (p. E-10). At one location, this turbidite sequence is truncated by a submarine fan-channel sandstone and the section is cut by dikes and sills.

Section 13, T. 14 S., R. 26 W., Seward Meridian

A contact between the upper Cretaceous Kaguyak Formation and the overlying Tertiary West Foreland Formation was examined at this location (p. E-8). The Kaguyak Formation consists of alternating thin-bedded sandstone, siltstone, and shale. The West Foreland Formation is composed of a dominantly pebble-cobble sandstone matrix conglomerate containing discontinuous sandstone lenses varying from 0.5 to 3 m thick. Clasts are mainly metasediments and plutonic rocks. The conglomerate appears massive at the base and contains faint bedding several meters thick in the upper part of the exposure. The conglomerate exceeds 152 m (500 feet) in thickness (Magoon, 1976).

Clam Cove (north side of Chinitna Bay)

Sedimentary features observed in the lower sandstone member of the Naknek Formation include: sand-filled mudcracks, pelecypods, belemnoids, and zones of fossil "hash", low-angle crossbedding, coalified wood fragments, and other carbonaceous debris. Some of the conglomerate sandstone contains clasts dominantly of recycled conglomerate. Some lenses and pods of siltstone exhibit loading into mudcracks. A marginal marine mud-flat depositional environment is suggested.

Sedimentary features observed in the Snug Harbor siltstone member include: soft-sediment deformation (p. E-4), channel cut and fill (p. E-4), parallel laminations, micro-cross-laminations (1 mm - 1 cm common), much carbonaceous debris, coalified reeds and wood fragments, and giant flame structures (p. E-3), some nearly 1 m high.

Massive sandstones are interbedded with lesser siltstone. The unit appears much more sandy than at Snug Harbor. The most probable depositional environment is middle to lower shoreface.

Massive sandstone beds of the Pomeroy Arkose member of the Naknek Formation are all well indurated, fractures, and interbedded with lesser siltstone. Many of the fractures contain calcite. Low-angle crossbedding and zones of shale rip-up clasts are common. Some of these shale fragments are up to 1/3 m long. The unit also contains zones of soft-sediment deformation and fossil fragments are occasionally present. Some thin silty interbeds contain graded bedding. The massive sandstone at this location may have been depositional in a middle to lower shoreface environment or as part of a submarine fan-channel complex. The silty beds exhibiting coarse-fine "couplets" or grading may represent interfan deposits.

Iniskin Peninsula

Massive Pomeroy member sandstones crop out along strike for thousands of feet along coastal exposures adjacent to Cook Inlet. These sandstones are well indurated and fractured with calcite interfill at many places. Sedimentary structures are generally lacking in the massive sandstones. Occasionally low-angle crossbedding is present; however, most of the sandstones appear to be massive or planar laminated. Interbedded with the massive sandstones are pebble conglomerates which have channel bases and siltstones which contain rare fossiliferous debris, shale rip-up zones, rare carbonaceous debris, coalified wood fragments, and some soft-sediment deformation. The massive sandstones were probably deposited in a linear clastic depositional environment that was middle to upper shoreface.

APPENDIX G

Cross Reference for Sample and Map Numbers

Lake Clark Quadrangle (Plate A)

Map Number	Sample Number	Analysis Done
1	154-IP-76	Geochemical
2	155-IP-76	Geochemical
3	151-IP-76	Geochemical
4	156-IP-76	Geochemical
5	153-IP-76	Geochemical
6	152-IP-76	Geochemical
7	66-JM-76	Age Date
8	65-JM-76	Age Date
9	64-JM-76	Age Date
10	63-JM-76	Age Date
11	162-IP-76	Hydrocarbon
12	161-IP-76	Geochemical
13	157-IP-76	Geochemical
14	163-IP-76	Geochemical
15	164-IP-76	Geochemical
16	165-IP-76	Geochemical
17	150-IP-76	Geochemical
18	158-IP-76	Geochemical
19	149-IP-76	Geochemical
20	148-IP-76	Geochemical
21	159-IP-76	Geochemical
22	160-IP-76	Geochemical
23	167-IP-76	Geochemical
24	166-IP-76	Porosity and Permeability
25	147-IP-76	Geochemical
26	146-IP-76	Geochemical
27	145-IP-76	Geochemical
28	37-JM-76	Hydrocarbon
29	38-JM-76	Paleontology
30	39-JM-76	Basin Maturity
31	40-JM-76	Macrofossil
32	41-JM-76	Macrofossil
33	42-JM-76	Macrofossil
34	43-JM-76	Porosity and Permeability
35	44-JM-76	Macrofossil
36	31-JM-76	Hydrocarbon
37	32-JM-76	Paleontology
38	33-JM-76	Basin Maturity
39	30-JM-76	Porosity and Permeability
40	34-JM-76	Hydrocarbon

Map Number	Sample Number	Analysis Done
41	35-JM-76	Paleontology
42	36-JM-76	Basin Maturity
43	27-JM-76	Hydrocarbon
44	28-JM-76	Paleontology
45	29-JM-76	Basin Maturity
46	26-JM-76	Porosity and Permeability
47	25-JM-76	Porosity and Permeability
48	119-IP-76	Porosity and Permeability
49	120-IP-76	Hydrocarbon
50	121-IP-76	Paleontology
51	122-IP-76	Hydrocarbon
52	57-JM-76	Porosity and Permeability
53	56-JM-76	Porosity and Permeability

Snug View Mountain - Bear Creek Ridge Stratigraphic Section (Plate V)

Map Number	Sample Number	Analysis Done
54	168-IP-76	Hydrocarbon
55	169-IP-76	Porosity and Permeability
56	170-IP-76	Hydrocarbon
57	171-IP-76	Paleontology
58	172-IP-76	Hydrocarbon
59	173-IP-76	Hydrocarbon
60	174-IP-76	Paleontology
61	175-IP-76	Basin Maturity
62	176-IP-76	Hydrocarbon
63	177-IP-76	Porosity and Permeability
64	178-IP-76	Hydrocarbon
65	179-IP-76	Paleontology
66	180-IP-76	Basin Maturity
67	181-IP-76	Hydrocarbon
68	182-IP-76	Paleontology
69	183-IP-76	Basin Maturity
70	45-JM-76	Porosity and Permeability
71	46-JM-76	Paleontology
72	47-JM-76	Basin Maturity
73	48-JM-76	Hydrocarbon
74	49-JM-76	Porosity and Permeability
75	50-JM-76	Porosity and Permeability
76	51-JM-76	Porosity and Permeability
77	52-JM-76	Paleontology
78	54-JM-76	Porosity and Permeability
79	53-JM-76	Paleontology
80	55-JM-76	Porosity and Permeability
81	67-JM-76	Geochemical

Map Number	Sample Number	Analysis Done
Iliamna Quadrangle (Plate C)		
82	62-JM-76	Age Date
83	61-JM-76	Age Date
84	60-JM-76	Geochemical
85	59-JM-76	Geochemical
86	58-JM-76	Geochemical
87	20-JCW-76	Hydrocarbon
88	21-JCW-76	Paleontology
89	22-JCW-76	Basin Maturity
90	23-JCW-76	Hydrocarbon
91	24-JCW-76	Basin Maturity
92	184-IP-76	Geochemical
93	185-IP-76	Geochemical
94	123-WL-76	Porosity and Permeability (thin section)
95	178-WL-76	Hydrocarbon
96	179-WL-76	Paleontology
97	180-WL-76	Basin Maturity
98	175-WL-76	Basin Maturity
99	176-WL-76	Hydrocarbon
100	177-WL-76	Paleontology
101	173-WL-76	Porosity and Permeability
102	174-WL-76	Macrofossil
103	181-WL-76	Porosity and Permeability
104	182-WL-76	Paleontology
105	183-WL-76	Hydrocarbon
106	184-WL-76	Basin Maturity
107	185-WL-76	Macrofossil
108	186-WL-76	Geochemical
109	187-WL-76	Porosity and Permeability
110	188-WL-76	Hydrocarbon
111	189-WL-76	Basin Maturity
112	186-IP-76	Geochemical
113	187-IP-76	Geochemical
114	193-IP-76	Geochemical
115	192-IP-76	Geochemical
116	191-IP-76	Geochemical
117A	194-IP-76	Geochemical
117B	195-IP-76	Lithology
118	197-IP-76	Geochemical
119	196-IP-76	Geochemical
120	200-IP-76	Basin Maturity, Vitrinite Reflectance

Map Number	Sample Number	Analysis Done
121	201-IP-76	Oriented Sandstone
122	188-IP-76	Geochemical
123	189-IP-76	Geochemical
124	190-IP-76	Geochemical
125	190-WL-76	Geochemical

Oil Bay Stratigraphic Section (Plate III)

Map Number	Sample Number	Analysis Done
126	124-WL-76	Hydrocarbon
127	125-WL-76	Paleontology
128	126-WL-76	Basin Maturity
129	127-WL-76	Macrofossil
130	129-WL-76	Hydrocarbon
131	130-WL-76	Paleontology
132	131-WL-76	Macrofossil
133	132-WL-76	Hydrocarbon
134	133-WL-76	Paleontology
135	134-WL-76	Hydrocarbon
136	135-WL-76	Hydrocarbon
137	136-WL-76	Paleontology
138	137-WL-76	Basin Maturity
139	138-WL-76	Porosity and Permeability
140	139-WL-76	Hydrocarbon
141	140-WL-76	Paleontology
142	141-WL-76	Hydrocarbon
143	132-WL-76	Hydrocarbon
144	143-WL-76	Paleontology
145	144-WL-76	Macrofossil
146	145-WL-76	Porosity and Permeability
147	146-WL-76	Porosity and Permeability
148	147-WL-76	Porosity and Permeability
149	148-WL-76	Basin Maturity
150	149-WL-76	Porosity and Permeability
151	150-WL-76	Macrofossil
152	151-WL-76	Hydrocarbon
153	152-WL-76	Paleontology
154	123-IP-76	Hydrocarbon
155	124-IP-76	Paleontology
156	153-WL-76	Hydrocarbon
157	154-WL-76	Paleontology
158	155-WL-76	Hydrocarbon
159	156-WL-76	Hydrocarbon
160	157-WL-76	Hydrocarbon

Map Number	Sample Number	Analysis Done
161	158-WL-76	Porosity and Permeability
162	159-WL-76	Porosity and Permeability
163	160-WL-76	Porosity and Permeability
164	161-WL-76	Porosity and Permeability
165	162-WL-76	Porosity and Permeability
166	127-IP-76	Hydrocarbon
167	126-IP-76	Porosity and Permeability
168	125-IP-76	Porosity and Permeability
169	128-IP-76	Porosity and Permeability
170	129-IP-76	Porosity and Permeability
171	130-IP-76	Porosity and Permeability
172	131-IP-76	Porosity and Permeability
173	132-IP-76	Porosity and Permeability
174	133-IP-76	Porosity and Permeability
175	134-IP-76	Lithology
176	135-IP-76	Porosity and Permeability
177	136-IP-76	Porosity and Permeability
178	137-IP-76	Hydrocarbon
179	138-IP-76	Paleontology
180	139-IP-76	Basin Maturity
181	140-IP-76	Hydrocarbon
182	141-IP-76	Paleontology
183	142-IP-76	Basin Maturity
184	141A-IP-76	Porosity and Permeability
185	142A-IP-76	Hydrocarbon
186	143-IP-76	Porosity and Permeability
187	144-IP-76	Porosity and Permeability
188	199-IP-76	Oriented Sandstone
189	198-IP-76	Oriented Sandstone
190	163-WL-76	Lithology
191	165-WL-76	Hydrocarbon
192	166-WL-76	Paleontology
193	167-WL-76	Basin Maturity
194	168-WL-76	Macrofossil
195	164-WL-76	Geochemical
196	172-WL-76	Porosity and Permeability
197	169-WL-76	Geochemical
198	170-WL-76	Porosity and Permeability
199	171-WL-76	Macrofossil
200	24-JM-76	Porosity and Permeability
201	16-JM-76	(Siltstone, not analyzed)
202	17-JM-76	(Siltstone, not analyzed)

Map Number	Sample Number	Analysis Done
203	18-JM-76	(Chert, not analyzed)
204	59-WL-76	Paleontology
205	60-WL-76	Porosity and Permeability
206	61-WL-76	Basin Maturity, Vitrinite Reflectance
207	62-WL-76	Porosity and Permeability
208	63A-WL-76	Oriented Sandstone
209	63-WL-76	Paleontology
210	64-WL-76	Porosity and Permeability
211	65-WL-76	Basin Maturity, Vitrinite Reflectance
212	66-WL-76	Paleontology
213	67-WL-76	Paleontology
214	67A-WL-76	Porosity and Permeability
215	68-WL-76	Paleontology
216	69-WL-76	Hydrocarbon
217	70-WL-76	Paleontology
218	71-WL-76	Porosity and Permeability
219	72-WL-76	Porosity and Permeability
220	73-WL-76	Porosity and Permeability
Seldovia Quadrangle (Plate D)		
221	121-WL-76	Hydrocarbon
222	120-WL-76	Basin Maturity
223	119-WL-76	Paleontology
224	118-WL-76	Hydrocarbon
225	117-WL-76	Basin Maturity
226	116-WL-76	Paleontology
227	115-WL-76	Hydrocarbon
228	114-WL-76	Paleontology
229	113-WL-76	Hydrocarbon
230	112-WL-76	Geochemical
231	111-WL-76	Porosity and Permeability
232	110-WL-76	Porosity and Permeability
233	109-WL-76	Paleontology
234	108-WL-76	Basin Maturity
235	107-WL-76	Hydrocarbon
236	106-WL-76	Porosity and Permeability
237	105-WL-76	Porosity and Permeability
238	104-WL-76	Basin Maturity
239	103-WL-76	Paleontology
240	102-WL-76	Hydrocarbon
241	29-JCW-76	Porosity and Permeability
242	30-JCW-76	Oriented Sandstone
243	31-JCW-76	Porosity and Permeability

Map Number	Sample Number	Analysis Done
Shelter Creek Stratigraphic Section (Plate IV)		
244	1-JCW-76	Porosity and Permeability
245	2-JCW-76	Lithology
246	3-JCW-76	Palynology
247	4-JCW-76	Porosity and Permeability
248	5-JCW-76	Porosity and Permeability
249	6-JCW-76	Porosity and Permeability
250	7-JCW-76	Lithology
251	8-JCW-76	Palynology
252	9-JCW-76	Basin Maturity, Vitrinite Reflectance
253	10-JCW-76	Palynology
254	11-JCW-76	Hydrocarbon
255	12-JCW-76	Palynology
256	68-JM-76	Geochemical
257	25-JCW-76	Porosity and Permeability
258	26-JCW-76	Hydrocarbon
259	26-JCW-76	Paleontology
260	28-JCW-76	Basin Maturity
261	107-IP-76	Hydrocarbon
262	108-IP-76	Basin Maturity
263	109-IP-76	Paleontology
264	110-IP-76	Porosity and Permeability
265	111-IP-76	Hydrocarbon
266	112-IP-76	Basin Maturity
267	113-IP-76	Porosity and Permeability
268	114-IP-76	Hydrocarbon
269	115-IP-76	Basin Maturity
270	116-IP-76	Paleontology
271	117-IP-76	Porosity and Permeability
272	118-IP-76	Porosity and Permeability
East Glacier Creek Stratigraphic Section II (Plate II)		
273	13-JCW-76	Hydrocarbon
274	14-JCW-76	Palynology
275	15-JCW-76	Porosity and Permeability
276	16-JCW-76	Porosity and Permeability
277	17-JCW-76	Porosity and Permeability
278	18-JCW-76	Porosity and Permeability
279	19-JCW-76	Porosity and Permeability
280	107A-IP-76	Geochemical

Map Number	Sample Number	Analysis Done
East Glacier Creek Stratigraphic Section I (Plate I)		
281	105-IP-76	Porosity and Permeability
282	104-IP-76	Porosity and Permeability
283	103-IP-76	Palynology
284	102-IP-76	Hydrocarbon
285	101-IP-76	Basin Maturity, Vitrinite Reflectance
286	100-IP-76	Basin Maturity
287	99-IP-76	Palynology
288	98-IP-76	Hydrocarbon
289	106-IP-76	Porosity and Permeability
290A	202-IP-76	Oriented Sandstone
290B	122-WL-76	Porosity and Permeability
Mt. Katmai Quadrangle (Plate E)		
291	74-WL-76	Macrofossil
292	75-WL-76	Hydrocarbon
293	76-WL-76	Paleontology
294	77-WL-76	Basin Maturity
295	78-WL-76	Porosity and Permeability
296	79-WL-76	Porosity and Permeability
297	80-WL-76	Paleontology
298	81-WL-76	Porosity and Permeability
299	82-WL-76	Macrofossil
300	83-WL-76	Paleontology
301	84-WL-76	Porosity and Permeability
302	85-WL-76	Paleontology
303	86-WL-76	Hydrocarbon
304	87-WL-76	Basin Maturity
305	88-WL-76	Hydrocarbon
306	89-WL-76	Paleontology
307	90-WL-76	Basin Maturity
Afognak Quadrangle (Plate F)		
308	86-IP-76	Lithology
309	87-IP-76	Porosity and Permeability
310	88-IP-76	Paleontology
311	89-IP-76	Hydrocarbon
312	90-IP-76	Basin Maturity
313	91-IP-76	Porosity and Permeability
314	92-IP-76	Hydrocarbon
315	93-IP-76	Basin Maturity
316	94-IP-76	Palynology
317	19-JM-76	Porosity and Permeability

Map Number	Sample Number	Analysis Done
318	20-JM-76	Macrofossil
319	21-JM-76	Macrofossil
320	22-JM-76	Macrofossil
321	23-JM-76	Macrofossil
322	95-IP-76	Hydrocarbon
323	96-IP-76	Palynology
324	97-IP-76	Basin Maturity
325	91-WL-76	Paleontology
326	92-WL-76	Hydrocarbon
327	93-WL-76	Macrofossil
328	94-WL-76	Basin Maturity
329	95-WL-76	Hydrocarbon
330	96-WL-76	Porosity and Permeability
331	97-WL-76	Porosity and Permeability
332	98-WL-76	Macrofossil
333	99-WL-76	Porosity and Permeability
334	100-WL-76	Paleontology
335A	101-WL-76	Porosity and Permeability
335B	79-IP-76	Hydrocarbon
336	80-IP-76	Paleontology
337	81-IP-76	Porosity and Permeability
338	82-IP-76	Paleontology
339	83-IP-76	Paleontology
340	83A-IP-76	Porosity and Permeability
341	84-IP-76	Hydrocarbon
342	85-IP-76	Porosity and Permeability
343	78-IP-76	Paleontology
344	77-IP-76	Hydrocarbon
345	76-IP-76	Hydrocarbon
346	75-IP-76	Paleontology
347	74-IP-76	Paleontology
348	73-IP-76	Basin Maturity
349	72-IP-76	Hydrocarbon

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Sample Number	Analysis Done	Map Number
59-WL-76	Paleontology	204
60-WL-76	Porosity and Permeability	205
61-WL-76	Basin Maturity, Vitrinite Reflectance	206
62-WL-76	Porosity and Permeability	207
63-WL-76	Paleontology	209
63A-WL-76	Oriented Sandstone	208
64-WL-76	Porosity and Permeability	210
65-WL-76	Basin Maturity, Vitrinite Reflectance	211
66-WL-76	Paleontology	212
67B-WL-76	Paleontology	213
67A-WL-76	Porosity and Permeability	214
68-WL-76	Paleontology	215
69-WL-76	Hydrocarbon	216
70-WL-76	Paleontology	217
71-WL-76	Porosity and Permeability	218
72-WL-76	Porosity and Permeability	219
73-WL-76	Porosity and Permeability	220
74-WL-76	Macrofossil	291
75-WL-76	Hydrocarbon	292
76-WL-76	Paleontology	293
77-WL-76	Basin Maturity	294
78-WL-76	Porosity and Permeability	295
79-WL-76	Porosity and Permeability	296
80-WL-76	Paleontology	297
81-WL-76	Porosity and Permeability	298
82-WL-76	Macrofossil	299
83-WL-76	Paleontology	300
84-WL-76	Porosity and Permeability	301
85-WL-76	Paleontology	302
86-WL-76	Hydrocarbon	303
87-WL-76	Basin Maturity	304
88-WL-76	Hydrocarbon	305
89-WL-76	Paleontology	306
90-WL-76	Basin Maturity	307
91-WL-76	Paleontology	325
92-WL-76	Hydrocarbon	326
93-WL-76	Macrofossil	327
94-WL-76	Basin Maturity	328
95-WL-76	Hydrocarbon	329
96-WL-76	Porosity and Permeability	330

Sample Number	Analysis Done	Map Number
97-WL-76	Porosity and Permeability	331
98-WL-76	Macrofossil	332
99-WL-76	Porosity and Permeability	333
100-WL-76	Paleontology	334
101-WL-76	Porosity and Permeability	335A
102-WL-76	Hydrocarbon	240
103-WL-76	Paleontology	239
104-WL-76	Basin Maturity	238
105-WL-76	Porosity and Permeability	237
106-WL-76	Porosity and Permeability	236
107-WL-76	Hydrocarbon	235
108-WL-76	Basin Maturity	234
109-WL-76	Paleontology	233
110-WL-76	Porosity and Permeability	232
111-WL-76	Porosity and Permeability	231
112-WL-76	Geochemical	230
113-WL-76	Hydrocarbon	229
114-WL-76	Paleontology	228
115-WL-76	Hydrocarbon	227
116-WL-76	Paleontology	226
117-WL-76	Basin Maturity	225
118-WL-76	Hydrocarbon	224
119-WL-76	Paleontology	223
120-WL-76	Basin Maturity	222
121-WL-76	Hydrocarbon	221
122-WL-76	Porosity and Permeability	290B
123-WL-76	Porosity and Permeability	94
124-WL-76	Hydrocarbon	126
125-WL-76	Paleontology	127
126-WL-76	Basin Maturity	128
127-WL-76	Macrofossil	129
128-WL-76	No Sample	
129-WL-76	Hydrocarbon	130
130-WL-76	Paleontology	131
131-WL-76	Macrofossil	132
132-WL-76	Hydrocarbon	133
133-WL-76	Paleontology	134
134-WL-76	Hydrocarbon	135
135-WL-76	Hydrocarbon	136
136-WL-76	Paleontology	137
137-WL-76	Basin Maturity	138
138-WL-76	Porosity and Permeability	139
139-WL-76	Hydrocarbon	140
140-WL-76	Paleontology	141
141-WL-76	Hydrocarbon	142

Sample Number	Analysis Done	Map Number
142-WL-76	Hydrocarbon	143
143-WL-76	Paleontology	144
144-WL-76	Macrofossil	145
145-WL-76	Porosity and Permeability	146
146-WL-76	Porosity and Permeability	147
147-WL-76	Porosity and Permeability	148
148-WL-76	Basin Maturity	149
149-WL-76	Porosity and Permeability	150
150-WL-76	Macrofossil	151
151-WL-76	Hydrocarbon	152
152-WL-76	Paleontology	153
153-WL-76	Hydrocarbon	156
154-WL-76	Paleontology	157
155-WL-76	Hydrocarbon	158
156-WL-76	Hydrocarbon	159
157-WL-76	Hydrocarbon	160
158-WL-76	Porosity and Permeability	161
159-WL-76	Porosity and Permeability	162
160-WL-76	Porosity and Permeability	163
161-WL-76	Porosity and Permeability	164
162-WL-76	Porosity and Permeability	165
163-WL-76	Lithology	190
164-WL-76	Geochemical	195
165-WL-76	Hydrocarbon	191
166-WL-76	Paleontology	192
167-WL-76	Basin Maturity	193
168-WL-76	Macrofossil	194
169-WL-76	Geochemical	197
170-WL-76	Porosity and Permeability	198
171-WL-76	Macrofossil	199
172-WL-76	Porosity and Permeability	196
173-WL-76	Porosity and Permeability	101
174-WL-76	Macrofossil	102
175-WL-76	Basin Maturity	98
176-WL-76	Hydrocarbon	99
177-WL-76	Paleontology	100
178-WL-76	Hydrocarbon	95
179-WL-76	Paleontology	96
180-WL-76	Basin Maturity	97
181-WL-76	Porosity and Permeability	103
182-WL-76	Paleontology	104
183-WL-76	Hydrocarbon	105
184-WL-76	Basin Maturity	106
185-WL-76	Macrofossil	107
186-WL-76	Geochemical	108

Sample Number	Analysis Done	Map Number
187-WL-76	Porosity and Permeability	109
188-WL-76	Hydrocarbon	110
189-WL-76	Basin Maturity	111
190-WL-76	Geochemical	125
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72-IP-76	Hydrocarbon	349
73-IP-76	Basin Maturity	348
74-IP-76	Paleontology	347
75-IP-76	Paleontology	346
76-IP-76	Hydrocarbon	345
77-IP-76	Hydrocarbon	344
78-IP-76	Paleontology	343
79-IP-76	Hydrocarbon	335B
80-IP-76	Paleontology	336
81-IP-76	Porosity and Permeability	337
82-IP-76	Paleontology	338
83-IP-76	Paleontology	339
83A-IP-76	Porosity and Permeability	340
84-IP-76	Hydrocarbon	341
85-IP-76	Porosity and Permeability	342
86-IP-76	Lithology	308
87-IP-76	Porosity and Permeability	309
88-IP-76	Paleontology	310
89-IP-76	Hydrocarbon	311
90-IP-76	Basin Maturity	312
91-IP-76	Porosity and Permeability	313
92-IP-76	Hydrocarbon	314
93-IP-76	Basin Maturity	315
94-IP-76	Palynology	316
95-IP-76	Hydrocarbon	322
96-IP-76	Palynology	323
97-IP-76	Basin Maturity	324
98-IP-76	Hydrocarbon	288
99-IP-76	Palynology	287
100-IP-76	Basin Maturity	286
101-IP-76	Basin Maturity, Vitrinite Reflectance	285
102-IP-76	Hydrocarbon	284
103-IP-76	Palynology	283
104-IP-76	Porosity and Permeability	282
105-IP-76	Porosity and Permeability	281

Sample Number	Analysis Done	Map Number
106-IP-76	Porosity and Permeability	289
107-IP-76	Hydrocarbon	261
107A-IP-76	Geochemical	280
108-IP-76	Basin Maturity	262
109-IP-76	Paleontology	263
110-IP-76	Porosity and Permeability	264
111-IP-76	Hydrocarbon	265
112-IP-76	Basin Maturity	266
113-IP-76	Porosity and Permeability	267
114-IP-76	Hydrocarbon	268
115-IP-76	Basin Maturity	269
116-IP-76	Paleontology	270
117-IP-76	Porosity and Permeability	271
118-IP-76	Porosity and Permeability	272
119-IP-76	Porosity and Permeability	48
120-IP-76	Hydrocarbon	49
121-IP-76	Paleontology	50
122-IP-76	Hydrocarbon	51
123-IP-76	Hydrocarbon	154
124-IP-76	Paleontology	155
125-IP-76	Porosity and Permeability	168
126-IP-76	Porosity and Permeability	167
127-IP-76	Hydrocarbon	166
128-IP-76	Porosity and Permeability	169
129-IP-76	Porosity and Permeability	170
130-IP-76	Porosity and Permeability	171
131-IP-76	Porosity and Permeability	172
132-IP-76	Porosity and Permeability	173
133-IP-76	Porosity and Permeability	174
134-IP-76	Lithology	175
135-IP-76	Porosity and Permeability	176
136-IP-76	Porosity and Permeability	177
137-IP-76	Hydrocarbon	178
138-IP-76	Paleontology	179
139-IP-76	Basin Maturity	180
140-IP-76	Hydrocarbon	181
141-IP-76	Paleontology	182
141A-IP-76	Basin Maturity	184
142-IP-76	Porosity and Permeability	183
142A-IP-76	Hydrocarbon	185
143-IP-76	Porosity and Permeability	186
144-IP-76	Porosity and Permeability	187
145-IP-76	Geochemical	27
146-IP-76	Geochemical	26
147-IP-76	Geochemical	25

Sample Number	Analysis Done	Map Number
148-IP-76	Geochemical	20
149-IP-76	Geochemical	19
150-IP-76	Geochemical	17
151-IP-76	Geochemical	3
152-IP-76	Geochemical	6
153-IP-76	Geochemical	5
154-IP-76	Geochemical	1
155-IP-76	Geochemical	2
156-IP-76	Geochemical	4
157-IP-76	Geochemical	13
158-IP-76	Geochemical	18
159-IP-76	Geochemical	21
160-IP-76	Geochemical	22
161-IP-76	Geochemical	12
162-IP-76	Hydrocarbon	11
163-IP-76	Geochemical	14
164-IP-76	Geochemical	15
165-IP-76	Geochemical	16
166-IP-76	Porosity and Permeability	24
167-IP-76	Geochemical	23
168-IP-76	Hydrocarbon	54
169-IP-76	Porosity and Permeability	55
170-IP-76	Hydrocarbon	56
171-IP-76	Paleontology	57
172-IP-76	Hydrocarbon	58
173-IP-76	Hydrocarbon	59
174-IP-76	Paleontology	60
175-IP-76	Basin Maturity	61
176-IP-76	Hydrocarbon	62
177-IP-76	Porosity and Permeability	63
178-IP-76	Hydrocarbon	64
179-IP-76	Paleontology	65
180-IP-76	Basin Maturity	66
181-IP-76	Hydrocarbon	67
182-IP-76	Paleontology	68
183-IP-76	Basin Maturity	69
184-IP-76	Geochemical	92
185-IP-76	Geochemical	93
186-IP-76	Geochemical	112
187-IP-76	Geochemical	113
188-IP-76	Geochemical	122
189-IP-76	Geochemical	123
190-IP-76	Geochemical	124
191-IP-76	Geochemical	116
192-IP-76	Geochemical	115

Sample Number	Analysis Done	Map Number
193-IP-76	Geochemical	114
194-IP-76	Geochemical	117A
195-IP-76	Lithology	117B
196-IP-76	Geochemical	119
197-IP-76	Geochemical	118
198-IP-76	Oriented Sandstone	189
199-IP-76	Oriented Sandstone	188
200-IP-76	Basin Maturity, Vitrinite Reflectance	120
201-IP-76	Oriented Sandstone	121
202-IP-76	Oriented Sandstone	290A
Jeff Morehouse		
16-JM-76	(Siltstone, not analyzed)	201
17-JM-76	(Siltstone, not analyzed)	202
18-JM-76	(Chert, not analyzed)	203
19-JM-76	Porosity and Permeability	317
20-JM-76	Macrofossil	318
21-JM-76	Macrofossil	319
22-JM-76	Macrofossil	320
23-JM-76	Macrofossil	321
24-JM-76	Porosity and Permeability	200
25-JM-76	Porosity and Permeability	47
26-JM-76	Porosity and Permeability	46
27-JM-76	Hydrocarbon	43
28-JM-76	Paleontology	44
29-JM-76	Basin Maturity	45
30-JM-76	Porosity and Permeability	39
31-JM-76	Hydrocarbon	36
32-JM-76	Paleontology	37
33-JM-76	Basin Maturity	38
34-JM-76	Hydrocarbon	40
35-JM-76	Paleontology	41
36-JM-76	Basin Maturity	42
37-JM-76	Hydrocarbon	28
38-JM-76	Paleontology	29
39-JM-76	Basin Maturity	30
40-JM-76	Macrofossil	31
41-JM-76	Macrofossil	32
42-JM-76	Macrofossil	33
43-JM-76	Porosity and Permeability	34
44-JM-76	Macrofossil	35
45-JM-76	Porosity and Permeability	70

Sample Number	Analysis Done	Map Number
46-JM-76	Paleontology	71
47-JM-76	Basin Maturity	72
48-JM-76	Hydrocarbon	73
49-JM-76	Porosity and Permeability	74
50-JM-76	Porosity and Permeability	75
51-JM-76	Porosity and Permeability	76
52-JM-76	Paleontology	77
53-JM-76	Paleontology	79
54-JM-76	Porosity and Permeability	78
55-JM-76	Porosity and Permeability	80
56-JM-76	Porosity and Permeability	53
57-JM-76	Porosity and Permeability	52
58-JM-76	Geochemical	86
59-JM-76	Geochemical	85
60-JM-76	Geochemical	84
61-JM-76	Age Date	83
62-JM-76	Age Date	82
63-JM-76	Age Date	10
64-JM-76	Age Date	9
65-JM-76	Age Date	8
66-JM-76	Age Date	7
67-JM-76	Geochemical	81
68-JM-76	Geochemical	256
John Wills		
1-JCW-76	Porosity and Permeability	244
2-JCW-76	Lithology	245
3-JCW-76	Palynology	246
4-JCW-76	Porosity and Permeability	247
5-JCW-76	Porosity and Permeability	248
6-JCW-76	Porosity and Permeability	249
7-JCW-76	Lithology	250
8-JCW-76	Palynology	251
9-JCW-76	Basin Maturity, Vitrinite Reflectance	252
10-JCW-76	Palynology	253
11-JCW-76	Hydrocarbon	254
12-JCW-76	Palynology	255
13-JCW-76	Hydrocarbon	273
14-JCW-76	Palynology	274
15-JCW-76	Porosity and Permeability	275
16-JCW-76	Porosity and Permeability	276
17-JCW-76	Porosity and Permeability	277
18-JCW-76	Porosity and Permeability	278
19-JCW-76	Porosity and Permeability	279
20-JCW-76	Hydrocarbon	87

Sample Number	Analysis Done	Map Number
21-JCW-76	Paleontology	88
22-JCW-76	Basin Maturity	89
23-JCW-76	Hydrocarbon	90
24-JCW-76	Basin Maturity	91
25-JCW-76	Porosity and Permeability	257
26-JCW-76	Hydrocarbon	258
27-JCW-76	Paleontology	259
28-JCW-76	Basin Maturity	260
29-JCW-76	Porosity and Permeability	241
30-JCW-76	Oriented Sandstone	242
31-JCW-76	Porosity and Permeability	243

APPENDIX H

Petrographic Descriptions of Selected Samples From Stratigraphic Columns and Traverses

TERTIARY ROCKS OF THE WEST FORELAND FORMATION

East Glacier Creek I

104-IP-76. Impure arkose; granule-conglomeratic clayey coarse to very coarse sandstone; igneous rock fragments, holohyaline, some spherulitic and perlitic texture, and hypocrystalline and holocrystalline, felty and pilotaxitic texture, subangular to subrounded; feldspar, primarily intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately sericitized; quartz polycrystalline grains and slight undulatory extinction common, bubble trains in many grains, angular to subangular; metamorphic rock fragments, albite-epidote hornfels facies, subrounded to rounded; brown detrital clay; minor epidote, brown biotite, sphene, magnetite, and apatite. Although some clasts in this rock have been broken in compaction, a potential pore volume of around 10 percent remained after compaction and is occupied by zeolite.

106-IP-76. Impure arkose; clayey medium to coarse sandstone; igneous rock fragments, holohyaline, hypocrystalline, and holocrystalline, some felty and pilotaxitic texture, subangular to subrounded; feldspar, primarily intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately sericitized; quartz, polycrystalline grains and slight undulatory extinction common, angular to subangular; metamorphic rock fragments, albite-epidote hornfels facies, subangular to rounded; brown detrital clay; minor brown biotite both fresh and in various stages of alteration to chlorite, epidote, green hornblende, magnetite, and apatite. Although some clasts in this rock have been broken in compaction, a potential pore volume of about 2 percent remained after compaction and is occupied by zeolite.

East Glacier Creek II

13-JCW-76. Arkose; granule-conglomeratic medium to very coarse sandstone; intermediate plagioclase, albite twinning and zoning common, subhedral grains common, fresh to greatly sericitized; igneous rock fragments, holohyaline, hypocrystalline, and holocrystalline, subrounded to well rounded; hornblende, green and brown; quartz, commonly as inclusions in feldspar but also in angular to subangular clasts, polycrystalline grains and slight undulatory extinction common; minor magnetite, brown biotite, and epidote. Few clasts have been broken in compaction, and a potential initial porosity of 10 to 15 percent has been filled in with zeolite.

16-JCW-76. Arkose; medium to very fine sandstone; feldspar, primarily intermediate plagioclase, albite twinning and zoning common, subangular, some subhedral clasts, fresh to moderately kaolinitized; hornblende, green and brown; quartz, largely in intergrowths with feldspar, some angular to subangular clasts, slight undulatory extinction common; magnetite; minor epidote, carbonate, apatite, sphene, and brown biotite. Few clasts have been broken in compaction, and a potential initial porosity of 15 to 20 percent has been filled in with zeolite.

17-JCW-76. Arkose similar to 16-JCW-76 above except that finer size grades are relatively more abundant so that a potential initial porosity of only about 2 or 3 percent existed prior to infilling with zeolite.

18-JCW-76. Arkose similar to 17-JCW-76 above.

19-JCW-76. Arkose; fine to coarse sandstone; similar to 13-JCW-76 above, except finer grained. This rock is loosely packed, and a potential initial porosity of 10 to 15 percent has been filled in with zeolite.

Shelter Creek

4-JCW-76. Impure arkose; medium to very coarse sandstone; intermediate plagioclase, albite twinning and zoning common, subangular to subrounded, fresh or slightly zeolitized; igneous rock fragments, holohyaline, perlitic texture common, and hypocrystalline and holocrystalline, felty and pilotaxitic textures common, angular to subrounded; quartz, slight undulatory extinction common, angular to subangular; metamorphic rock fragments, albite-epidote hornfels facies. This rock is loosely packed, and a potential initial porosity of about 20 percent has been filled in with zeolite.

5-JCW-76. Arkose; clayey fine to coarse sandstone; igneous rock fragments, hypocrystalline and holocrystalline, felty and pilotaxitic textures common, angular to subrounded; intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately sericitized; quartz, slight undulatory extinction common, angular to subangular; brown biotite, fresh and altered in various degrees to chlorite; metamorphic rock fragments, albite-epidote hornfels facies; magnetite; brown detrital clay; minor green hornblende, epidote, and sphene. Some clasts have been broken in compaction, but the rock is not tightly packed and had a potential initial porosity of about 5 percent which has been filled in with zeolite.

6-JCW-76. Arkose; medium to very coarse sandstone. This rock is similar to 5-JCW-76 above, except it is coarser grained and contains less clay; a potential initial porosity of 10 to 15 percent has been filled in with zeolite.

JURASSIC ROCKS OF CHINITNA AND NAKNEK FORMATIONS

Akumwarvik Bay

67A-WL-76. Arkose; slightly granule-conglomeratic silty, fine to very coarse sandstone; igneous rock fragments, hypocrystalline and holocrystalline, granophyric, felty and pilotaxitic textures common, subangular to subrounded; intermediate plagioclase, albite twinning and zoning common, subrounded to rounded, fresh to greatly sericitized; quartz, polycrystalline grains and slight undulatory extinction common, some clasts display mosaic or lineage structure, angular to subangular; metamorphic rock fragments, largely albite-epidote hornfels facies but some cataclastic types and one fragment of quartzose schist, subrounded; green hornblende; minor brown detrital clay and sphene. This rock is tightly packed, and many clasts have been broken in compaction; a probable initial porosity of about 1 percent has been filled in with zeolite.

67B-WL-76. Impure arkose; silty, fine to very coarse sandstone; igneous rock fragments, hypocrystalline and holocrystalline, felty and pilotaxitic textures common, subangular; feldspar, primarily intermediate plagioclase, albite twinning and zoning common, subangular, fresh to moderately sericitized or kaolinitized; quartz, polycrystalline grains and slight undulatory extinction common, some clasts display mosaic or lineage structure, subangular; metamorphic rock fragments, largely albite-epidote hornfels facies and cataclastic types, subangular to subrounded; chlorite; brown detrital clay; minor muscovite, green hornblende, epidote, chert. This rock is tightly packed, and many clasts have been broken in compaction. A probable initial porosity of about 1 percent has been filled in with zeolite.

71-WL-76. Arkose; very fine to medium sandstone; intermediate plagioclase, albite twinning and zoning common, subangular to subrounded, fresh to moderately kaolinitized; quartz, slight undulatory extinction common, angular to subangular; green hornblende; brown biotite; magnetite; minor muscovite and epidote. Although only a few clasts have been broken in compaction, this rock is tightly packed. A probable initial porosity of about 1 percent has been filled in with zeolite.

72-WL-76. Arkose similar to 71-WL-76 above, except that brown biotite rather than green hornblende is the predominant mafic mineral.

Oil Bay

126-IP-76. Arkose; silty very fine to medium sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to moderately kaolinitized; green hornblende; quartz, slight undulatory extinction common, angular to subangular; minor magnetite, chlorite after biotite, sphene, epidote, and apatite. Although only a few clasts have been broken in compaction, this rock is tightly packed. A probable initial porosity of about 2 percent has been filled in with zeolite.

129-IP-76. Arkose; very fine to coarse sandstone; feldspar, largely intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to moderately kaolinitized; hornblende, green and brown; quartz, slight undulatory extinction common, angular to subangular; magnetite; igneous rock fragments, hypocrystalline and holocrystalline felty texture common; metamorphic rock fragments, albite-epidote hornfels facies; minor calcite, apatite. This rock is tightly packed, and some clasts have been broken in compaction. About 2 percent probable initial pore space has been filled in with zeolite.

131-IP-76. Arkose; fine to coarse sandstone; intermediate plagioclase, albite twinning and zoning common, subangular to subrounded, commonly moderately kaolinitized; igneous rock fragments, largely microcrystalline; hornblende, brown and green; minor brown biotite, fresh and in various stages of alteration to chlorite, clinopyroxene, magnetite, and contact metamorphic rock fragments. This rock is tightly packed with some clasts broken in compaction. A probable initial porosity of about 3 percent has been filled in with zeolite.

132-IP-76, 133-IP-76, 135-IP-76, 136-IP-76, 141-IP-76, 144-IP-76. Arkose; sandstones with various poorly sorted mixtures of very fine to coarse sand size clasts; intermediate plagioclase, albite twinning and zoning common, angular to subangular, some fresh but largely moderately kaolinitized; igneous rock fragments, microcrystalline; hornblende, brown and green; quartz, slight undulatory extinction common, angular to subangular; minor brown biotite, magnetite, cataclastic metamorphic rock fragments, epidote, and sphene. This rock is tightly packed with few clasts broken in compaction. A probable initial pore space of about 2 percent is filled in with zeolite.

143-IP-76. Very fine sandy mudstone; very angular clasts of quartz and fresh intermediate plagioclase along with brown biotite, green hornblende, magnetite, and epidote in a brown detrital clay matrix. The rock is about half clay and half silt and sand.

138-WL-76. Arkose; calcareous very fine to medium sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh; quartz, slight undulatory extinction common, angular to subangular; hornblende, green and brown; magnetite; igneous rock fragments; brown biotite, fresh and altered to various degrees to chlorite; contact metamorphic rock fragments; micritic matrix, locally recrystallized to pseudospar. This rock is tightly packed; few clasts have been broken in compaction, probably because of a cushioning effect by the micritic matrix which makes up about 15 percent of the rock.

143-WL-76. Subarkose; muddy very fine to fine sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to moderately kaolinitized; quartz, slight undulatory extinction common, angular to subangular; hornblende, largely green with minor brown; igneous rock fragments, hypocrystalline and holocrystalline; magnetite; brown biotite, fresh and altered to chlorite to various degrees; contact metamorphic rock fragments; brown detrital clay; minor epidote, apatite, and sphene. This rock is tightly packed.

145-WL-76. Arkose; calcareous muddy, sandy granule conglomerate; igneous rock fragments, hypocrystalline and holocrystalline, commonly porphyritic, subangular to rounded; intermediate plagioclase, albite twinning and zoning common, subangular to subrounded, fresh; quartz, slight undulatory extinction common, generally smaller than plagioclase, subangular to subrounded; cataclastic quartzite fragment; brown calcareous detrital clay; minor hornblende, brown biotite, chlorite, and magnetite. Some clasts in this rock have been broken in compaction despite the presence of about 30 percent calcareous mud matrix. What might otherwise have amounted to about 1 percent porosity in compression-shadows near larger clasts and tears in the matrix has been filled in with zeolite.

146-WL-76. Subarkose; silty very fine to fine sandstone; quartz, slight undulatory extinction common, very angular to subangular; intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to slightly kaolinitized; green hornblende; igneous rock fragments, hypocrystalline and holocrystalline; magnetite; sparry calcite in spaces between some clasts, probably recrystallized micrite; minor brown biotite, chlorite, epidote, and apatite. This is a very tightly packed rock with a few clasts which have been broken in compaction.

147-WL-76. Subarkose as above.

159-WL-76, 160-WL-76. Arkose; fine to coarse sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subrounded, moderately kaolinitized; hornblende, green and brown; igneous rock fragments, hypocrystalline, porphyritic texture common; magnetite; quartz, slight undulatory extinction common, angular to subangular; brown biotite; minor apatite and clinozoisite. These rocks are tightly packed, and many clasts have been broken in compaction. A probable initial porosity of about 3 to 5 percent has been filled in with zeolite.

161-WL-76, 162-WL-76. Arkose; fine to coarse sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to moderately kaolinitized; hornblende, green and brown; quartz, slight undulatory extinction common, clasts generally smaller than those of plagioclase, angular to subangular; magnetite; igneous rock fragments, hypocrystalline and holocrystalline; minor apatite. These rocks are tightly packed, and many clasts have been broken in compaction. A probable initial porosity of 3 to 5 percent has been filled in with zeolite.

Shelter Creek

1-JW-76. Arkose; fine to very coarse sandstone; feldspar, largely intermediate plagioclase, albite twinning and zoning common, angular to subangular, fresh to greatly zeolitized, zeolite does not form rinds on partly zeolitized clasts; quartz, slight undulatory extinction common, angular to subangular; igneous rock fragments, holocrystalline, felty texture common; hornblende, largely green but some brown; magnetite; minor brown biotite, fresh and altered to various degrees to chlorite, epidote, sphene, apatite, cataclastic rock fragments, and sedimentary rock fragments. This rock is tightly packed, and some clasts have been broken in compaction. A probable initial porosity of about 5 percent has been filled in with zeolite.

Snug View Mountain - Bear Creek Ridge

45-JM-76. Arkose; fine to coarse sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately kaolinitized; hornblende, brown and green; quartz, slight undulatory extinction common, generally finer grained than feldspar, very angular to subangular; igneous rock fragments, holohyaline and hypocrystalline; magnetite; minor epidote and apatite. This rock is tightly packed, and some clasts have been broken in compaction. A probable initial porosity of about 2 percent has been filled in with zeolite.

55-JM-76. Arkose; very fine to medium sandstone; feldspar, largely intermediate plagioclase, albite twinning and zoning common, subangular to subrounded, fresh to moderately kaolinitized; quartz, slight undulatory extinction common, generally finer grained than feldspar, angular to subangular; hornblende, brown and green; magnetite; igneous rock fragments, holohyaline and hypocrystalline; brown biotite, fresh and altered to various degrees to chlorite; minor muscovite, apatite, epidote, sphene, and carbonate. Although only a few clasts have been broken in compaction, this rock is tightly packed. A probable initial porosity of less than 1 percent has been filled in with zeolite.

169-IP-76. Arkose; muddy very fine to fine sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately kaolitinized; quartz, slight undulatory extinction common, very angular to subangular; igneous rock fragments, holohyaline and holocrystalline; hornblende, largely green but some brown; brown biotite, fresh and altered to various degrees to chlorite; magnetite; brown detrital clay, which together with silt forms matrix around sand-size grains; minor epidote and apatite. This rock is very tightly packed, and many clasts have been broken in compaction.

177-IP-76. Arkose; very fine to fine sandstone; intermediate plagioclase, albite twinning and zoning common, angular to subrounded, fresh to moderately kaolinitized; quartz, slight undulatory extinction common, very angular to subangular; brown biotite, fresh and altered to various degrees to chlorite; hornblende, green and brown; igneous rock fragments, holocrystalline; magnetite; minor brown detrital clay, epidote, apatite, and sphene. This rock is better sorted than any of the other rocks described, and the elongation of clasts in the rock lies in a single plane and thus imparts an anisotropic fabric to the rock. The rock is tightly packed, and some clasts have been broken in compaction. Micas have been especially broken up in compaction, and the minor brown detrital clay may be finely shredded biotite and chlorite. A very minor probable initial porosity of less than 1 percent has been filled in with zeolite.

APPENDIX I

Palynology Report[1]

94-IP-76

? Alnus (single).

Age: Probably Tertiary
Environment: Nonmarine

The organic residues are all black in color and thus display a very high degree of thermal alteration.

96-IP-76

Barren of palynomorphs.

Age: Indeterminate
Environment: Indeterminate

The organic residues are black as in the above sample.

99-IP-76

Pinus (R), Laevigatosporites sp. (R), Betulaceae (R), Alnus (R).

Age: Tertiary
Environment: Nonmarine

103-IP-76

Undifferentiated bisaccates (R), Lycopodiumsporites sp. (R), Laevigatosporites sp. (R), Deltoidospora spp. (R), Betulaceae (R), Alnus (R), unidentified periporate (single), Pilosisporites versus (single, reworked).

Age: Tertiary (probably Pliocene)
Environment: Nonmarine

3-JW-76

Barren of palynomorphs.

Age: Indeterminate
Environment: Indeterminate

8-JCW-76

Undifferentiated bisaccates (R), Alnus (R).

Age: Tertiary
Environment: Nonmarine

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1 Performed by Anderson, Warren and Associates, consulting micropaleontologists, San Diego, California, August 1976.

10-JCW-76

Not processed.

12-JCW-76

Undifferentiated bisaccates (R), Laevigatosporites sp. (R), Lycopodiumsporites sp. (R), Deltoidospora spp. (R), Chomotriletes fragilis (R).

Age: Cretaceous ?
Environment: Nonmarine

Chomotriletes fragilis is most common in Jurassic and Cretaceous age strata and possibly occurs as young as the Early Tertiary. Considering the assemblage recovered in the sample below, and the presence of C. fragilis here, a Cretaceous age assignment is possible.

No other palynomorphs of time-stratigraphic importance were recovered.

14-JCW-76

Podocarpus (R), Rugubivesiculites sp. (R), R. reductus (R), Osmundacidites wellmani (F), Taurocusporites segmentatus (R), Neoraistrickia truncata (single).

Oligosphaeridium sp. (single), Sirmiodinium grossi ? (single).

Age: Cretaceous (probably Albian)
Environment: Probably Nonmarine

The land-derived palynomorphs indicate a probable Albian age. Two dinoflagellate species, apparently reworked from Neocomian sediments, were also observed.

APPENDIX J

Geochemical Analyses

Forty-five stream sediment samples were analyzed for gold, silver, copper, lead, zinc, molybdenum, tin, uranium, and thorium. These results are included but not analyzed.

Sample Number	Gold	Silver	Copper	Lead	Zinc	Molybdenum	Tin	Uranium	Thorium
112-WL-76	0.11	0.0	28	19	108	3	0	1.3	5.75
164-WL-76	0.10	0.0	30	12	110	4	0	0.5	1.30
169-WL-76	0.04	0.0	16	6	24	0	0	0.5	1.00
186-WL-76	0.07	0.0	38	18	80	1	0	1.1	5.00
190-WL-76	0.10	0.0	44	12	82	0	0	0.9	2.50
58-JM-76	0.10	0.0	46	20	204	1	0	0.2	3.00
59-JM-76	0.08	0.0	34	12	72	1	0	0.4	1.25
60-JM-76	0.08	0.0	51	17	88	0	0	0.5	1.25
67-JM-76	0.05	0.0	58	14	64	2	0	2.4	1.50
68-JM-76	0.05	0.0	52	12	31	0	0	0.5	1.25
107A-IP-76	0.16	0.0	55	19	190	1	0	0.4	2.75
145-IP-76	0.09	0.0	32	29	169	3	0	0.7	1.00
146-IP-76	0.05	0.0	60	13	142	2	0	0.5	0.25
147-IP-76	0.07	0.0	41	13	183	0	0	0.5	3.75
148-IP-76	0.16	0.0	34	14	61	0	0	1.2	1.25
149-IP-76	0.04	0.0	26	10	29	1	0	0.6	0.50
150-IP-76	0.16	0.0	56	14	41	1	0	0.4	2.25
151-IP-76	0.10	0.0	37	11	22	0	0	1.1	4.75
152-IP-76	0.17	0.0	49	17	21	1	0	4.6	8.00
153-IP-76	0.07	0.0	33	9	18	0	0	0.7	1.75
154-IP-76	0.05	0.0	21	11	30	1	0	1.1	1.50
155-IP-76	0.03	0.0	34	7	31	0	0	1.4	2.00
156-IP-76	0.03	0.0	22	7	22	0	0	1.9	1.25
157-IP-76	0.14	0.0	88	11	46	1	0	2.0	1.00
158-IP-76	0.09	0.0	55	11	26	0	0	0.6	1.50
159-IP-76	0.06	0.0	27	17	69	1	0	0.6	2.00
160-IP-76	0.03	0.0	26	10	35	0	0	2.2	0.50
161-IP-76	0.08	0.0	74	16	38	0	0	0.7	4.00
163-IP-76	0.04	0.0	34	14	41	0	0	0.6	0.50
164-IP-76	0.04	0.0	21	12	57	0	0	1.1	3.00
165-IP-76	0.03	0.0	23	10	55	0	0	1.1	2.00
167-IP-76	0.06	0.0	23	15	72	0	0	0.4	0.75
184-IP-76	0.08	0.0	18	25	32	0	0	0.5	0.00
185-IP-76	0.15	0.0	31	13	31	0	0	0.2	1.00
186-IP-76	0.05	0.0	38	17	41	3	0	0.4	0.50
187-IP-76	0.09	0.0	42	16	39	1	0	0.5	0.25
188-IP-76	0.04	0.0	33	11	26	0	0	0.4	1.00
189-IP-76	0.11	0.0	63	13	53	2	0	0.5	0.25
190-IP-76	0.13	0.0	56	18	84	0	0	0.6	1.25
191-IP-76	0.13	0.0	24	15	43	1	0	0.8	2.00
192-IP-76	0.07	0.0	39	14	40	0	0	0.6	1.00
193-IP-76	0.11	0.0	34	13	41	0	0	0.2	1.50
194-IP-76	0.09	0.0	23	22	64	2	0	0.6	2.75
196-IP-76	0.06	0.0	20	17	62	0	0	0.2	2.25
197-IP-76	0.13	0.0	26	19	70	1	7		3.25