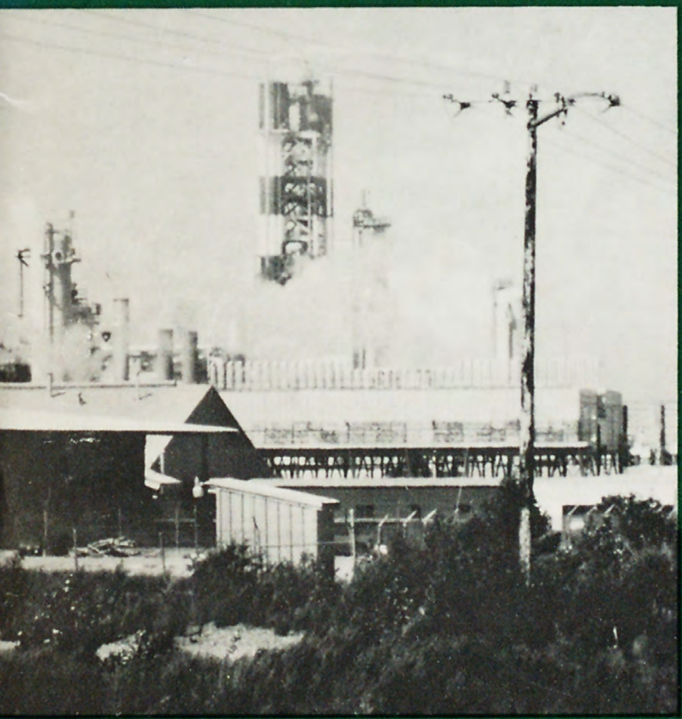
Outer Continental Shelf Oil and Gas Information Program

Gulf of Alaska and Lower Cook Inlet Summary Report 3



Prepared for the U.S. Department of the Interior, Minerals Management Service, in cooperation with the U.S. Geological Survey

U.S. Geological Survey Open-File Report 82-20

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PUBLICATION STATUS OF OCSIP DOCUMENTS

Type of Document	Initial	Updates			Revisions		
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Mid-Atlantic	11/79	6/80	2/81	9/81	10/82		
South Atlantic	7/80	2/81	9/81		7/82		
Gulf of Alaska	9/80				8/81	8/82	
Gulf of Mexico	9/80				12/81	9/82	
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Outer Continental Shelf Oil and Gas Information Program

Gulf of Alaska and Lower Cook Inlet Summary Report 3

June 1982

Second revision of Outer Continental Shelf Oil and Gas Activities in the Gulf of Alaska (including Lower Cook Inlet) and their Onshore Impacts: A Summary Report, September 1980

By Joanne Barnes Jackson and
Frederick N. Kurz

Prepared for the U.S. Department of the Interior,
Minerals Management Service, in cooperation with
the U.S. Geological Survey
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U.S. Geological Survey Open-File Report 82-20

Note to Readers

On January 19, 1982, Secretary of the Interior James G. Watt issued Secretarial Order No. 3071 establishing a Minerals Management Board and a Minerals Management Service (MMS) that would be under the supervision of the Under Secretary. On May 10, 1982, Secretary Watt signed an amendment to Secretarial Order No. 3071. In accordance with the amended order, the Minerals Management Board will continue to be chaired by the Under Secretary, with other members of the Board being the Assistant Secretaries for Energy and Minerals, Land and Water Resources, Indian Affairs, and Policy, Budget, and Administration. The Board will supervise and oversee MMS operations.

The Minerals Management Service will implement new policy and guidance procedures developed by the Minerals Management Board and will be responsible for exercising the following:

- All functions carried out previously by the former Conservation Division of the U.S. Geological Survey (USGS);

- Outer Continental Shelf Program support activities, including functions of the Office of OCS Program Coordination; all functions related to the management of offshore energy and minerals administered by the Bureau of Land Management (BLM); all functions that support the OCS program in the Geologic Division and the Office of the Assistant Director for Resource Programs of the U.S. Geological Survey; oil spill trajectory analysis functions of the Office of Earth Science Applications, U.S. Geological Survey; all functions of the Office of Policy Analysis relating to scheduling the sale of leases of OCS lands; and all functions relating to the OCS program transferred from the Department of Energy.

Until further notice, the Minerals Management Service will continue to use administrative support services provided by the U.S. Geological Survey and the Bureau of Land Management, and the Office of OCS Information will continue to use the USGS open-file report numbering system for summary reports and indexes. References to the U.S. Geological Survey and the Bureau of Land Management remain in this document. Future Office of OCS Information publications will report changes in organization as they occur.

Acknowledgments

A number of people have provided information and insights to the authors. All of them deserve special thanks. Art Monson of the City of Yakutat; Lynn Fried of the City of Kodiak; Gretchen Keiser and Tom Lawson of the Office of the Governor, State of Alaska; Lonnie C. Smith and Blair E. Wondzell of Alaska Oil and Gas Conservation Commission, State of Alaska; Phyllis Casey of the Bureau of Land Management (BLM) Outer Continental Shelf Office, Anchorage; Paul Lowry and Kyle Monkelien of the Minerals Management Service (MMS), Anchorage; Ray Beittel of MMS, Reston, Virginia; L.B. Magoon of MMS, Menlo Park, California; and Bob Fahrenbruch of ARCO Exploration were especially generous.

The Field Draft Review Committee helped improve the report in a number of ways. Its members were Paul Lowry and Joe Jones of MMS Anchorage; Phyllis Casey of BLM's Alaska OCS Office; Bob Beauchamp and Mona Schermerhorn of BLM, Washington, D.C.; and Keith Meekins, Branch of Resource Evaluation, Ray Beittel, Branch of Environmental Management, Bruce Weetman, Branch of Resource Evaluation, Hank Porterfield, Branch of Information Management, and Doug Slitor and Mary Davis of the Office of OCS Information, MMS, Reston, Virginia.

At Rogers, Golden & Halpern, Fritts Golden provided overall project direction. Sandy Dechert designed the report, and Richard Barrett edited the report and supervised its production. Laurie Seniuk, Gene Gilroy, Kim Tomlinson, and Joan McCusker executed the graphics. Liz Porter compiled appendix B. Valerie Smith, Sue McGuire, Sam Karen Norgard, and Matthew McClain provided editorial, graphics, and technical support.

English-Metric Conversion

(The following table gives the factors used to convert English units to metric units.)

Multiply English units	by	to obtain metric units
feet	0.3048	meters
statute miles	1.6093	kilometers
nautical (geographic) miles	1.8530	kilometers
acres	0.4047	hectares
barrels (U.S. petroleum)	0.1589	cubic meters
cubic feet	0.0283	cubic meters
short tons	0.9071	metric tons

Acronyms and Abbreviations

AEIDC - Arctic Environmental Information and Data Center
ANCSA - Alaska Native Claims Settlement Act of 1971
BLM - Bureau of Land Management, DOI
CFR - Code of Federal Regulations
COST - Continental Offshore Stratigraphic Test
DEIS - draft environmental impact statement
DMM - Deputy Minerals Manager
DOI - Department of the Interior
EIS - environmental impact statement
EPA - Environmental Protection Agency
IPP - Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities, BLM
km2 - square kilometers
LNG - liquefied natural gas
m2 - square meters
m3 - cubic meters
MMS - Minerals Management Service, DOI
NEPA - National Environmental Policy Act of 1969
NOAA - National Oceanic and Atmospheric Administration
NPDES - National Pollutant Discharge Elimination System
NTIS - National Technical Information Service
OCS - Outer Continental Shelf
OCSEAP - Outer Continental Shelf Environmental Assessment Program
RTWG - Regional Technical Working Group, BLM
U.S.C. - United States Code
USGS - U.S. Geological Survey, DOI

Abstract

Five Outer Continental Shelf (OCS) lease sales have been held in the Gulf of Alaska subregion of Alaska. Lease Sale 39, in the northern Gulf of Alaska, was held on April 13, 1976, and it resulted in the leasing of 76 tracts. Lease Sale CI, held on October 27, 1977, resulted in the leasing of 87 tracts in Lower Cook Inlet. Lease Sale 55 in the eastern Gulf of Alaska, held on October 21, 1980, leased 35 tracts. The first Reoffering Sale (RS-1), held on June 30, 1981, resulted in the leasing of one tract in the eastern Gulf of Alaska. Lease Sale 60, the most recent sale in the subregion, was held on September 29, 1981. It resulted in the leasing of 13 tracts in the Lower Cook Inlet and the Shelikof Strait. Exploratory drilling has been conducted on tracts leased in Lease Sales 39 and CI. No commercial discoveries were made, and no further exploratory drilling is anticipated on tracts leased in either sale. ARCO has plans to explore a tract leased in Lease Sale 55 in January 1983. Chevron has conducted geohazard studies on tracts leased in Lease Sale 60. The results of these studies will determine if exploratory wells will be drilled. Exploratory drilling, if it does take place, is not anticipated before the summer of 1983.

In March 1982, the Department of the Interior prepared new resource estimates for the Gulf of Alaska subregion. The risked mean resource estimates for tracts leased in Lease Sale 55 and Lease Sale RS-1 are 12.1 million barrels of oil and 46.2 billion cubic feet of gas. The risked mean resource estimates for tracts leased in Lease Sale 60 are 5.6 million barrels of oil and 5 billion cubic feet of gas.

The onshore impacts from previous OCS exploration in the Gulf of Alaska and the Lower Cook Inlet were minimal. Yakutat will be used to support exploratory drilling on any Lease Sale 55 or Lease Sale RS-1 tracts. If exploratory drilling takes place on Lease Sale 60 tracts, support facilities are expected to be located in Kenai or on Kodiak Island.

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Introduction

This report is the second in a series of revisions to the Gulf of Alaska and Lower Cook Inlet Summary Report. The first report in this series, **Outer Continental Shelf Oil and Gas Activities in the Gulf of Alaska and their Onshore Impacts** (USGS Open-File Report 80-1028) was published in September 1980. The second report, **Gulf of Alaska and Lower Cook Inlet Summary Report 2** (USGS Open-File Report 81-607) was published in June 1981. This report may be used in conjunction with the earlier reports, which provided baseline information on oil- and gas-related activities in the Gulf of Alaska subregion. An effort has been made to not duplicate material presented in the previous report unless the inclusion of such information is necessary to understand current events. These summary reports are designed to assist State and local planners and other officials in the Gulf of Alaska subregion in planning for the onshore effects of Outer Continental Shelf (OCS) oil-and gas-related development. This is achieved by describing the activity that has occurred recently and by discussing the activity that is planned to take place during the next year. The information presented in the summary report is a synthesis of data collected from Federal agencies, OCS-related studies, and discussions among the staff of the Office of OCS Information, Federal, State, and local officials, and others.

THE MINERALS MANAGEMENT SERVICE

In January 1982, Secretary of the Interior James Watt issued Secretarial Order No. 3071, which changed the name of the U.S. Geological Survey's Conservation Division to the Minerals Management Service (MMS) and placed the Minerals Management Service under the supervision of a Minerals Management Board headed by Under Secretary Donald Hodel. Because the Outer Continental Shelf Information Program had been a part of the Conservation Division, it, too, became a part of the Minerals Management Service. This reorganization will not change the Outer Continental Shelf Information Program functions or its reports.

On May 10, 1982, Secretary Watt signed an amendment to Secretarial Order No. 3071. In accordance with the amended order, the Minerals Management Board will continue to be chaired by the Under Secretary, with other members of the Board being the Assistant Secretaries for Energy and Minerals, Land and Water Resources, Indian Affairs, and Policy, Budget, and Administration. The Board will supervise and oversee MMS operations.

The need for planning to accommodate the impacts of oil- and gas-related development has long been recognized. State and local governments need current information to make these plans. In response to the requests about offshore resources and related onshore activity, section 26 of the Outer Continental Shelf Lands Act Amendments of 1978 (43 U.S.C. 1352) created an Outer Continental Shelf Oil and Gas Information Program, which is now managed by the Office of Outer Continental Shelf Information (OCSI), Minerals Management Service (MMS). Authorities and operating procedures are detailed in the Code of Federal Regulations (30 CFR 252), published in the Federal Register on August 7, 1979. Under this program, regional summary reports of data and information are made available to affected States to assist them in planning for the onshore impacts of potential OCS oil- and gas-related development and production. This program has also prepared indexes of information used by the Federal Government in its OCS decision-making process.

THE ALASKA OCS

The Alaska OCS comprises 74 percent of the total area of U.S. offshore lands. This is due to the State's 6,640-mile (10,686-km) coastline (Jamison, 1981, oral commun.) and the great width of the Continental Margin off Alaska. Because of the size of Alaska's OCS and the number of lease sales scheduled for the State, the Office of OCS Information prepares separate reports for three subregions. The Gulf of Alaska, including Lower Cook Inlet, constitutes one subregion; the Arctic, which includes the Beaufort (Diapir Field) and Chukchi (Barrow Arch) Seas, constitutes another subregion; and the Bering Sea makes up the third subregion. As stated above, this is the third summary report for the Gulf of Alaska subregion. A summary report and an update have been issued for the Arctic subregion, and a summary report will be issued for the Bering Sea subregion after the first OCS sale is held in that subregion. A map of these subregions and the Bureau of Land Management's proposed planning regions for the State is presented in figure 1.

THE GULF OF ALASKA SUBREGION

The Gulf of Alaska subregion has a long history of oil- and gas-related activity. There were reports of petroleum in the Cook Inlet area as early as 1853. By 1892, claims were being staked, and it is believed that the first drilling occurred in 1898 (Barry, 1973). The first commercial discovery was made in the Gulf of Alaska upland area near Katalla in 1902. Production in this area continued until 1933 when the small refinery was destroyed by fire. In 1957, another commercial discovery was made on the Kenai Peninsula, in the Swanson River area, by the Richfield Oil Corporation. In 1962, the Pan American Petroleum Corporation discovered oil in State waters in Upper Cook Inlet, and by 1969, four refineries had been built at Nikiski, just north of Kenai. Currently, there are 14 platforms producing oil and gas from State-leased areas in Upper Cook Inlet. Exploration of State leases continues. A map of the fields and facilities in the Cook Inlet area is presented in figure 2.

New planning areas have been proposed by the Department of the Interior for the State of Alaska that reflect geologic basins more accurately than do the previous boundaries (Carlton, 1981, oral commun.). The names of several of the planning areas have been changed. The four planning areas in the Gulf of Alaska subregion are Gulf of Alaska, Kodiak, Cook Inlet, and Shumagin.

HISTORY OF OCS LEASING IN ALASKA

Six Alaska Outer Continental Shelf lease sales have been held. Figure 3 shows the locations of these sales. Five of these have been in the Gulf of Alaska subregion. Lease Sale 39 offered 189 tracts in the northern Gulf of Alaska. It was held in Anchorage on April 13, 1976, and 76 tracts were leased. Exploratory drilling of these tracts began in September 1976. The second sale--Lease Sale CI--offered 135 tracts. This lease sale was held in Anchorage on October 27, 1977, and resulted in the leasing of 87 tracts. The third lease sale in the subregion, Lease Sale 55 in the Gulf of Alaska, south and east of Lease Sale 39, was held on October 21, 1980, in Anchorage. Bids were accepted on 35 of the 210 tracts offered.

The fourth sale held in Alaska was the Joint Federal/State Beaufort Sea Oil and Gas Lease Sale (Sale BF). This sale was conducted in Fairbanks on December 11, 1979. Because of litigation, bids on the Federal tracts were not accepted until July 10, 1980. An Arctic summary report that covered the Joint Sale was published in October 1981 (USGS Open-File Report 81-621). An update to the Arctic Report will be published in May 1982.

The fifth OCS lease sale held in Alaska, Reoffering Sale RS-1, was held on June 30, 1981. It offered 175 tracts in the Gulf of Alaska, 173 of which were offered but not bid on in Lease Sale 55. The other two tracts were bid upon in Lease Sale 55, but the bids were rejected for insufficiency. Only one tract was leased in Reoffering Sale RS-1. Lease Sale 60, the sixth OCS sale in Alaska, was held on September 29, 1981, in Anchorage. This sale offered 153 tracts in the Lower Cook Inlet and the Shelikof Strait; 13 tracts were leased.

FIGURE 1.--Gulf of Alaska, Bering Sea, and Arctic subregions and planning areas. (Adapted from Collins and Stadnychenko, 1981, and DOI, 1982a, by Rogers, Golden & Halpern, 1982.)

Two other lease sales in the Gulf of Alaska subregion were scheduled but not held. These sales were Lease Sale 46 and Lease Sale 61. A draft environmental impact statement (DEIS) was published for Lease Sale 46 in April 1977. This sale was originally scheduled for July 1980 and was to offer tracts south of Kodiak Island. Shortly after publication, a change in the leasing schedule changed the sale date to December 1968. A second DEIS was published in December 1979. Public hearings were conducted in Kodiak in March 1980. However, in March 1980, Lease Sale 46 was canceled because of the low resource potential and interest in exploration and concerns expressed by the residents and officials of the Kodiak area. Another lease sale--Lease Sale 61--was scheduled to be held in April 1983. This sale was also to offer tracts south of Kodiak Island, and it encompassed about the same area of call as the canceled Lease Sale 46. However, this sale was deleted from the April 1981 draft proposed 5-year OCS oil and gas leasing schedule. All pre-lease-sale activities for this sale have been terminated.

COOK INLET LITIGATION

Leasing of the OCS in the Cook Inlet has been the subject of controversy and litigation. In 1967, the Federal Government brought suit against the State of Alaska when the State prepared to permit oil and gas exploration and development in portions of Lower Cook Inlet. The United States Government claimed that the lower portion of the Inlet constituted high seas. This dispute was resolved by the U.S.

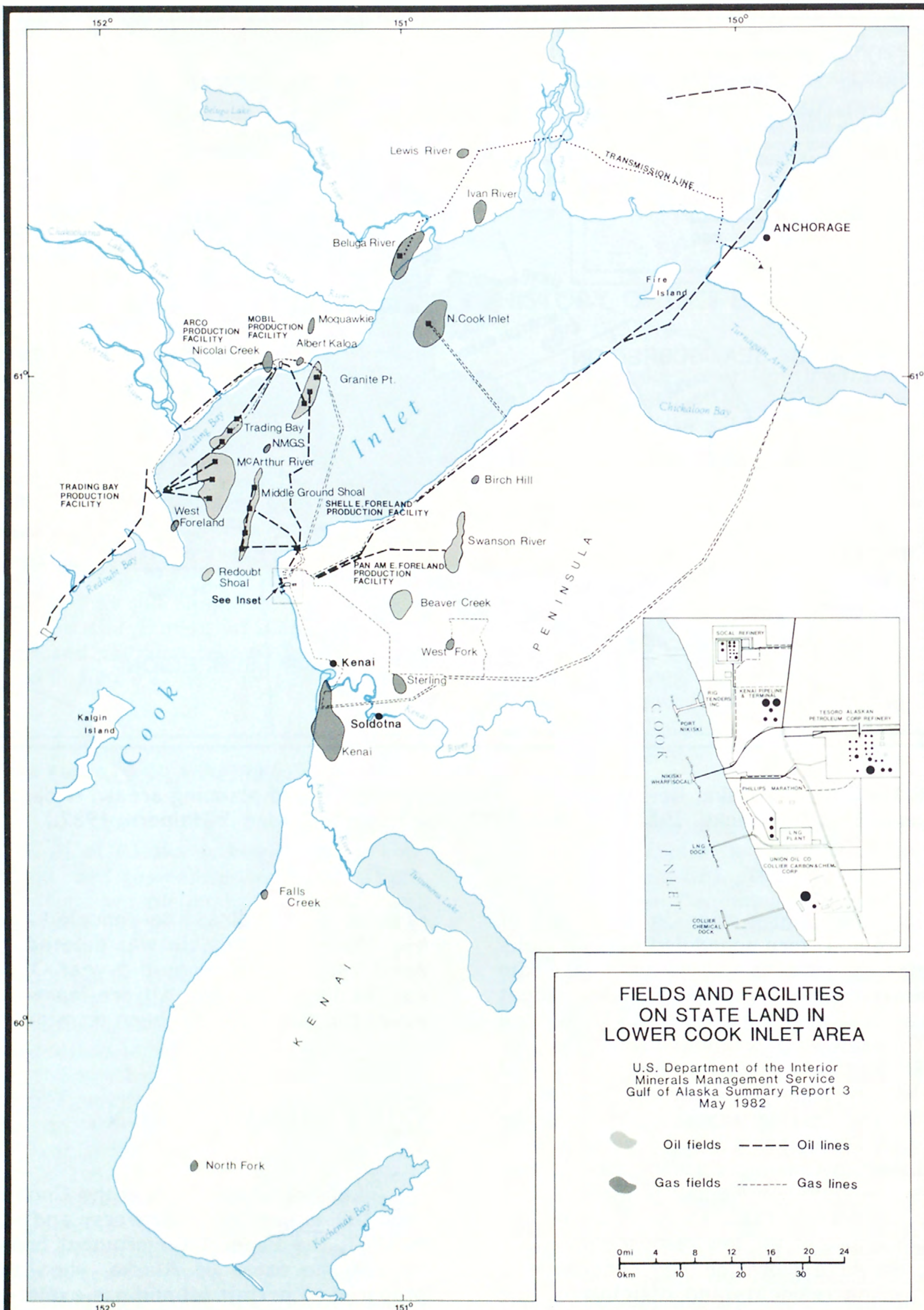

FIGURE 2.--Location of fields and facilities on State land in the Cook Inlet area. (Redrafted from Alaska Oil and Gas Conservation Commission, 1980, by Rogers, Golden & Halpern, 1982).

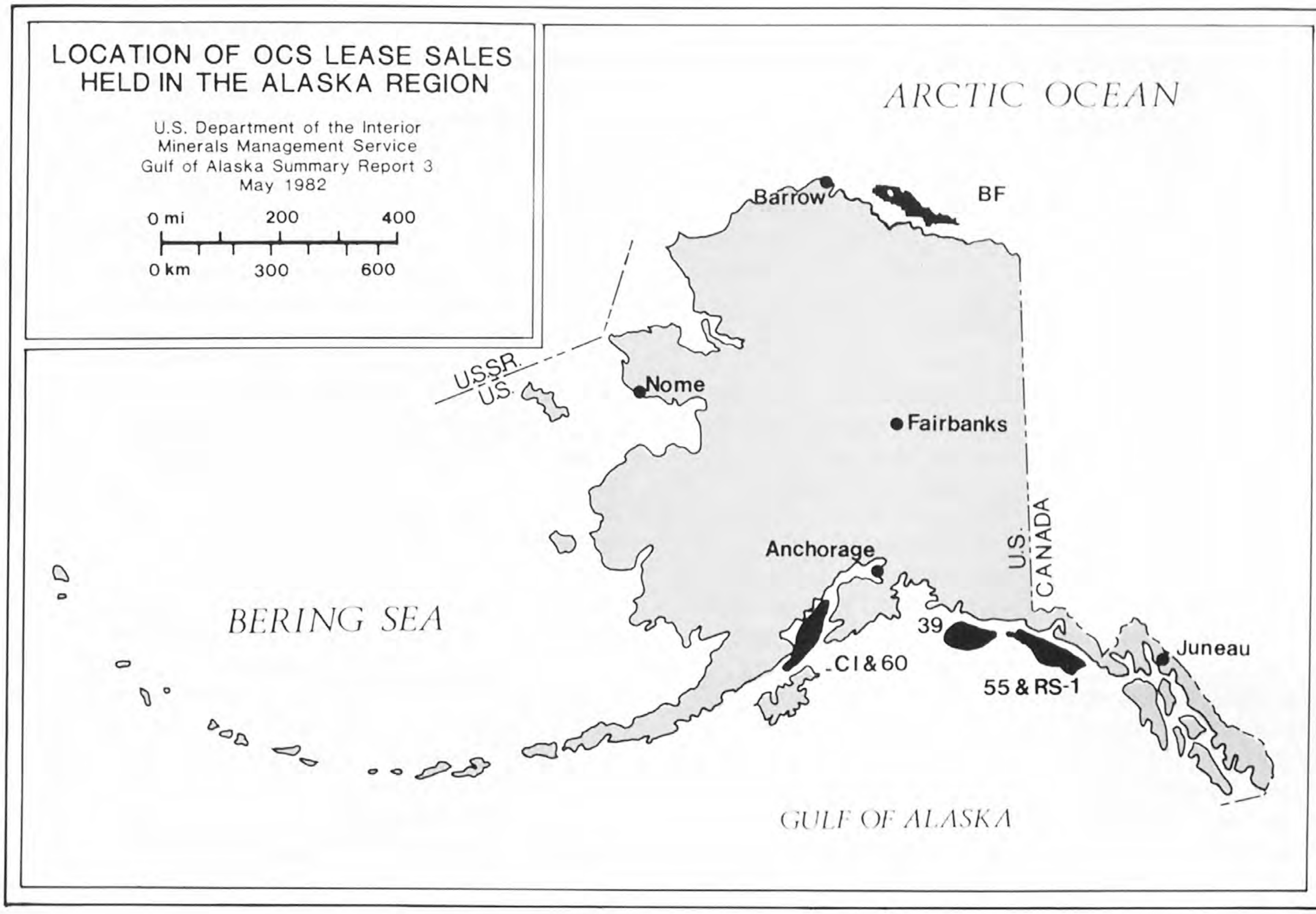

FIGURE 3.--Location of OCS lease sales held in the Alaska Region. (Redrafted from Collins and Stadnychenko, 1981, and Jackson and others, 1981, by Rogers, Golden & Halpern, 1982.)

Supreme Court in June 1975 (**United States** v. **State of Alaska,** A-45-67, 422 U.S. 184), in which the court ruled that the State had insufficient evidence to establish Cook Inlet as a historic bay and that the Federal Government had paramount rights to the submerged land in the lower, or seaward, portion of Cook Inlet.

A second legal dispute occurred in 1977 when the English Bay Village Corporation, a Native village corporation that was established as a result of the Alaska Native Claims Settlement Act (ANCSA), filed suit against the Secretary of the Interior, alleging that the final environmental impact statement (EIS) for the proposed Lease Sale CI did not meet the requirements of National Environmental Policy Act of 1969 (NEPA) (**English Bay Village Corp, et al.,** v. **Secretary of the Interior, et al.,** Civil No. 77-174). The Village Corporation claimed the EIS did not adequately discuss potential impacts to the English Bay community and failed to address the long-term impacts of onshore support facilities on Lower Cook Inlet fisheries. As a result of this suit, the Secretary of the Interior postponed the sale from February 1977 to October 1977 to study the Corporation's claim. The lease sale was held without a final decision on the case.

After the sale, a settlement was entered for amicable resolution of the suit and the case was dismissed in March 1978, subject to compliance by the Department of the Interior with the settlement agreement. As a result of the settlement agreement, the Bureau of Land Management was required to hold a public hearing in English Bay Village on the first development phase environmental impact statement prepared for tracts leased in Lease Sale CI. The settlement also required the Fish and Wildlife Service to develop a study on the possible toxicity of the drilling muds on biota in the Lower Cook Inlet and required the U.S. Geological Survey to issue notices of the receipt of development plans for Lower Cook Inlet in the Federal Register. Additionally, the Department of the Interior was required by the settlement to use "the best available and safest technology" that is economically achievable, without regard to the economic condition of the lessees (**English Bay Village Corp., et al.**, v. **Secretary of the Interior, et al.**, settlement agreement, 1978).

OCS LEASING SCHEDULE

Section 18 of the OCS Lands Act as amended states that the Secretary of the Interior shall annually review and periodically revise the OCS oil and gas leasing program.

On October 6, 1981, a three-judge Court of Appeals in Washington, D.C., unanimously ruled on the **State of California** v. **Andrus** (80-1894) that the current June 1980 leasing schedule did not meet all the requirements of the OCS Lands Act, as amended. The ruling stated that the June 1980 leasing schedule failed to (1) identify offshore California Lease Sales 78 and 80 "with greater specificity," (2) "consider the need" enumerated in sections 18(a)(2)(B) and (G) to share benefits and risks of the plan among all OCS regions, (3) consider the relative environmental sensitivity of different OCS areas, and (4) "strike a proper balance" required in section 18(a)(3) between environmental factors and economic factors. The court also stated that the proposed leasing schedule, which would be submitted by Department of the Interior Secretary Watt to Congress for approval, would be prepared in accordance with the ruling and that until the proposed leasing schedule is approved, the June 1980 schedule must be followed.

On January 19, 1982, the appeals court approved a timetable for submission of the proposed leasing schedule. Under this timetable, the Department of the Interior was to announce a tentative proposed final leasing schedule on or about March 15, 1982, which would be based on consideration of all factors in sections 18(a)2 and (a)3 of the OCS Lands Act. The Department of the Interior was to show that new data had been considered as well as the analysis method of incorporating the new data in the development of the proposed leasing schedule.

A final supplement to the final environmental impact statement was published in March 1982. Notice of its availability was published in the Federal Register, vol. 47, no. 45, March 8, 1982. On March 15, 1982, a news release was issued by the Office of the Secretary of the Department of the Interior announcing a tentative proposed 5-year OCS oil and gas leasing program (DOI, 1982a). It was submitted for comments to Congress, the U.S. Attorney General, and to Governors of affected coastal States, and it was published for public comment in the Federal Register, vol. 47, no. 54, March 19, 1982. Comments and recommendations were due by April 19, 1982. A proposed final program along with the comments and recommendations received was submitted to the President and Congress on May 7, 1982, and it is expected that the final program will be approved in July.

Sixteen lease sales in the Alaska region are proposed in the May 1982 proposed final 5-year OCS leasing schedule. Two sales, Lease Sale 71 in the Diapir Field (Beaufort Sea) and Lease Sale 57 in the Norton Basin, are scheduled to be held in 1982. One sale is scheduled for 1983--Lease Sale 70 in the St. George Basin. The Department of the Interior will consult with the Alaska Land Use Council following issuance of the proposed notice of sale for Lease Sale 70. Four sales are scheduled for 1984: Lease Sale 83 in Navarin Basin, Lease Sale 87 in Diapir Field (Beaufort Sea), Lease Sale 88 in the Gulf of Alaska and Cook Inlet, and Lease Sale 89 in St. George Basin. In 1985, three lease sales are scheduled: Lease Sale 85 in Barrow Arch (Chukchi Sea), Lease Sale 92 in the North Aleutian Basin, and Lease Sale 100 in Norton Basin. Four lease sales are proposed for 1986: Lease Sale 107 in the Navarin Basin, Lease Sale 97 in the Diapir Field (Beaufort Sea), Lease Sale 99 in Kodiak, and Lease Sale 101 in the St. George Basin. Two lease sales are scheduled for 1987: Lease

The revenues produced by OCS lease sales currently go to the U.S. Department of the Treasury. These revenues are also used to fund the Land and Water Conservation Fund. Between 1965 and mid-1981, $22,567,028 was used to fund various projects in Alaska. Ninety percent of this money comes from OCS revenues (Seacourt, 1981, oral commun.). OCS revenue sharing legislation is currently being considered by Congress. The House subcommittee on oceanography approved OCS revenue sharing legislation on February 25, 1982. A similar bill was introduced into the Senate by Senator George J. Mitchell on February 23, 1980.

Sale 109 in the Barrow Arch (Chukchi Sea) and Lease Sale 86 in Shumagin. Figure 4 shows the lease sales scheduled for the Alaska region in the May 1982 proposed final 5-year OCS leasing program. Figure 5 shows the locations of the scheduled sales.

On April 1, 1982, the Department of the Interior announced the reoffering of approximately 3.2 million acres (1,294,720 hectares) on the Outer Continental Shelf. This lease sale is identified as Reoffering Sale RS-2, and it is tentatively scheduled for July 1982. In this lease sale, 564 tracts offshore the South and Mid-Atlantic States, California, and Alaska will be offered. The 140 tracts that will be offered in Alaska are in the Cook Inlet and Shelikof Strait; they are tracts that were offered but not leased in Lease Sale 60.

ORGANIZATION OF THIS REPORT

This Gulf of Alaska Summary Report is designed to assist State and local officials in planning for future OCS activity. The report contains descriptions of the OCS-related activity that has occurred since the publication of the last summary report and projects foreseeable activity in the subregion. The Office of OCS Information staff is available to consult with State agencies if additional information or clarification is desired (telephone: (703) 860-7166).

Each summary report produced by the Office of OCS Information begins with a chapter presenting the most recent OCS oil and gas resource and reserve estimates. The magnitude and timing of OCS activity are discussed in chapter 2. Chapter 3 presents information on oil and gas transportation strategies, including those that are developed as part of the BLM's ongoing Intergovernmental Planning Program (IPP). Chapter 4 describes the nearshore and onshore activities that may result from projected offshore activity for each of the lease sales. Because of the distinctive nature of the two lease sale areas described in this report, chapters 1, 2, and 4 present general material followed by information specific to each lease sale area. Appendixes provide further detail, and a glossary presents definitions of geologic, industry-specific, and other terms used in the report.

Resource and reserve estimates presented in this summary report reflect the most recent Federal Government information. Other information contained in this report is based in part on data collected by Federal agencies in the course of planning, leasing, and managing the Gulf of Alaska OCS, as well as information on OCS activities that was prepared outside the Federal Government. In the course of preparing this report, interviews were conducted with Federal officials, oil industry representatives, and State and local officials. Concerns voiced in these interviews and those already identified in published documents resulted in the identification of issues that are presented in this summary report.

A continuing concern of State and local officials in the Gulf of Alaska subregion is the nature and magnitude of onshore facilities that may be located in or otherwise affect their communities as a result of offshore development. Central to this concern is whether or not the Gulf of Alaska and Lower Cook Inlet OCS have oil and gas in commercial quantities. This summary report presents a background for discussion of this issue by

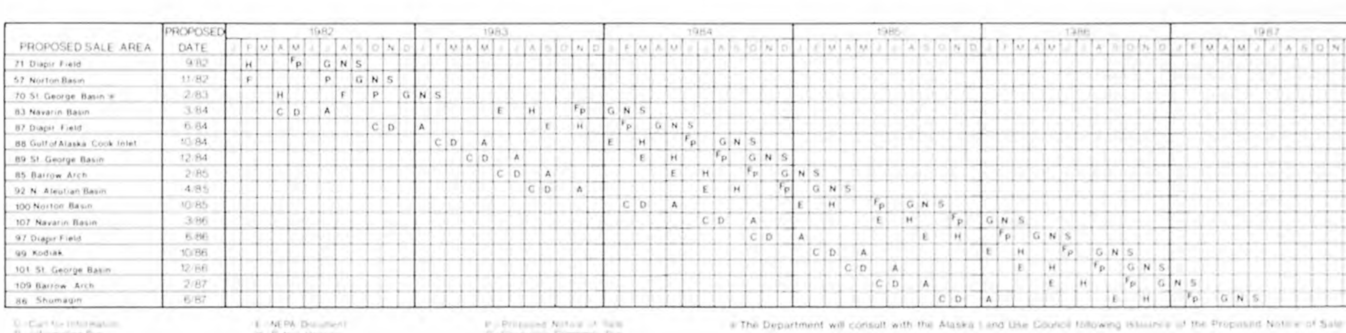

FIGURE 4.—May 1982 proposed final 5-year OCS leasing schedule. (Redrafted from DOI, 1982b, by Rogers, Golden & Halpern, 1982.)

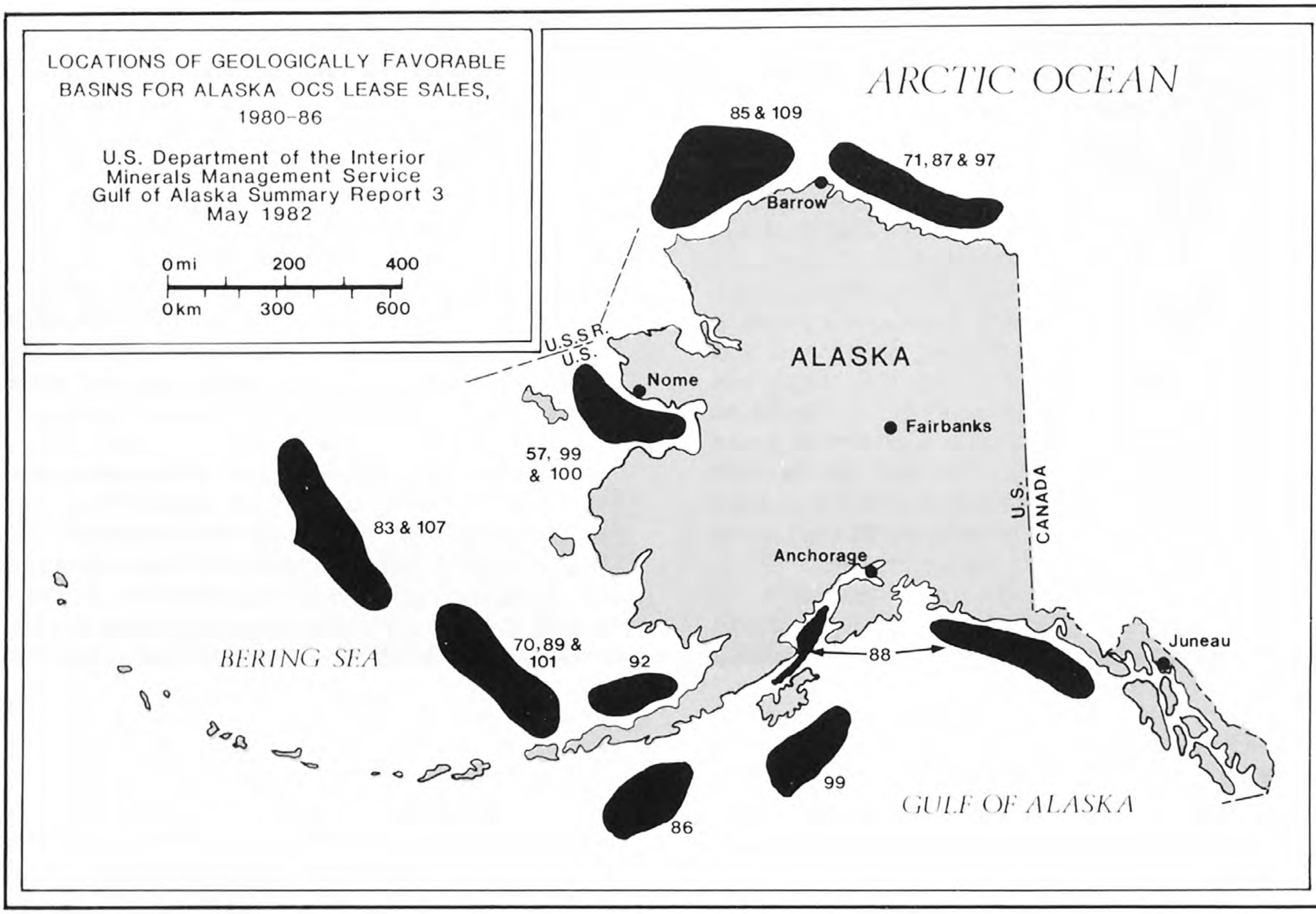

FIGURE 5.—General areas of proposed lease sales in the proposed final 5-year OCS leasing program. (Adapted from Collins and Stadnychenko, 1981, by Rogers, Golden & Halpern, 1982.)

explaining what resource estimates mean, how they are derived, what they can be used for, and how the process of estimating resources relates to the process of exploring for oil and gas. This explanation of the nature of resource estimates provides a basis for understanding some of the uncertainties concerning the OCS-related activity in the Gulf of Alaska and Lower Cook Inlet.

As exploration of the Outer Continental Shelf in the Gulf of Alaska and Lower Cook Inlet continues, knowledge of the subregion's resource potential will improve. In the event of either a discovery of oil or gas in commercial amounts or another lease sale, a new summary report will be prepared. This report will include the most recent resource and reserve estimates, anticipated production curves, transportation strategies, and descriptions of existing and anticipated nearshore and onshore support activity and production facilities.

1. Offshore Oil and Gas Resources of the Gulf of Alaska

Offshore oil and gas resources within a region result from the region's geologic history and structure. This chapter discusses the petroleum geology of the Outer Continental Shelf (OCS) in the Gulf of Alaska subregion. The first section of the chapter provides a geologic overview. The next section summarizes geologic features affecting petroleum exploration and development in the northern Gulf of Alaska. The geology of this area was presented in more detail in previous summary reports for this subregion (USGS Open-File Reports 80-1028 and 81-607). The third section focuses on the geology of the Lower Cook Inlet-Shelikof Strait. The fourth section of the chapter provides a discussion of the various procedures used by the Federal Government to estimate hydrocarbon potential. The most recent oil and gas resource and reserve estimates for the Gulf of Alaska subregion are provided in the final section of the chapter. A more detailed discussion of the Gulf of Alaska subregion geology is presented in appendix A.

OVERVIEW OF THE GEOLOGY OF THE SUBREGION

The Gulf of Alaska subregion is contained within two geologic provinces: the Pacific-Margin Tertiary province and the Alaska Peninsula-Cook Inlet province. Figure 6 shows the location of these two petroleum provinces.

The Pacific-Margin Tertiary Province, which fringes the Gulf of Alaska, extends from south of Kodiak Island, in the western part of the Gulf, to Cross Sound in the eastern part of the Gulf, a distance of over 900 miles (1,448 km). It is estimated by Plafker (1971) that approximately 40,000 square miles (103,560 km2) of onshore and offshore lands within the province are underlain by a thick sequence of Tertiary marine and nonmarine sediments, which are potential source rocks for petroleum deposits. Of this total, roughly 85 percent of these deposits are found beneath the Gulf of Alaska Outer Continental Shelf. In addition to the source rocks, subsurface structures that could serve as potential hydrocarbon traps are also present on these offshore lands (Von Huene and others, 1971). However, the 11 exploratory wells drilled to date in this subprovince have encountered no commercial deposits of hydrocarbons. Three lease sales, Lease Sale 39, Lease Sale 55, and Reoffering Sale RS-1, have taken place within this province.

The Alaska Peninsula-Cook Inlet province is a topographic lowland that extends from approximately the Chitina Valley southwestward across Cook Inlet to the tip of the Alaska Peninsula. It is bounded by a semicircle of mountains that include the Alaska Range on the north and west and the Kenai-Chugach Mountains on the east. The province is underlain by a long narrow wedge of moderately deformed clastic rocks of late Mesozoic and Tertiary age that cover an area that is greater than 900 miles (1,448 km) long and between 5 to 50 miles (8.0-80 km) wide. Commercial accumulations of oil and gas are present in the Tertiary rocks of this province. These Tertiary rocks, and possible upper Mesozoic rocks, are believed to have the best potential for future hydrocarbon discoveries (Gryc, 1971). Both Lease Sale CI and 60 were located in the north-central portion of this province.

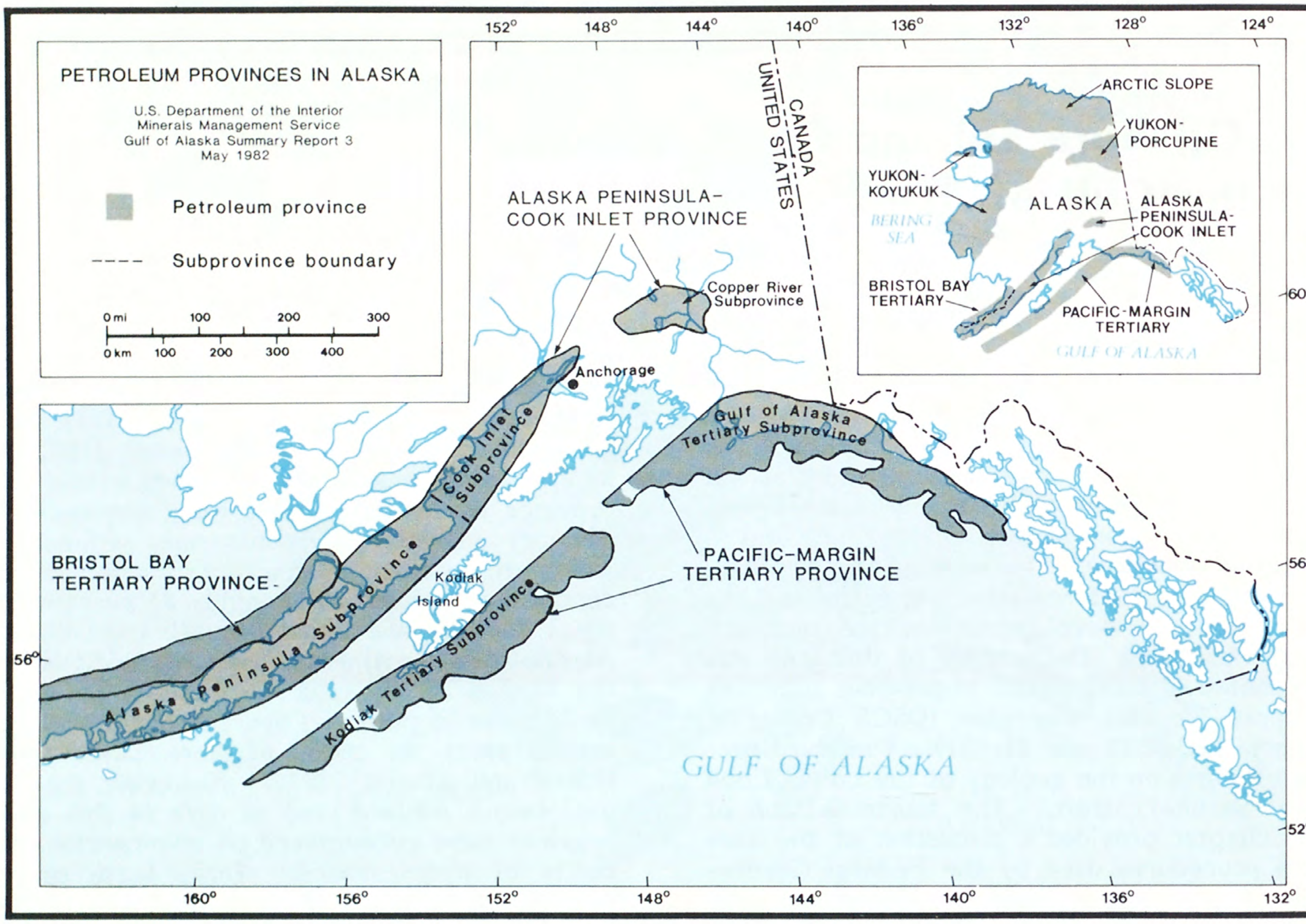

FIGURE 6.—Petroleum provinces of the Gulf of Alaska area. (Adapted from Gates and others, 1968, by Rogers, Golden & Halpern, 1982.)

GEOLOGIC ASPECTS OF THE NORTHERN GULF OF ALASKA

The northern Gulf of Alaska OCS is located in the northeastern portion of the Pacific-Margin Tertiary Province. The OCS part of the province contains approximately 20,000 square miles (51,780 km2) of offshore lands. Major physiographic features of the OCS in the northern Gulf of Alaska are shown in figure 7. The width of the Continental Shelf varies from 8 miles (13 km) at the eastern end of the area to 65 miles (105 km) in the west. The surface of the OCS in this area is gently undulated, with six submarine valleys separating extensive shelf areas. These submerged valleys are remnants of glaciation.

Exploratory drilling associated with Lease Sale 39 on the Yakataga Shelf failed to encounter commercial deposits of hydrocarbons. Tracts leased in Lease Sale 55 are located on the Yakutat Shelf, between Icy Bay and Dry Bay. The Lease Sale 55 area is about 125 miles (201 km) southeast of the Lease Sale 39 area.

Although a Continental Offshore Stratigraphic Test (COST) well, also known as a deep stratigraphic test well, was not drilled for Lease Sale 55, data samples from ocean-bottom dredging have been collected and analyzed by U.S. Geological Survey (USGS) geologists (Plafker and others, 1980). These samples indicate that a previously unrecognized sequence of rocks on the Continental Slope extending beneath the Lease Sale 55 area contains sufficient organic material to have generated petroleum. To date, no exploratory wells have been drilled on Lease Sale 55 tracts. A more complete discussion of

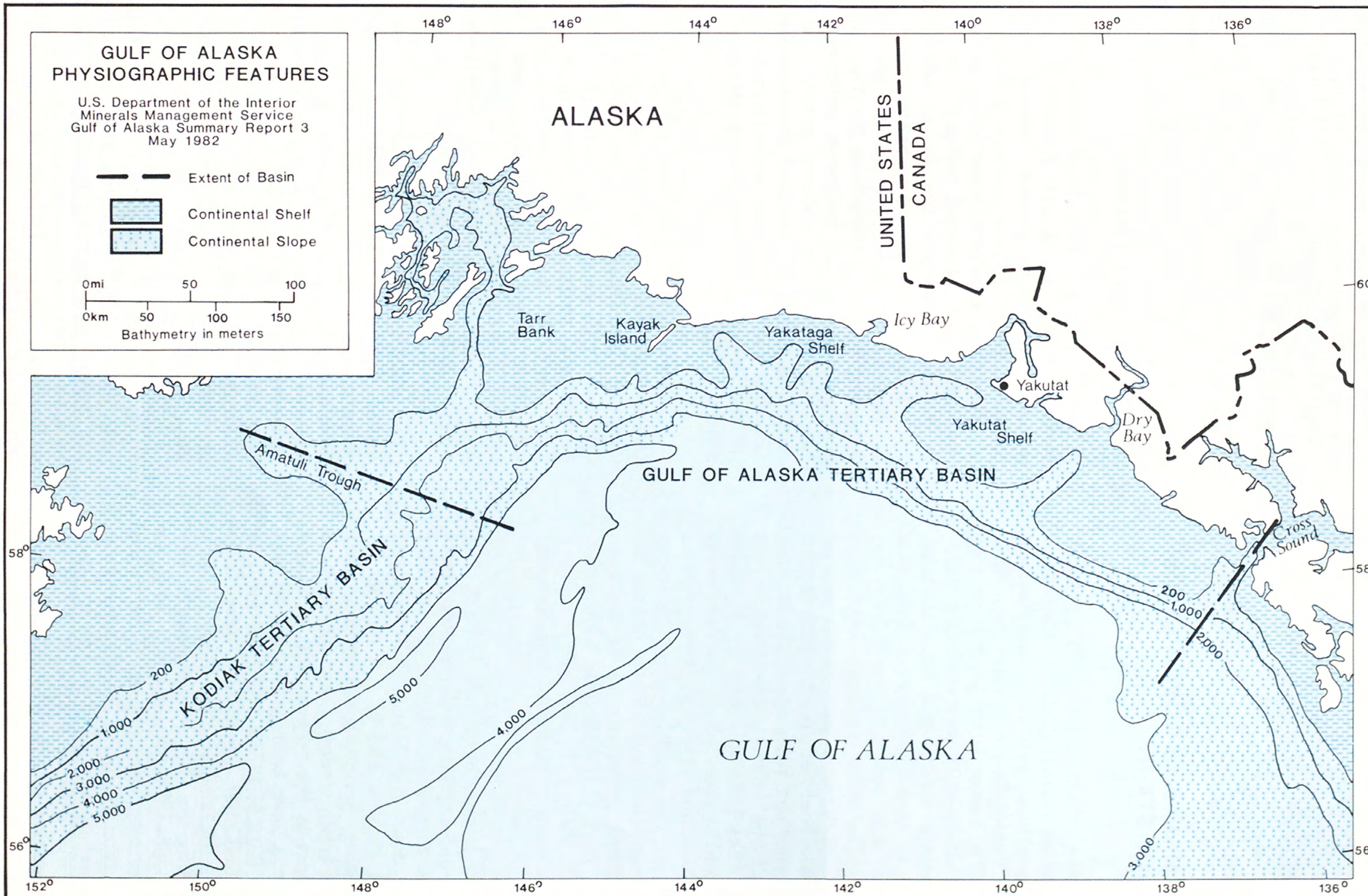

FIGURE 7.--Major physiographic features of the OCS in the northern Gulf of Alaska. (Adapted from Plafker and others, 1978, by Rogers, Golden & Halpern, 1982.)

the geology of the northern Gulf of Alaska Outer Continental Shelf is contained in the **Gulf of Alaska and Lower Cook Inlet Summary Report 2,** June 1981 (USGS Open-File Report 81-607).

GEOLOGIC ASPECTS OF LOWER COOK INLET-SHELIKOF STRAIT

The Lower Cook Inlet OCS includes 3,500 square miles (9,061 km2) of submerged land in the Cook Inlet petroleum subprovince of the Alaska Peninsula-Cook Inlet province. Physiographically, Lower Cook Inlet is part of a large northeast-to-southwest-trending estuary that is nearly surrounded by mountains except where it opens southward into the Shelikof Strait and southeastward into the Gulf of Alaska. The inlet gradually deepens to the south, but depths generally do not exceed 660 feet (201 m). Shelikof Strait, which is also part of the Cook Inlet subprovince, is located to the south of the Lower Cook Inlet. This strait is 140 miles (225 km) long by 30 miles (48 km) wide and is bounded on the northwest by the mountains and glaciers of the Alaska Peninsula and on the southwest by the rocky west coast of Kodiak Island. Water depths for most of the Strait generally range between 495 and 660 feet (150-201 m). However, depths greater than 825 feet (251 m) are common in western portions of the Shelikof Strait.

The Cook Inlet subprovince is part of a belt of Mesozoic-Tertiary sedimentary rocks that extend northeast into Upper Cook Inlet and southwest down the Alaska Peninsula and Shelikof Strait (figs. 6 and 8). A number of northeast-trending anticlinal structures that contain hydrocarbon deposits are present in the northern part of the subprovince. Onshore wells in the area have been producing oil and gas since 1957 (Crick, 1971). Offshore wells in State waters in Upper Cook Inlet have been producing oil and gas since 1963 (Barry, 1973). Data collected by the U.S. Geological Survey indicate that Upper Cook Inlet could serve as a structural analog for Lower Cook Inlet (Magoon and others, 1976). Most subsurface folds (anticlines) on the OCS in Lower Cook Inlet parallel the general northeast trend of petroleum-producing structures in Upper Cook Inlet.

A notable exception to this trend is the east-west Augustine-Seldovia Arch, a major subsurface structural feature of Lower Cook Inlet (fig. 8). The Augustine-Seldovia Arch divides the area into two oppositely plunging synclines. Migration from both Upper Cook Inlet and Shelikof Strait could bring petroleum to the vicinity of the Arch (BLM, Alaska OCS Office, 1976). Stratigraphic traps could be present in areas where northeast-trending anticlines intersect the Arch.

Although the petroleum geology of the Shelikof Strait is not well understood at the present time, some general observations are possible using existing onshore geologic and offshore seismic information. These data indicate that middle Jurassic rocks, possibly similar to those that are the source of current Cook Inlet oil production on State land, might be present beneath portions of the Strait (Magoon, 1982, oral commun.). The limited geologic information available indicates that the area of highest resource potential is the southeast portion of Shelikof Strait where the Cenozoic reservoir rocks unconformably overlie the Mesozoic source rocks (Magoon and others, 1979).

Petroleum exploration of the OCS in Lower Cook Inlet has been limited to the area north of Cape Douglas. Lease Sale CI, held in October 1977, generated a total of eight dry exploratory wells. In addition, prior to the sale one COST well was drilled northeast of Augustine Island. All of these wells were located in water less than 328 feet (100 m) deep. Lease Sale 60 was the first offering of tracts within the Shelikof Strait.

Some geologic features and processes in Lower Cook Inlet-Shelikof Strait area may jeopardize offshore oil and gas exploration and development activities. A number of geologic hazards associated with seismicity, volcanism, sedimentation, and bedform migration may pose potential problems to future oil- and gas-related activity within the Lower Cook Inlet-Shelikof Strait OCS (Science Applications, Inc., 1979).

In areas where potential geologic hazards have been identified, special engineering procedures may be required, or facility locations may have to be changed. A more detailed discussion of these conditions is presented in appendix A.

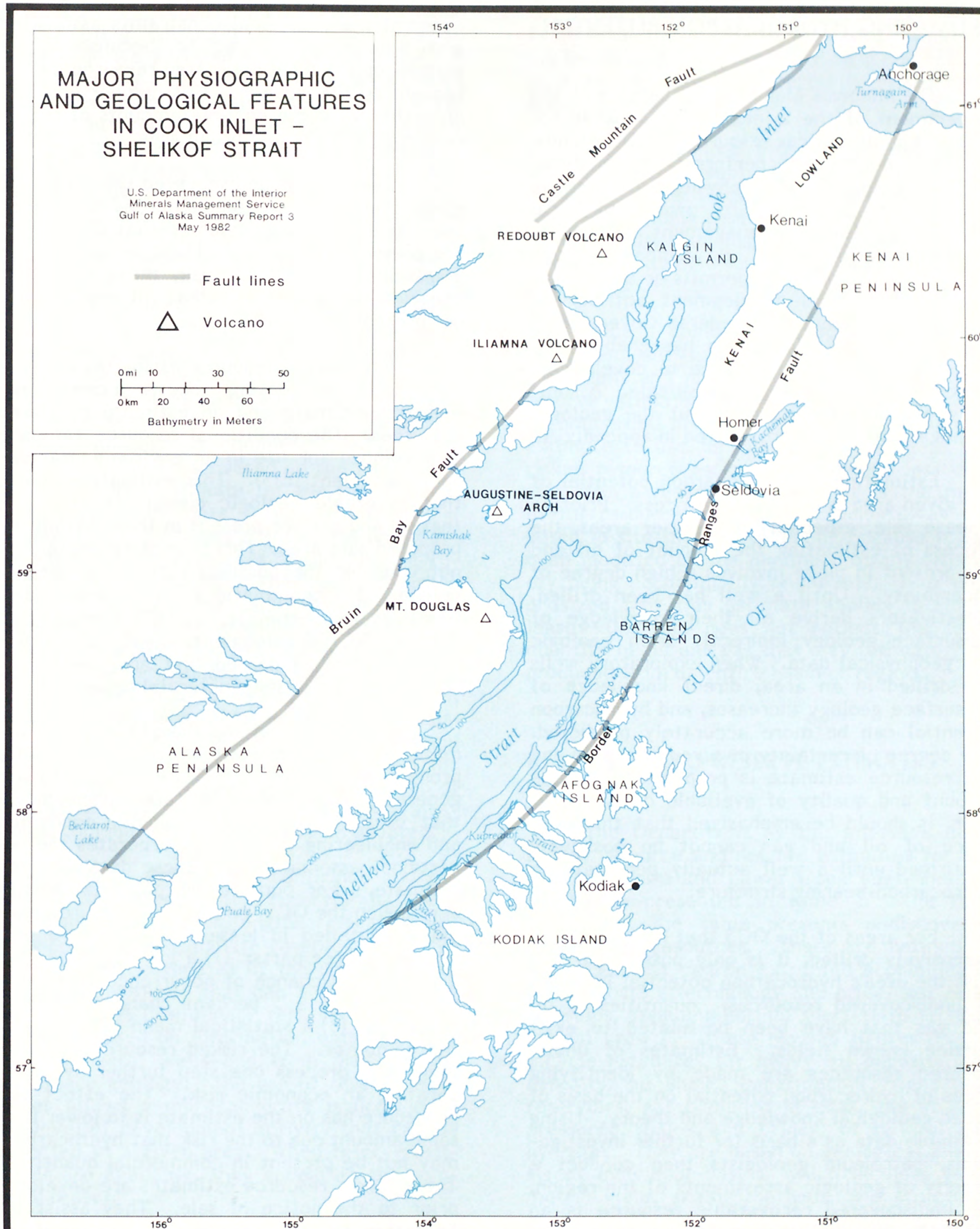

FIGURE 8.—Major physiographic and geological features of Cook Inlet-Shelikof Strait. (Redrafted from Magoon and others, 1979, by Rogers, Golden & Halpern, 1982.)

ESTIMATING HYDROCARBON POTENTIAL

The Minerals Management Service of the Department of the Interior is responsible for estimating oil and gas resources on OCS lands. For this purpose, it performs and analyzes various geologic and geophysical surveys. In addition to conducting its own geophysical studies, the Minerals Management Service has the information that oil companies have gathered under prelease permits or as a result of exploration and development activity on tracts leased from the Federal Government. Analysis of this information has enabled the Minerals Management Service to develop resource estimates for each lease sale. A summary of current thinking about the geologic setting of this area is presented in appendix A.

Estimating the hydrocarbon potential of any given area is a complex process. Prior to a lease sale, especially in frontier areas, the process of estimating the amount of oil and gas present in place involves a high degree of uncertainty. Until a well has been drilled, investigators derive all their knowledge of subsurface geology indirectly from geologic and geophysical data. When exploratory wells are drilled in an area, direct knowledge of subsurface geology increases, and hydrocarbon potential can be more accurately predicted. The degree of certainty involved in any oil and gas resource estimate is proportional to the amount and quality of available data. However, it should be emphasized that the existence of oil and gas cannot be positively confirmed until a well actually penetrates a hydrocarbon-bearing structure.

For areas of the OCS that have not been extensively drilled, it is only possible to discuss the area's hydrocarbon potential in terms of **undiscovered resources:** quantities of oil and gas that have been postulated to exist outside known fields. Estimates of undiscovered resources are made by identifying areas of hydrocarbon potential on the basis of broad geological knowledge and theory. Using available data as a basis for further investigations, petroleum geologists then conduct a variety of geologic assessments of the region. An **undiscovered recoverable resource** is an estimate of undiscovered resources that is modified to account for the technological, economic, and physical constraints associated with hydrocarbon extraction, because only a portion of the total estimated resource can be brought to the surface. This number provides an estimate of the possible amounts of recoverable oil and gas in a broad area.

In estimating undiscovered resources and undiscovered recoverable resources for a given lease sale, it is first assumed that oil and gas are present in the area. Then, by applying an assessment of geologic risk, these estimates consider the probability that oil and gas are not present in the area.

Two kinds of resource estimates are produced in the pre-leasing process: a **conditional resource estimate** and an estimate of **risked resources.** The conditional resource estimate is developed for use in an environmental impact statement (EIS). This estimate assumes that favorable geologic conditions exist and that oil and gas are present in traps within the proposed sale area. This type of estimate does not consider the possibility that the area is devoid of accumulations of hydrocarbons. Based on this estimate, the EIS scenarios of exploration, development, and production activities are composed and are then evaluated in terms of their potential impacts.

The conditional and risked resource estimates produced for lease sale area studies are probabilistic in nature. These estimates are generated by a computer simulation model that uses the available geologic, economic, and engineering data and incorporates the uncertainty associated with these data into the estimate. For purposes of potential leasing acreage on the OCS, conditional resource estimates (detailed in lease sale EIS's) are presented in three parts: (1) a low estimate with a 95 percent chance of occurrence, (2) a high estimate with a 5 percent chance of occurrence, and (3) a statistical mean calculated in the computer. The risked resource estimate takes this process one step further by incorporating an economic risk. The effect this procedure has on the estimate is to lower it by some amount due to the risk that hydrocarbons may not be present in commercial quantities. These risked resource estimates are developed prior to the notice of sale. They assist the Secretary of the Interior in deciding which tracts will be offered for sale.

Another computer simulation model is used to derive a resource economic value for each tract, so that the Government can efficiently evaluate the bids received at a lease sale. This model considers the degree of uncertainty associated with various economic, geologic, and engineering parameters, and yields a range of resource economic values for the tract. The statistical mean of this range is risked and is used as an aid to determine bid adequacy.

Once a lease sale is held, the risked resource estimates for the sale are updated to reflect the quantities of oil and gas contained under leases actually purchased. Tracts for which no bids were received or for which bids were rejected are not included in these updated estimates. If commercial volumes of hydrocarbons are discovered on the leases, the risked resource estimate for the sale is again revised using new data derived from drilling. In most cases, a reassessment of the undiscovered recoverable resources would also be required for the basin. The updated risked resource estimate for lands leased in past sales and the reassessed undiscovered recoverable resources are used for the next sale in the basin. The procedures described above are currently in effect. However, the Department of the Interior is considering a modified leasing process that would allow additional acreage to be offered for sale. Due to the incremental effort caused by the evaluation of substantially increased acreage, new evaluation techniques may also have to be adopted.

After a discovery is confirmed and the commercial potential of a reservoir has been established, petroleum engineers and geologists are able to calculate reserves. Reserve estimates are estimates of the portion of the discovered resource that can be economically extracted. A preliminary reserve calculation might be based on information obtained from one or several wells and from maps of the subsurface geology. The use of reserve estimates allows a more accurate projection of the level of development activity that can be expected in a given area. When reserve estimates are available, they appear in the summary report.

The characteristics of these various types of estimates are summarized in table 1. In general, the estimates incorporate increasing levels of detail in the data base and reflect an increasing degree of certainty in the estimate.

Manipulation of resource and reserve estimates, such as subtracting the reserves on leases from the undiscovered recoverable resources or adding reserves to resources, would lead to false conclusions. These estimates were made at different times under changing conditions.

Once a commercial discovery has been confirmed, site-specific planning for OCS development and production should be based on reserve estimates. However, in the absence of a commercial discovery, the most appropriate estimate to use for planning purposes is the risked resource estimate. Although less certain than a reserve estimate, it is the most useful resource estimate for general--as opposed to site-specific--planning because it has been modified by the likelihood of any discovery being economically producible. It is emphasized that this estimate applies to single lease sales and does not reflect the total quantity of oil and gas that may ultimately be produced from an entire basin or region.

RESOURCE AND RESERVE ESTIMATES

The Department of the Interior's most recent resource and reserve estimates for the Gulf of Alaska and Lower Cook Inlet-Shelikof Strait are presented in table 2. The first section of the table presents **undiscovered recoverable resources.** These are defined as resources that can be extracted economically under existing technology and price/cost relationships, assuming normal short-term technological growth. These revised figures do not include estimates for heavy oil deposits, tar deposits, oil shale, impermeable "tight" gas reservoirs, gas occluded in coal, gas in geopressured shales and brines, or natural gas hydrates. They are based on geological analysis of individual basins, which includes volumetric yield, analog methods, and structural analysis. Because of uncertainties involved with estimating the amounts of undiscovered resources, estimates are reported as a range

TABLE 1.—Characteristics of undiscovered recoverable resources, conditional resources, risked resources for leased lands, and reserves

Undiscovered recoverable resources	Conditional resources	Risked resources for leased lands	Reserves
• Indicates regional petroleum potential	• Developed for the EIS prior to the lease sale for the entire sale offering	• A probabilistic aggregation of tract-specific estimates for tracts actually leased, but not yet developed	• Estimated on a reservoir-by-reservoir basis, after a discovery is made and commercial accumulation is established
• Available data utilized is limited	• Increased quantity of data	• Increased quantity and quality of data	• Greater volume of data influences interpretations derived from well logs, formation of tests, core samples, and actual production rates
--	• Use of computer simulation model	• Use of computer simulation model	• Possible use of computer programs
--	• Probabilistic in nature	• Probabilistic in nature	--
• Heavy reliance on knowledgeable but subjective opinion	• Heavy reliance on knowledgeable but subjective opinion	• Heavy reliance on knowledgeable but subjective opinion	• Based on actual data collected from drilling wells, with reliance on subjective opinion
• Estimates consider the possibility that the area is devoid of commercial accumulations of oil and/or gas	• Estimates do not consider the possibility that the area is devoid of commercial accumulations of oil and/or gas	• Estimates consider the possibility that the area does not contain accumulations of commercial hydrocarbons	• Estimates are for proven commercial accumulations of hydrocarbons

of values corresponding to different probabilities of occurrence. The mean estimate is provided in table 2.

The second set of estimates, **risked resources for leased lands,** was updated to March 1982. In addition, these estimates were geographically disaggregated on the basis of comments made to the staff of the Office of OCS Information concerning uses of resource estimates for planning.

The **reserve estimates** are based on actual discoveries on existing leases. There have been no commercial discoveries in either the Gulf of Alaska or Lower Cook Inlet-Shelikof Strait OCS; therefore, there are no reserve estimates.

TABLE 2.—Gulf of Alaska OCS oil and gas mean resource and reserve estimates

	Oil (million barrels)	Gas (billion cubic feet)
Undiscovered recoverable resources		
Gulf of Alaska (water depth 0-2,500 m)	400	2,200
Lower Cook Inlet (water depth 0-200 m)	400	2,200
Risked resources for leased lands		
Gulf of Alaska leased lands (35 tracts leased in Lease Sale 55 and 1 tract leased in RS-1)	12.1	46.2
Lower Cook Inlet (13 tracts leased in Lease Sale 60)	5.6	5.0
Reserves		
Gulf of Alaska	0	0
Lower Cook Inlet-Shelikof Strait	0	0

SOURCES: USGS, Geologic Division, 1980 (undiscovered recoverable resource estimate); MMS, 1982 (risked resources for leased lands and reserves).

2. Magnitude and Timing of Offshore Development

This chapter presents new information concerning Outer Continental Shelf (OCS) regulations and summarizes the lease sale and exploratory history of the Gulf of Alaska subregion. It also discusses Lease Sale 60 and the first Reoffering Sale (RS-1) and presents the anticipated exploratory activity in the Lower Cook Inlet and the Gulf of Alaska.

On February 10, 1982, the proposed Alaska Region OCS Operating Orders were published in the Federal Register by the Minerals Management Service. The proposed orders incorporate provisions of the Gulf of Alaska Operating Orders and the Arctic Operating Orders, and they will cover the entire Alaska OCS. The Alaska Operating Orders will supersede the Gulf of Alaska Operating Orders and Arctic Operating Orders and will apply to land leased in previous sales as well as land leased in future Federal OCS sales. The final operating orders are expected to be published in June 1982.

The Environmental Protection Agency (EPA) is proposing general National Pollutant Discharge Elimination System (NPDES) permits for oil and gas activity on the Alaska Outer Continental Shelf. General permits will apply to large areas, while individual permits, currently in use, are required for each discharge system. Operators will be allowed to discharge pollutants after notifying the Environmental Protection Agency of their agreement to meet general permit requirements. The general permits for Alaska will be developed by EPA Region 10 in Seattle, Washington.

LEASE SALE 39

Lease Sale 39 was the first lease sale to be held in the Gulf of Alaska subregion. The sale was held in Anchorage on April 13, 1976. Of 189 tracts in the eastern Gulf of Alaska offered for lease, 76 were leased. These tracts totaled 409,058 acres (165,505 hectares) and were leased for a total of $560 million. Exploratory drilling of these tracts began in September 1976 and resulted in 11 dry holes in the Yakataga Shelf area. The last well was plugged and abandoned in July 1978. All of the leases issued in this sale have been relinquished.

LEASE SALE CI

The first Federal OCS lease sale in Cook Inlet was held in Anchorage on October 27, 1977. In this lease sale, 135 blocks covering 495,307 acres (200,401 hectares) were offered, and 87 blocks were leased. The sale attracted considerable attention because it tested a new bidding method. Two-thirds of the tracts were offered under the traditional cash bonus method, while the remaining one-third were

> The words "block," "lease," "tract," and "OCS serial number" have discrete definitions and applications. **Block** is used to refer to a geographical area as portrayed on OCS official protraction diagrams or leasing maps. A block in the Alaska Region generally contains 5,693 acres (2,304 hectares). All blocks have identifying numbers. **Lease** is used to mean a contract authorizing exploration for and development and production of minerals on the submerged lands covered by such a contract. A **tract** is the description of a single leasing unit for administrative purposes; it is a convenient way of numbering a unit that may contain a single block or portions of several blocks. The block numbers and OCS official protraction diagram numbers comprise the legal description of a tract in the lease contract. The lease contract is also assigned in **OCS serial number**. The Minerals Management Service uses these numbers to identify blocks after a sale has occurred. Tract numbers are generally used by trade publications to identify blocks.

offered for a cash bonus, with royalty bidding. Eight exploratory wells were drilled between July 2, 1978, and June 28, 1980; all of them have been plugged and abandoned. No further drilling activity has occurred or is anticipated, although 38 leases remain active. A discussion of the litigation concerning Lease Sale CI is found on p. 3.

LEASE SALE 55

The second lease sale held in the Gulf of Alaska, Lease Sale 55, was held in Anchorage on October 21, 1980. It offered 210 tracts off the coast of Yakutat. Nine companies participated in the bidding, which was dominated by ARCO. A total of $117.6 million was offered for 37 tracts. Two bids were rejected by the Bureau of Land Management for insufficiency.

To date, no exploratory drilling has taken place on any of the tracts leased in Lease Sale 55. However, ARCO has a rig under contract to drill Continental Offshore Stratigraphic Test (COST) wells in the St. George, North Aleutian, and Navarin Basins. This rig--SEDCO 708--may drill an exploratory well on Tract 150 (OCS-Y 0211). If the SEDCO 708 has not completed drilling the COST wells in St. George and North Aleutian Basins by the end of the year, ARCO will drill in the Gulf of Alaska with another rig. In either case, exploratory drilling is expected to begin in January 1983. (Fahrenbruch, 1982, oral commun.).

REOFFERING SALE RS-1

In May 1981, the Bureau of Land Mangement published a notice of sale for a Reoffering Sale (RS-1) in the eastern Gulf of Alaska. The 175 tracts offered in this sale had been offered in Lease Sale 55. Two of these tracts had received bids in that sale, but these bids were rejected as insufficient.

The notice of sale stated that seven stipulations would be included in leases resulting from this sale. The first stipulation is designed to protect cultural and archeological resources. The second stipulation requires leases to conduct an environmental training program for all personnel involved in exploration or development activities. This program shall inform each person of specific types of environmental, social, and cultural concerns that relate to the individual's job. The third stipulation lists pipeline requirements. The fourth stipulation requires subsea wellheads and pipelines, unless buried, to be designed and constructed to prevent interference to fishing gear. The fifth stipulation pertained only to tracts leased with a sliding-scale royalty. The sixth stipulation prohibits underwater blasting with high-velocity explosives for seismic exploration. The seventh and final stipulation pertained only to tracts leased with a net profit share. A more detailed discussion of the stipulations pertaining to pipelines is found on page 25.

RS-1 was held in Anchorage on June 29, 1981. Only ARCO and a group of companies led by Chevron submitted bids in the sale. A total of five tracts received bids. ARCO submitted bids on Tracts 131 and 152. ARCO had submitted bids on these tracts in Lease Sale 55, but the bids were rejected for insufficiency. The Chevron group bid on tracts 75, 131, 152, 154, and 177. For Tract 131, ARCO bid $207,636 and the Chevron group bid $170,496. The same tract received a bid of $1.8 million from ARCO in Lease Sale 55. For Tract 152, ARCO bid $2,373,613 and the Chevron group bid $2,320,128. In Lease Sale 55, ARCO bid $5.09 million for Tract 152. Only Chevron's bid of $170,496 on Tract 75 was accepted by the Bureau of Land Management. Tract 75 is located in the northwest corner of the sale area and borders ARCO's Tract 101 leased in Lease Sale 55 for $150,336. At this time, Chevron has not released any information about plans to explore the tract.

LEASE SALE 60

The leasing process for Lease Sale 60 began on December 28, 1978, with the call for nominations. Scoping meetings for the environmental impact statement began in 1979. A total of seven scoping meetings were held. Three of these were public meetings. The first public meeting was held in Anchorage on May 23, 1979; this meeting was a combined meeting for Lease Sales 46 and 60. The second public meeting was held in Kodiak on August 14, 1979, and the third public meeting was held in Homer on August 17, 1979. Three additional scoping sessions were held for State and Federal personnel. The first of these meetings was held in Anchorage on May 14, 1979. Like the first public meeting, it covered both Lease Sales 46 and 60. The second of these meetings was held in Juneau on May 19, 1979. The third meeting took place on February 1, 1980. A final scoping meeting was held in Kodiak on March 5, 1980. The purpose of this meeting was to receive the comments of members of the Kodiak Area Native Association, Overall Economic Development Committee.

As a result of these meetings and the written comments received by the Bureau of Land Management, the following major issues were determined to be the principal foci for the environmental impact statement:

- impacts on commercial fish and the commercial fishing industry,
- cumulative effects impacts,
- impacts on land use and coastal zone management,
- local socioeconomic impacts,
- marine transportation impacts,
- environmental data gaps,
- impacts on subsistence activities,
- impacts on water quality,
- geological hazards,
- marine mammals, and
- endangered species (BLM, Alaska OCS Office, 1981).

The draft environmental impact statement was issued on August 20, 1980, and the final environmental impact statement was issued in March 1981. Six alternatives were presented in the final environmental impact statement; the first of these was the proposal as stated, and it called for the offering of all 153 tracts in the Lower Cook Inlet and northern Shelikof Strait. These tracts were located 2 to 23 miles (3.2-37 km) offshore and in water depths of 49 to 680 feet (15-207 m). The U.S. Geological Survey estimated the mean recoverable oil and gas resources in this area to be 670 million barrels (106,463,000 m3) of oil and 1.17 trillion cubic feet (33,111,000,000 m3) of gas.

The deletion of various tracts in the sale area were proposed in three alternatives. One of these (alternative V) proposed the deletion of all blocks south of Block 1055, or all 81 blocks within Shelikof Strait and 19 blocks in Lower Cook Inlet. This alternative was designed to lessen impacts to the Kodiak Archipelago. Another altnernative (alternative IV) was a modification of alternative V; it proposed the deletion of 66 blocks in Shelikof Strait and 19 blocks in Lower Cook Inlet. Alternative VI proposed modification of the sale area by deleting all of the blocks in Lower Cook Inlet. This alternative was designed to lessen impacts on the marine mammal and bird habitats in the Anchor Point area and in Kamishak Bay. In addition to these alternatives, the final environmental impact statement also contained a no sale alternatives (alternative II) and a delay the sale alternative (alternative III).

The notice of sale for Lease Sale 60 was published on April 5, 1981. It included a description of the five stipulations that would be included in leases resulting from the sale. The first stipulation was designed to protect sites, structures, or objects of historical or cultural significance. The second stipulation gave the Deputy Minerals Manager (DMM) for Field Operations in the Alaska Region the authority to require site-specific environmental surveys or studies if the DMM has reason to believe that significant biological populations or habitats exist within the lease sale area. The third stipulation required an orientation program for all personnel involved in exploration or development that will promote an understanding of and appreciation for local values, customs, and lifestyles. This type of orientation program was implemented during the construction of the Trans-Alaska Pipeline, and it was also required in Lease Sales CI, 55, and BF. The fourth stipulation detailed pipeline requirements to ensure the proper transportation of hydrocarbon products; this mitigating measure was also applied to Lease Sales 42, 48, and 55. The fifth stipulation applied only to blocks leased with a net profit share. A more detailed discussion of the stipulations pertaining to pipelines is found on page 25.

Lease Sale 60 was held on September 29, 1981, in Anchorage. It offered 153 tracts. Chevron submitted high bids totaling $4,405,899 on 13 tracts. Amoco Production Company, the only other company that participated in the sale, submitted two bids. All high bids were accepted. Four tracts were leased in the northern part of the sale area near Anchor Point in Lower Cook Inlet, and nine tracts were leased in the southern part of the sale area in the Shelikof Strait opposite Afognak Island.

Chevron conducted geohazard studies on three tracts in Shelikof Strait: Tract 139 (OCS-Y 0252), Tract 124 (OCS-Y 0249), and Tract 120 (OCS-Y 248) and two tracts in Lower Cook Inlet: Tract 24 (OCS-Y 0243) and Tract 25 (OCS-Y 0244). A 100-foot (30-m) core sample was taken from Tract 25 (OCS-Y 0244). This work was conducted during the first part of May 1982. The results of these studies and surveys will determine if Chevron will drill. Exploratory drilling, if it does take place, is not anticipated before the summer of 1983 (Gallager, 1982, oral commun.).

CONCLUSION

Although there have been no commercial hydrocarbon discoveries on the OCS in either Lower Cook Inlet or the northern Gulf of Alaska, planning for potential oil and gas development continues in both areas. The pace of drilling currently suggests that the initial optimism of the oil industry has been dampened. However, the exploration results to date neither prove nor disprove the existence of hydrocarbons. Many wells must be drilled before the resource potential of the area is established. For example, 51 exploratory wells were drilled in the North Sea before a commercial discovery was made.

3. Oil and Gas Transportation Strategies

If commercially producible quantities of oil and gas are discovered on the Outer Continental Shelf (OCS) in the Gulf of Alaska or Lower Cook Inlet, they will have to be transported ashore for processing, refining, and distribution. The process of planning for and constructing the necessary transportation facilities is multifaceted, and because of the complexity of this process, it is desirable to begin planning as early as possible.

OCS TRANSPORTATION PLANNING

The previous Gulf of Alaska summary reports (USGS Open-File Reports 80-1028 and 81-607) summarized the role of the Intergovernmental Planning Program (IPP) in planning for and regulating oil and gas transportation. This report presents recent IPP activities and various information affecting OCS oil and gas transportation.

Intergovernmental Planning Program

The Department of the Interior's Bureau of Land Management (BLM) has the lead role in the transportation planning process for oil and gas discovered on the OCS. This planning process is coordinated through the BLM's Intergovernmental Planning Program for OCS Oil and Gas Leasing, Transportation and Related Facilities. Each of BLM's six offshore leasing areas has an advisory committee called the Regional Technical Working Group (RTWG). Each working group meets approximately four times a year to offer advice to the Bureau of Land Management on technical aspects of leasing, transport of oil and gas to shore, and BLM's environmental studies program.

The Alaska RTWG has held four meetings since the publication of the most recent Gulf of Alaska Summary Report. The first of these meetings was held on June 24 and 25, 1981, in Anchorage. The major topics discussed at this meeting were the draft proposed 5-year oil and gas leasing schedule, the streamlining of the leasing process, and the designation of new planning units. The next meeting was held in Juneau on September 9 and 10, 1981. Discussion items included the proposed mitigating measures for Lease Sale 57 in the Norton Sound and the issues raised in a scoping meeting for North Aleutian Shelf Lease Sale 75. General discussions concerned the functions, roles, and activities of a State/Federal Transportation Planning Organization and the RTWG's role. in transportation planning. Another meeting was held November 18, 1981, in Anchorage. During this meeting the results of Lease Sale 60 were reported, and the ranking of proposed environmental studies was discussed as well as mitigating measures for proposed Lease Sale 70 in St. George Basin. The group also discussed the preparation of a regional transportation management plan for the Beaufort Sea.

Another meeting of the RTWG was held in Anchorage on February 4, 1982. Topics discussed at the meeting included: the new 5-year leasing schedule, the establishment of the Minerals Management Service, the environmental and socioeconomic studies program, and the proposed mitigation measures for Lease Sale 71 in the Beaufort Sea. In addition, Claude Sellars, Supervisor of Engineering and Development for Shell Oil Company, discussed pipeline technology in the Arctic.

The most recent meeting of the RTWG was held on April 6, 1982, in Anchorage. At the meeting, the new and old leasing processes were compared, a report on the State's transportation plan was presented, and the future of the IPP was discussed. The next RTWG meeting is scheduled for August 4, 1982, in Anchorage.

The current members of the Alaska Regional Technical Working Group Committee are listed in table 3. The U.S. Coast Guard is now represented by Captain Karl Wassenberg. Kit Duke has been recommended as the representation from the State/Federal Transportation Planning Organization. Mel Monsen, Jr., has been recommended as the representative from United Fishermen of Alaska, and Lee Gefverd has been recommended to serve as an additional representative from the Alaska Oil and Gas Association. The Honorable Alan Beardsley, the Mayor of the City of Kodiak, has resigned from the committee.

TABLE 3.—Alaska Regional Technical Working Group Committee

Member	Affiliation
Ms. Ester Wunnicke (co-chairperson)	Bureau of Land Management
Mr. Bill Van Dyke (co-chairperson)	State of Alaska
Mr. Byron Morris	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
Mr. Jim Sweeney	Environmental Protection Agency
Mr. Gerald Reid	Fish and Wildlife Service
Mr. Rod Smith	Minerals Management Service
Capt. Karl Wassenberg	U.S. Coast Guard
Ms. Kit Duke (recommended)	State/Federal Transportation Planning Organization
Mr. Dave Benton (recommended)	Friends of the Earth
Mr. Mel Monsen, Jr. (recommended)	United Fishermen of Alaska, Bering Sea Fishermen Association
Ms. Kay Diebels (recommended)	Private citizen
Mr. Gil Jemmott	Alaska Oil and Gas Association
Mr. Lee Gefverd (recommended)	Alaska Oil and Gas Association

For further information concerning the Alaska Regional Technical Working Group Committee membership, contact Gordy Euhler, Bureau of Land Management, 620 East 10th Avenue, P.O. Box 1159, Anchorage, AK 99510 (telephone (907) 276-2955).

LEASE STIPULATIONS FOR TRANSPORTATION

All tracts leased in Lease Sale 55, the Reoffering Sale, and Lease Sale 60 are bound by stipulations pertaining to transportation. Pipelines must be used to transport hydrocarbons if the following conditions are met:

- pipeline right-of-way can be determined and obtained;
- laying pipelines is technically feasible and environmentally preferable; and
- pipelines can be laid without net social loss (in the opinion of the lessor), taking into account any incremental costs of pipelines over alternative methods of transportation and any incremental benefits in the form of increased environmental protection or reduced multiple-use conflicts.

When these criteria are not met and surface transportation must be employed, all vessels used for carrying hydrocarbons to shore from such vessels are described in the Ports and Waterways Safety Act of 1972, as amended. In addition, the lessor specifically reserves the right to require that any pipeline used for transporting production to shore be placed in certain designated management areas. In selecting the means of transportation, consideration will be given to any recommendation of any intergovernmental committee.

All oil and gas pipelines, including flow lines and gathering lines, are to be designed and constructed to provide for adequate protection from water currents, storms, geohazards, and other hazards as determined on a case-by-case basis. After the development of sufficient pipeline capacity, no crude oil will be transported by a surface vessel except in the case of an emergency.

In order to protect fishing gear, all pipelines (including gathering lines) must have a smooth surface design unless they are buried. If an irregular pipe surface is unavoidable because of the need for valves, anodes, or other protrusions, they must be shielded so that trawl gear can pass over the object without snagging.

PHYSICAL AND ENVIRONMENTAL CONSTRAINTS TO OIL AND GAS TRANSPORTATION

A number of geologic hazards have been identified that would constrain the siting of submarine pipelines, pipeline landfalls, and onshore support structures, if hydrocarbons were produced from the Lower Cook Inlet or Shelikof Strait. Most of these hazards are associated with seismicity, volcanism, sedimentation, and bedform migration.

Tracts leased in Sale 60 are located in an area where earthquakes ranging from 6.0 to 8.8 on the Richter scale are known to occur. Earthquakes of this size can induce a number of seismically related events, including tsunamis (seismic sea waves), landslides, avalanches, mud flows, faulting (ground breaking), liquefaction of soils, and differential compaction of soils.

Because four active volcanoes are located adjacent to the Lower Cook Inlet-Shelikof Strait OCS, care must be taken in the placement of structures to avoid ejecta. In general, impacts from lava flows, noxious gas clouds, mud flows, and landslides have local impacts. Volcanically related tsunamis, however, could cause damage on a regional scale.

The migration of bedforms can cause severe problems by either undermining or covering fixed structures such as pipelines. A large field of sand waves and other bedforms that range in thickness from 0.7 feet (0.2 m) to at least 40 feet (12 m) has been identified in Lower Cook Inlet.

OIL SPILL CONTINGENCY PLANNING

The impacts resulting from both catastrophic and chronic oil spills and the probability of spills are two of the most debated topics in oil and gas development. In an attempt to determine the actual incidence of oil spills in the Cook Inlet area, Blair E. Wondzell, of the Alaska Oil and Gas Conservation Commission, compiled data from Environmental Protection Agency and U.S. Coast Guard records. The results of the Oil and Gas Commission's efforts are reproduced in table 4. A comparative analysis of these figures indicates that since 1966, nonindustry spills comprise almost three times the volume of oil industry spills. Over the last 10 years, the volume of oil spilled by nonindustry has been almost 24 times the volume spilled by the oil industry. Furthermore, a comparison of the amount of oil produced to the amount spilled shows that between 1966 and the present, the percentage of oil spilled equals 0.001. During the past 10 years, the percentage spilled is even less--0.0001 (Wondzell, 1981).

In the event of an oil spill, the prime responsibility for cleaning up lies with the operator who caused the spill. The Gulf of Alaska Operating Orders currently in effect require OCS lease holders to submit an oil spill contingency plan for approval by the area supervisor with, or prior to submitting, an exploration plan or a development and production plan. Oil spill contingency plans are reviewed annually. If the originator of a spill is unknown, or if the spill exceeds the operator's capabilities to clean up, the U.S. Coast Guard's Regional Response Team will assemble the necessary government and private agencies and individuals for a quick response. The Response Team is headed by an on-scene coordinator.

CONCLUSION

If commercially producible quantities of oil and gas are discovered on the OCS in the Gulf of Alaska subregion, they will have to be transported onshore for processing, refining, and distribution. Although a number of pipeline corridors (shown in fig. 2) have been established in the Upper Cook Inlet as a result of offshore production in State waters, it is unlikely that these corridors will be used if a commercial discovery of oil and gas is made in Lower Cook Inlet. The process of planning and constructing oil and gas pipelines is complex. Economic, environmental, and physical factors need to be included to ensure that the alternatives being considered are both technically and economically feasible. Furthermore, pipelines cannot be designed and built with absolute assurance against breaks and spills. This is particularly a problem in areas subject to earthquakes and volcanic eruptions. Because of the complexity of the process, it is desirable to begin planning early, so that measures to minimize hazards concerning pipeline and tanker transportation strategies can be thoroughly studied.

TABLE 4.—Crude oil production and oil spills in Cook Inlet

Year	Crude oil production (barrels)	Recorded oil spills in Cook Inlet waters: Oil industry[1] (barrels)	(incidents)[4]	Non-industry[2] (barrels)	(incidents)[4]	Unknown[3] (incidents)
1962-64		No records		No records		
1965	31,867	87	1			
1966	2,652,688	2,467	9 (2)	2,000	1	14
1967	15,933,006	1,982	9 (10)	8,025	2	21
1968	52,524,619	2,278	32 (19)	288	5 (2)	17
1969	60,886,964	246	12 (11)	2	2 (4)	9
1970	70,006,786	28	9 (16)	43	1 (5)	24
1971	66,161,697	75	10 (15)	2,674	3 (5)	4
1972*	63,742,157	22	11 (1)	4	9 (4)	6
1973	61,714,937	131	12	25	8	5
1974	59,933,837	150	25 (4)	145	8 (1)	7
1975	60,034,539	23	13	9	10 (4)	9
1976	54,511,252	76	15 (4)	9,430	23 (8)	16
1977	49,839,033	10	12 (1)	12	36 (10)	14
1978	45,039,005	14	9 (1)	8	25 (6)	17
1979	38,368,066	4	5	25	35 (3)	9
1980	32,310,047	3	3	56	38 (11)	31
TOTAL	733,690,500	7,596	187 (84)	22,746	206 (63)	203

[1]Oil industry spills include all spills of crude oil, including tankering of crude oil out of Cook Inlet, and spills of refined products associated with exploration, development, and production operations.

[2]Non-industry spills include spills from fishing boats and other vessels not associated with the petroleum industry, spills from vessels carrying refined products to communities, and other non-oil industry users.

[3]Unknown spills have no reported volumes.

[4]The number in parentheses indicates the number of additional spills for which no volume was reported.

*Data prior to 1972 are from EPA records; 1972 and later data were furnished by the U.S. Coast Guard.

SOURCE: Alaska Oil and Gas Conservation Commission, 1981.

4. Nature and Location of Nearshore and Onshore Facilities

The onshore effects of OCS activity in the Gulf of Alaska subregion have been limited to support bases for exploratory drilling resulting from Lease Sales 39 and CI. The onshore activity resulting from Lease Sale 39 was concentrated in Yakutat and Seward. Onshore support for Lease Sale CI was provided by Kenai, Homer, and to a lesser extent, Seward. Support activity for exploratory drilling on tracts leased in Lease Sales 55 or RS-1 will center in Yakutat. The location of an onshore support base for tracts leased in Lease Sale 60 will be determined by which tracts, if any, Chevron explores. The general nature of support activity for exploratory drilling is discussed in the first section of this chapter. The second section discusses the communities in the Gulf of Alaska subregion that may be affected.

SITING ONSHORE FACILITIES

Onshore support bases, or service bases, provide the materials and services that are needed to maintain offshore oil and gas activity. Materials are delivered to the support base by truck, barge, rail, or plane and are stored there until supply boats or helicopters transfer them to the offshore operations. The primary locational factor in the siting of a support base in Alaska is the distance from offshore activity.

Most support bases for exploratory drilling include berths for supply boats, dock space for loading and unloading, warehousing and open storage areas, a helipad, and space to house supervisory and communications personnel. Support bases are optimally located at a shore point that is closest to the offshore operation sites. However, support facilities need not be concentrated in one location, and their locations may not be determined solely on the basis of proximity to exploration sites. The attitude of local communities toward growth and oil- and gas-related activities, as well as the existing infrastructure, play a major role in the location of support facilities.

The siting of support facilities in the Gulf of Alaska subregion illustrates this point. Yakutat's desire to minimize all impacts resulting from Lease Sale 39 shaped the type and location of support facilities for Lease Sale 39. Offshore exploration, development, and production in the State-owned portion of Cook Inlet resulted in the establishment of support facilities at Kenai. These facilities were also used to support exploratory drilling on Lease Sale CI tracts. A history of the siting of support operations for Lease Sales 39 and CI was presented in the initial summary report for this subregion (USGS Open-File Report 80-1028).

If a discovery of commercially producible hydrocarbons is made, other facilities will be necessary. These might include a deepwater port, a marine terminal, or a liquefied natural gas (LNG) plant. At this time, it is impossible to provide definitive information about the possible construction of OCS production facilities in the Gulf of Alaska subregion. The type of production facilities, the number of development wells, the location of onshore facilities, and the transportation facilities needed to bring the produced hydrocarbons to shipping terminals are dependent on the amount of hydrocarbons, depth to the producing horizon, distance to shore, water depth, character of the sea floor, and other factors. Therefore, the following discussion of onshore facilities in the Gulf of Alaska subregion is limited to support facilities for exploration.

GULF OF ALASKA FACILITIES

ARCO plans to support the planned exploratory drilling of a Lease Sale 55 tract in Yakutat. Yakutat is located on the Gulf of Alaska at Yakutat Bay, which is the only natural deepwater harbor on the Gulf of Alaska between Cordova and Cape Spencer. The Lease Sale 55 area lies about 50 miles (80 km) directly south of Yakutat. Prior to Lease Sale 39, ARCO and Shell Oil Company acquired 2-1/2 acres (1.0 hectare) of land on the south side of Monti Bay, across from the City of Yakutat, and constructed a small support base (fig. 9). This base consists of a finger pier 115 feet (35 m) long and 24 feet (7.3 m) wide, with both covered and open storage. The ARCO/Shell consortium also leased an adjacent 77-acre (31-hectare) parcel for possible expansion of onshore service operations.

During exploratory activities resulting from Lease Sale 39, the support base at Yakutat employed approximately 90 people. It is expected that about the same number of people will be used to support the exploratory drilling of a Lease Sale 55 tract.

LOWER COOK INLET FACILITIES

There are a number of possible locations for support facilities for exploratory drilling on Lease Sale 60 tracts (fig. 10). These include Kenai, Homer, and Port Lions. Kenai is an established support base for offshore oil and gas activity. It has been used since the mid-1960's to support exploration, development, and production activities resulting from State leases in Upper Cook Inlet. Kenai was the primary support base for exploratory drilling resulting from Lease Sale CI. If Chevron decides to explore one of the four tracts in the northern part of the Lease Sale 60 area, it is

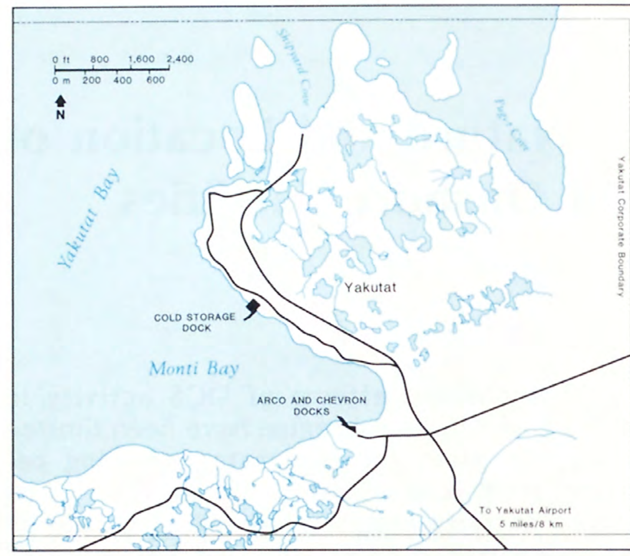

FIGURE 9.—Yakutat and Monti Bay. (Adapted from Collins and Stadnychenko, 1981, by Rogers, Golden & Halpern, 1982.)

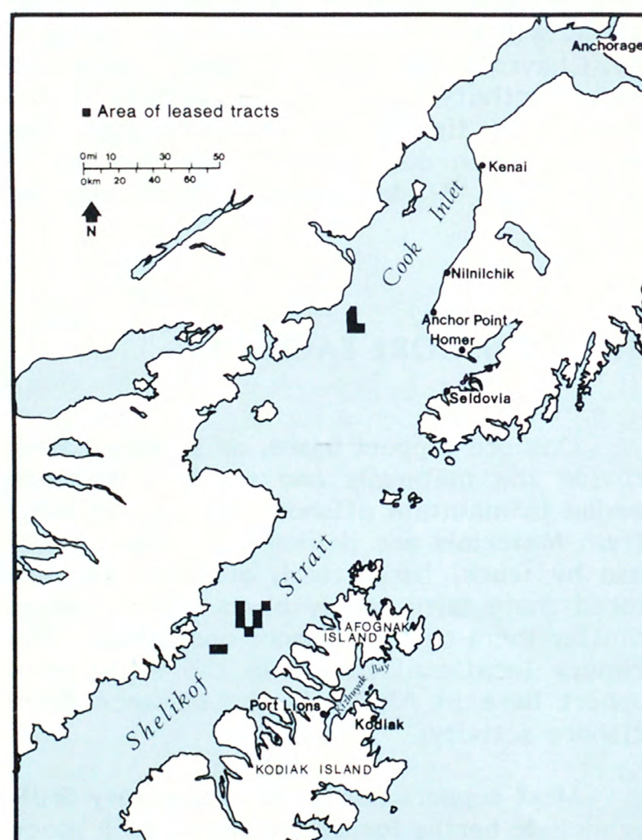

FIGURE 10.—Cook Inlet and Shelikof Strait area. (Redrafted from USGS, 1956, by Rogers, Golden & Halpern, 1982.)

likely that Kenai will be used as a support base.

Homer is located on Kachemak Bay. The bay is known for its diversity of commercial fish species. During Lease Sale CI exploratory drilling, Homer served as a secondary support base. The supply boats servicing the Lower Cook Inlet drilling vessels docked at Homer about 40 percent of the time. Homer's airport was used as a helicopter base for all drilling vessel personnel. If Chevron decides to drill one of the four northern Lease Sale 60 tracts, it is likely that Homer's dock and airport will again be used.

If Chevron decides to explore any of the nine tracts they obtained in Shelikof Strait as a result of Lease Sale 60, Kodiak Island will probably be used to support those operations. The most likely location for a support facility is Port Lions. Port Lions is a small community located at the north of Kodiak Island. According to the 1980 U.S. Census, the population of Port Lions is 215. If support facilities are located in Port Lions, expansion of its airport would be necessary, possibly including the extension of the runway into Kizhuyak Bay.

CONCLUSION

Exploratory drilling resulting from Lease Sales 39 and CI had minimal impacts on local communities. The existing infrastructure was capable of meeting the demands placed on it. As a result, it is presumed that any exploratory drilling of tracts leased in Lease Sales 55 and 60 will also have minimal impacts. If a commercial discovery of oil or gas is made in the Gulf of Alaska subregion, much greater impacts can be expected.

This report will be updated in approximately 6 months. If a commercial discovery of oil or gas is made in the Gulf of Alaska subregion, the Office of OCS Information will issue a new summary report. The Office of OCS Information staff is also available to assist agencies if additional information or clarification is desired. The address and phone number of the Office of OCS Information can be found on the inside front cover of this report.

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Appendix A. The Geologic Setting

PETROLEUM GEOLOGY

Hydrocarbons are formed within the upper part of the earth's crust. Through the actions of heat and pressure, deposited organic matter is transformed into various mixtures of crude oil and natural gas. The time between deposition of organic material and the formation of hydrocarbons is on the order of millions of years (Tissot and Welte, 1978).

The occurrence of hydrocarbon accumulations depends on many factors (Miller and others, 1975):

- an adequate thickness of sedimentary rocks;
- the presence of source beds (rocks containing relatively large amounts of organic matter);
- a suitable environment for maturation of the organic matter into oil and/or gas;
- the presence of porous and permeable reservoir rocks;
- hydrodynamic conditions permitting the migration of hydrocarbons and their ultimate entrapment in reservoir rocks;
- a thermal history that favors production and preservation of hydrocarbons;
- formation of adequate geologic traps for accumulation of the hydrocarbons; and
- suitable timing of petroleum generation and mitigation to ensure the entrapment and preservation of the hydrocarbons.

In a prospective hydrocarbon province, geologists look for structural or stratigraphic traps, in which oil and gas can accumulate. Structural traps include anticlines, sediments draped over salt diapirs and other dome-like intrusions, and fault traps. Examples of stratigraphic traps are reefs and the edges of porous strata that are truncated by beds of impermeable material. Traps may also be formed by a combination of structural and stratigraphic elements.

THE GULF OF ALASKA OUTER CONTINENTAL SHELF

The northern Gulf of Alaska Outer Continental Shelf (OCS) is underlain by portions of a large sedimentary basin (Gulf of Alaska Tertiary Basin) that contains a thick sequence of sediments with petroleum reservoir potential. Petroleum seepages and petroliferous rocks discovered onshore within the basin suggest that source rocks may also be present offshore. To date, exploratory drilling within the northern Gulf of Alaska OCS has failed to encounter commercial deposits of hydrocarbons. A more complete discussion of the geology of this area is contained in the Gulf of Alaska and Lower Cook Inlet Summary Report 2, June 1981 (USGS Open-File Report 81-607).

THE LOWER COOK INLET-SHELIKOF STRAIT OUTER CONTINENTAL SHELF

Although the rock record of the Lower Cook Inlet-Shelikof Strait area is not complete, Magoon and others (1976) have attempted to explain the geologic history of the region by means of a model. This model envisions the Cook Inlet-Shelikof Strait area as part of a former arc-trench system similar in origin to the present Aleutian Arc. It is suggested that beginning in late Triassic time a subduction zone developed near Seldovia, where the northwestward-moving oceanic Pacific Plate was forced beneath the continental North American Plate. This activity continued into early Jurassic time when subduction induced volcanic activity occurred and portions of the Alaska-Aleutian batholith were emplaced just landward of the present-day northwest coast of Lower Cook Inlet and Shelikof Strait. This uplift provided the Matanuska-Wrangell Forearc Basin (fig. 11) with a source area for shallow water deposits of middle Jurassic age. Beginning in Early Cretaceous time, the Matanuska-Wrangell Forearc Basin became unstable and underwent several periods of uplift-erosion and downwarp-sedimentation. To the southeast, altered rocks (Chugach Terrane) of the Kenai Peninsula were initially deposited in a deepwater marine environment and later (Late Cretaceous) accreted to the Continental Margin as a result of thrust faulting (BLM, Alaska OCS Office, 1976).

Structurally, the Lower Cook Inlet-Shelikof Strait OCS is part of a northeast-trending trough (Matanuska-Wrangell basin) filled with Mesozoic and Tertiary sedimentary rocks. Within the basin, the aggregate thickness of the Mesozoic rocks may be more than 39,370 feet (12,000 m) and the aggregate thickness of the Tertiary rocks may be as much as 25,000 feet (7,620 m). The trough is bounded by two major faults, the Bruin Bay fault on the north-

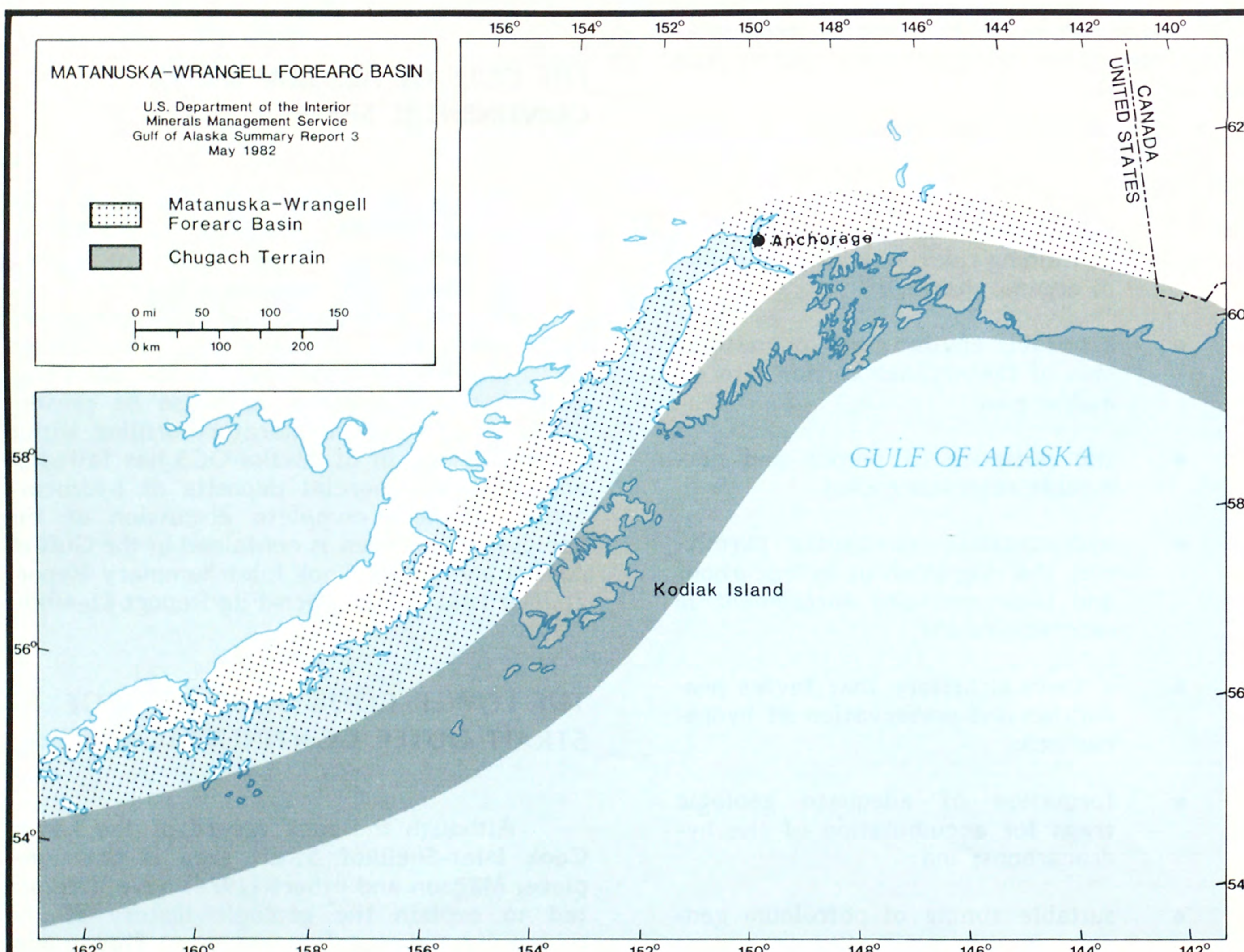

FIGURE 11.--Matanuska-Wrangell Forearc Basin. (Redrafted from Magoon and others, 1976, by Rogers, Golden & Halpern, 1982.)

west and the Border Ranges fault on the southeast (shown on figure 8, p. 13). West of the Bruin Bay fault, the rocks of the Alaska-Aleutian batholith are plutonic, extrusive volcanic, or metamorphosed sedimentary units. To the east of the Border Ranges fault, the rocks are undifferentiated deposits of melange and flysch. Three cross sections of the Lower Cook Inlet-Shelikof Strait OCS are contained in figure 12.

Information about the geology of the Lower Cook Inlet-Shelikof Strait OCS has been garnered from a variety of sources, including seismic tests, exploratory wells, and the review of available literature for conterminous areas. Information about the subsurface geology of Lower Cook Inlet can be extrapolated from data that have been generated by exploratory and development wells located offshore to the north and onshore to the east. Seismic data from the OCS areas in Lower Cook Inlet were first collected in 1975 prior to Lease Sale CI. Approximately 300 miles (483 km) of seismic data were acquired and evaluated by the U.S. Geological Survey. Also, two onshore areas (Cape Douglas and Seldovia) were mapped geologically for the purpose of extending the data offshore into the OCS lease sale area. A Continental Offshore Stratigraphic Test (COST) well was drilled in June 1977 to a depth of 12,387 feet (3,776 m) in 216 feet (66 m) of water in Lower Cook Inlet to provide stratigraphic information to the petroleum industry before the lease sale. As a result of the sale, eight exploratory wells were drilled on the Lower Cook Inlet OCS.

Information about the subsurface geology of the Shelikof Strait can be inferred from reconnaissance geology maps and onshore well records. In addition, 270 miles (435 km) of deep-reflection seismic, gravity, and magnetic data have been collected in a coarse grid; however, this grid is inadequate to determine the location and trend of offshore structures. To date, no wells have been drilled in the Shelikof Strait OCS.

Within the Lower Cook Inlet-Shelikof Strait OCS, rocks of early Jurassic age are considered to be the economic basement for petroleum exploration (Magoon and others, 1979). Unconformably overlying this basement sequence are middle and upper Jurassic marine sedimentary rocks. The middle Jurassic siltstone (Tuxedni Group) is the source rock for the oil currently being produced in Upper Cook Inlet. The thermal maturity of this formation results from deep burial in Cook Inlet and from igneous intrusion in Shelikof Strait (Magoon and others, 1979).

Lower Cretaceous siltstones and sandstones unconformably overlie the Jurassic sequence. There is no evidence that these rocks are potential source rocks, but Lower and Upper Cretaceous sandstones penetrated by COST Well No. 1 have fair to good reservoir potential, respectively.

Tertiary rocks of Lower Cook Inlet are primarily nonmarine coarse clastic deposits, including volcaniclastic conglomerates. Some of these stratigraphic units are potential source rocks for gas only. Tertiary sandstone and conglomerate strata possess good to excellent reservoir properties. In the Cook Inlet area, Tertiary rocks are commonly termed the Kenai Group and divided into the West Foreland Formation, Hemlock Conglomerate, and Tyonek, Beluga, and Sterling Formation. Approximately 80 percent of the oil produced in Upper Cook Inlet comes from the Hemlock conglomerate, and much of the remaining 20 percent of production is from the Tyonek Formation. Less than 2 percent of the production is from the West Foreland Formation, the oldest unit in the Tertiary sequence.

Well data indicate that the total Tertiary sequence is approximately 22,966 feet (7,000 m) thick north of Kenai in Upper Cook Inlet (Magoon and others, 1979). The sequence thins considerably toward Shelikof Strait; outcrop data obtained onshore in Lower Cook Inlet show that Tertiary rocks are approximately 6,070 feet (1,850 m) thick.

Producing oil fields in Upper Cook Inlet are located on the east and west flanks of the basin. All these fields are structural traps, either anticlines or faulted anticlines, and the oil reservoirs are sandstone and conglomerate rocks of Tertiary age. Similar northeast-trending structures are present on the Lower Cook Inlet OCS. However, exploratory drilling to date has not encountered commercial quantities of hydrocarbons trapped in these structures.

The major subsurface structural feature of Lower Cook Inlet is an east-west trending transbasin arch called the Augustine-Seldovia

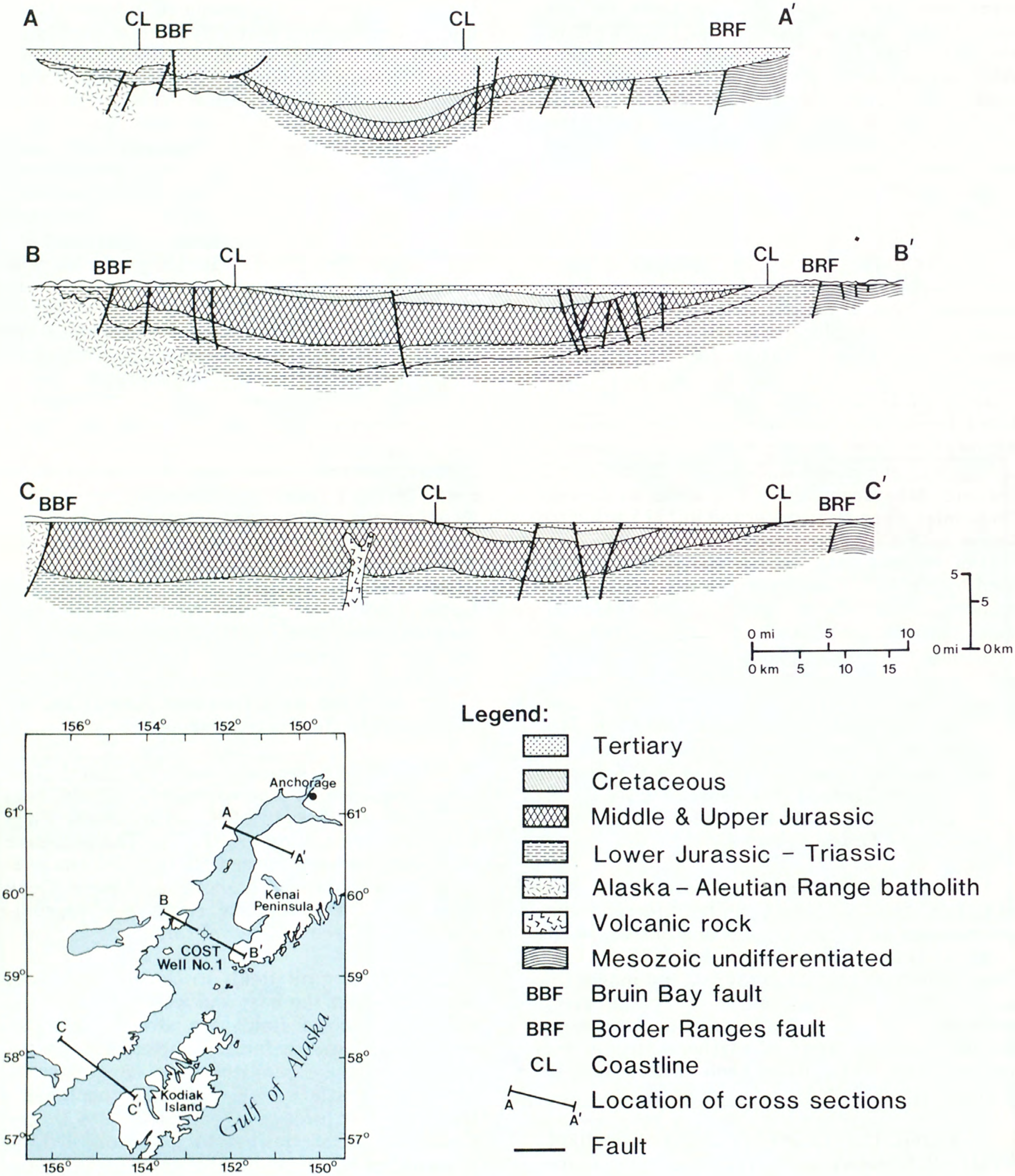

FIGURE 12.--Geologic cross section of Upper Cook Inlet, Lower Cook Inlet, and Shelikof Strait. (Redrafted from Magoon and others, 1979, by Rogers, Golden & Halpern, 1982.)

Arch. This structure is much larger than the northeast-trending folds described above. Structural traps could be present either on the flanks of the Arch or where the northeast-trending anticlines intersect it. Because the entire Cook Inlet basin flexes around the Arch, oil could migrate either from the southern part of the basin or from known petroleum source rocks in Upper Cook Inlet. Exploratory drilling has been conducted in vicinity of the Arch, but commercial quantities of hydrocarbons have not been discovered there. However, not all potential structures on the Lower Cook Inlet OCS have been explored.

To date, the petroleum geology of Shelikof Strait has received little study. The information that is available suggests that middle (?) Jurassic rocks, which are possibly similar to the source rocks found in the Upper Cook Inlet, are present in portions of the Strait's subsurface. Seismic data indicate that these and other Mesozoic rocks are unconformably overlain by Cenozoic reservoir rocks. Jurassic rocks onshore at Cape Douglas that have experienced igneous intrusion are known to be thermally mature (Magoon and others, 1979). Also, the burial depth of middle (?) Jurassic rocks under the Alaska Peninsula may be sufficient to generate oil and gas. Industry's interest in Shelikof tracts leased in Lease Sale 60 was based on information gathered from a dry onshore hole to the south that suggests a possible trend (Oil & Gas Journal, 1981).

Field studies indicate that a number of geologic hazards to oil and gas development exist, both within the Lower Cook Inlet-Shelikof Strait OCS and along the adjacent coastline. While careful consideration must be given to the avoidance or mitigation of these hazards, it must also be remembered that oil and gas exploration has been conducted for several years in the adjacent Upper Cook Inlet, which possesses a similar geological setting.

The Cook Inlet-Shelikof Strait area is located in a seismic risk zone that is susceptible to earthquakes of magnitude Richter 6.0-8.8 and where major structural damage could occur. Damage from an earthquake of this magnitude can be caused either directly by ground shaking, fault displacement, and surface warping, or indirectly by seismic sea waves (tsunamis), ground failure, and consolidation of sediment (BLM, Alaska OCS Office, 1981).

Volcanism is another hazard in the Lower Cook Inlet-Shelikof Strait that must be considered. Hazards associated with Alaska volcanoes include ash falls, lava flows, gas clouds, mud flows, landslides, flash floods, lightning discharges, corrosive rains, earthquakes, and tsunamis (BLM, Alaska OCS Office, 1976). While some of these hazards can produce damage on a regional scale, most are local in their effect.

Movement of sand and bedforms is a potential hazard in Lower Cook Inlet-Shelikof Strait, but currently there are insufficient data available to identify potential problem areas (Magoon and others, 1979). Erosion and redistribution of bottom sediment can result in the undermining or burial of fixed structures, anchors, semisubmersibles (when pontoons are close, within approximately 32 feet (10 m) to sea bottom) and pipelines.

Appendix B. OCS-Related Studies

There are several sources of information on Federal, State, and local oil- and gas-related activities in Alaska. Among them are the Arctic Environmental Information and Data Center (AEIDC), the Alaska Office of the Outer Continental Shelf Environmental Assessment Program (OCSEAP) of the Bureau of Land Management (BLM) and National Oceanic and Atmospheric Administration (NOAA), the BLM's Alaska OCS Office, and the U.S. Geological Survey's Public Inquiries Office. Studies available from or for inspection at these locations are discussed in this appendix, as well as Alaska oil- and gas-related studies produced for other Federal, State, and local agencies.

One of the best sources of Federal, State, and local studies concerning Alaska is the Arctic Environmental Information and Data Center. The AEIDC, a research unit of the University of Alaska, was established in 1972 by the Alaska State Legislature. The major objective of the AEIDC is to provide referral to and disseminate resource information about Arctic regions, with emphasis on the Alaska environment.

The Information Services staff of the AEIDC provides information referral, continually develops and maintains specialized information files, and retrieves and distributes information. These services are augmented by computerized data bases. The AEIDC's collection of 8,000 documents includes materials that are unpublished or out-of-print, and materials that are not restricted by copyright can be reproduced for a minimal charge.

The AEIDC publishes Current Research Profile for Alaska to document and categorize the scope of scientific research about or being conducted in Alaska. It contains abstracts of research in physical, biological, and related social sciences conducted during a given year. The most recent edition is for 1980.

For more information on AEIDC reports and services, contact:

AEIDC
707 A Street
Anchorage, AK 99501
(907) 279-4523.

The studies listed below were not included in the earlier Gulf of Alaska Summary Reports.

FEDERAL STUDIES

U.S. Department of the Interior:

Bureau of Land Management

The OCS environmental studies program of the Bureau of Land Management includes a number of BLM-funded studies administered through the National Oceanic and Atmospheric Administration's Outer Continental Shelf Environmental Assessment Program (OCSEAP). The studies funded under OCSEAP address the following subject areas: contaminant distributions; environmental hazards; pollutant transport, weathering, and fate; living resources; and effects of petroleum on marine organisms.

The reporting of these studies consists of annual, quarterly, and final reports as well as synthesis reports prepared prior to each lease sale. OCSEAP final reports, summarized in this section, are contractually required reports containing the investigator's conclusions, hypotheses, and recommendations concerning the specific subject covered in a given study. These reports are not necessarily the last report of the contract, and additional material may be presented in OCSEAP quarterly and annual reports, synthesis reports, other government or institution reports, and the open literature. The National Oceanic and Atmospheric Administration issues bound quarterly and annual reports as well as bound volumes of final reports categorized as physical science studies (volumes 1-3) and biological studies (volumes 1-16). Recent volumes are available from:

Writer/Editor
NOAA/OMPA/OCSEAP Alaska Office
P.O. Box 1808
Juneau, AK 99802
(907) 586-7441.

Requests for earlier volumes will be referred to NOAA's distribution center in Boulder, Colorado, or to the Department of Commerce's National Technical Information Service (NTIS). The address of NTIS is:

NTIS
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650.

Citations of publications resulting from these OCSEAP studies through January 1980 are compiled in **Environmental Assessment of the Alaskan Continental Shelf—Comprehensive Bibliography, 1980.** This report and information on more recent OCSEAP publications may be obtained from the NOAA/OMPA/OCSEAP office or:

Coordinator,
Environmental Studies Program
P.O. Box 1159
Anchorage, AK 99510
(907) 276-2955.

The Bureau of Land Management also funds some OCS environmental studies separately from OCSEAP. These are primarily marine mammal studies, some of which are summarized below. Other marine mammal studies include a tagging study to test a new radio tag design for use on gray whales and a tissue structural study on bowhead whales. Inquiries on these studies should be made to the BLM Alaska OCS Office. In addition, an ongoing study on oil toxicity and seabirds is being funded out of the BLM Pacific OCS Office to determine long-term effects of ingested crude oil on seabird reproduction. For information contact the BLM Pacific OCS Office, Federal Building, Room 200, 1340 West 6th Street, Los Angeles, CA 90017.

The Bureau of Land Management's OCS Socioeconomic Studies Program researches socioeconomic, sociopolitical, and transportation impacts of oil and gas activities and the effects on the man-made and natural physical environment. Studies are conducted prior to each lease sale. Many of the reports resulting from these studies are available from the source listed below as well as from NTIS:

Coordinator,
Socioeconomic Studies Program
P.O. Box 1159
Anchorage, AK 99510
(907) 276-2955.

Studies for the Gulf of Alaska summarized below include OCSEAP final reports, additional BLM-funded environmental studies, socioeconomic studies under BLM's Socioeconomic Studies Program, and other BLM studies. Although most reports are available through the National Technical Information Service, these studies may also be reviewed at the BLM Alaska OCS Office, 620 East 10th Avenue, Anchorage, Alaska; at the Washington OCS Office of the BLM, 18th and C Streets, NW., Washington, D.C.; or at the NOAA/OMPA/OCSEAP Alaska Office in Juneau.

Ainley, D.G., Grau, C.R., Morell, S.H., Roudybush, T.E., and others, 1979, Influence of petroleum on egg formation and embryonic development in seabirds: prepared for OCSEAP, RU 423. Available from NOAA/OMPA/OCSEAP.

This report evaluates the effects of brief sublethal exposure to an oil spill on reproduction of Cassin's Auklet and Western Gulls nesting on the Farallon

Islands, California. A single oral dose of bunker C fuel oil or Prudhoe Bay crude oil was administered and the effects noted on egg production, hatching success, fledging success, egg yolk structure, and yolk composition. Laboratory studies were designed to determine effects on yolk qualities and composition and embryonic changes in response to the oil.

Anderson, J.W., Roesijadi, G., Augenfeld, J.M., Riley, R.G., and others, 1980, Research to determine the accumulation of organic constituents and heavy metals from petroleum-impacted sediments by marine detritivores of the Alaskan OCS: prepared for OCSEAP by Battelle Pacific Northwest Laboratories, Richland, Wash., RU 454. Available from NOAA/OMPA/OCSEAP.

This study investigates the fate of petroleum hydrocarbons in the water column and intertidal zone and their bioavailability to, and effects on, the biota. Investigations included two field habitats to supplement laboratory observations.

Arneson, Paul, 1980, Identification, documentation and delineation of coastal migratory bird habitat in Alaska: prepared for OCSEAP by the Alaska Department of Fish and Game, Anchorage, Alaska, RU3, 35 p. Available from NOAA/OMPA/OCSEAP.

The two major objectives of this study were to determine seasonal density and distribution, critical habitats, migratory routes and breeding locales in littoral and estuarine habitats for principal bird species in seven regions of south central Alaska and to delineate bird habitat types seaward of the stormtide line. The coastal surveys were conducted between October 1973 and August 1978. Thirty-nine habitat types were used in the final analysis of habitat preferences of birds.

Barnes, I.L., Kingston, H.M., Rains, T.C., and Moody, J.R., 1977, Research and evaluation of trace element methodology for the analysis of sea water: prepared for OCSEAP by the Institute of Materials Research, National Bureau of Standards, Washington, D.C., RU 47. Available from NOAA/OMPA/OCSEAP.

This study investigates methods of trace element analysis of sea water. The study demonstrates that a number of plastic materials may be suitable for the collection and storage of samples of sea water and that analysis for a variety of elements may be done accurately on as little as 100 milliliters of water using graphite furnace atomic absorption spectometry, if extreme care is taken to prevent contamination during the preconcentration procedure. A new preconcentration procedure has been developed that removes elements that are interferences in many analytical methods, making possible the use of a variety of techniques such as atomic absorption (flame or flameless), neutron activation, and x-ray fluorescence.

Blackburn, James E., 1979, Demersal fish and shellfish assessment in selected estuary systems of Kodiak Island: prepared for OCSEAP by the Alaska Department of Fish and Game, Kodiak, Alaska, RU 486, 47 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This study presents the results of a total of 240 otter trawl hauls that were completed in Ugak and Alitak Bays on Kodiak Island during June, July, August, and September, 1976, and March 1977. The predominant taxa captured in order of importance were snow crab, king crab, yellowfin sole, shrimp, great sculpin, flathead sole, yellow Irish Lord, Pacific halibut, Pacific cod, walleye pollock, starry flounder, and Gymnocanthus. Features of temporal and spatial distribution and limited comments on growth and food habits are presented.

Blackburn, James E., Anderson, Karen, Hamilton, Carole I., and Starr, Suzanne J., 1980, Pelagic and demersal fish assessment in the Lower Cook Inlet estuary system: prepared for OCSEAP by the Alaska Department of Fish and Game,

Kodiak, Alaska, RU 512, 333 p. Available from NOAA/OMPA/OCSEAP.

This study includes a survey of the nearshore community of fishes and commercial invertebrates in Lower Cook Inlet to determine their distributions, relative abundance, seasonal movements, and food habits; a review of available information on fisheries of Cook Inlet and Shelikof Strait; and a description of the potential for impact of oil-related activities on marine resources of Cook Inlet and Shelikof Strait.

Burns, *John J., and Frost, Kathryn J., 1979, The natural history and ecology of the bearded seal, Erignathus barbatus: prepared for OCSEAP by the Alaska Department of Fish and Game, Fairbanks, Alaska, RU 230, 77 p. Available from NOAA/OMPA/OCSEAP.*

This report presents a study of the natural history .and ecology of bearded seals undertaken from June 1975 through April 1979. A preliminary life table was developed and presented. Based on recent harvests, the contribution of bearded seals to village economies was estimated. In addition, growth parameters, some behavioral characteristics, seasonal movements, and pathology and contaminant burdens were summarized. Direct and indirect effects of OCS development, excluding major accidents such as spills, were also discussed.

Calkins, *Donald G., and Curatolo, James A., 1979, Marine mammals of Lower Cook Inlet and the potential for impact from Outer Continental Shelf oil and gas exploration, development, and transport: prepared for OCSEAP by the Alaska Department of Fish and Game, Anchorage, Alaska, RU 243, 77 p. Available from NOAA/OMPA/OCSEAP.*

This study reviews all available data on marine mammals in Cook Inlet; all pertinent information on the physical, chemical, and biological properties of Cook Inlet; and the known oil operations, probable development scenarios, and the fate of oil in the marine environment. Marine mammal use of Lower Cook Inlet and the potential for impact by oil and gas exploration, production, and transportation on marine mammals are discussed.

Cannon, *P. Jan, 1976, The environmental geology and geomorphology of the Gulf of Alaska Coastal Plain: prepared for OCSEAP by the Division of Geoscience, University of Alaska, Fairbanks, Alaska, RU 99. Available from NOAA/OMPA/OCSEAP.*

This report presents information that can be used in an environmental assessment of the coastal plain of the Gulf of Alaska. It also contains an evaluation of radar imagery as a major information source for environmental geological mapping. Five maps display certain baseline data necessary for an environmental assessment of the coastal plain.

Carls, *Mark G., and Rice, Stanley D., 1980, Toxicity of oil-well drilling muds to Alaskan larval shrimp and crabs: prepared for OCSEAP by the National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska, RU 72, 35 p. Available from NOAA/OMPA/OCSEAP.*

This study was undertaken in the laboratory to measure the toxicity of drilling muds to crab and shrimp larvae to provide a better basis for assessing potential environmental effects of drilling muds. Several types of tests were conducted on six species of crab and shrimp larvae.

Cimberg, *Robert L., Gerrodette, Tim, and Muzik, Katherine, 1981, Habitat requirements and expected distribution of Alaskan coral: prepared for OCSEAP by VTN Oregon, Inc., Wilsonville, Oreg., RU 601, 53 p. and appendixes. Available from NOAA/OMPA/OCSEAP.*

This study is a literature review concerning the known and predicted dis-

tributions, habitats, and commercial value of Alaskan corals in order to assess impacts of oil and gas exploration and development on these organisms. The report concludes that the greatest anticipated impact would result from increased sediment fouling and toxicity from drilling fluids and muds; the extent of damage would depend on pollutant concentration and species sensitivity.

Costa, D.P., and Kooyman, G.L., 1980, Effects of oil contamination in the sea otter, Enhydra lutris: prepared for OCSEAP by the Scripps Institution of Oceanography, University of California, La Jolla, California, RU 71, 43 p. Available from NOAA/OMPA/OCSEAP.

This study measured the effects of crude oil contamination on sea otters through studies on the changes in the animals' physiology and behavior before and after contact with oil. The study showed that small amounts of crude oil contamination have large effects on the metabolic rate of sea otters. The study concludes that any contact with oil at any time of year would have a profound influence on the health of individual sea otters through increases in the animal's thermal conductance and the subsequent increase in metabolic rate, and that death may follow from pneumonia or hypothermia, depending upon the amount of the animal's fur fouled. Rehabilitation of oil-fouled sea otters would be very costly, and the success rate is likely to be low.

Dames & Moore, 1980, Evaluation of CODAR data, Lower Cook Inlet, Alaska: prepared for OCSEAP, Los Angeles, Calif., RU 436, 32 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This study presents a limited comparison of Coastal Ocean Dynamics Application Radar (CODAR) generated data to traditionally measured data and their subsequent application in predicting resultant surface drift. The CODAR data were acquired in Lower Cook Inlet, Alaska, during the period July 1-8, 1980. CODAR is seen as one of the more promising and newly emerging oceanographic monitoring technologies, with direct application to pollutant transport patterns and oil spill modeling. This is one of a series of studies conducted by Dames & Moore to investigate the behavior of hypothetical oil spills within the Alaska Outer Continental Shelf.

Dames & Moore, 1979, Oil spill trajectory analysis, Lower Cook Inlet, Alaska: prepared for OCSEAP, Los Angeles, Calif., RU 436, 81 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

The primary purpose of this study was to update existing wind and water current fields using recently available data and to analyze the transport of postulated surface oil slicks under these fields. The results of this project include not only the predicted oil spill behavior, but also the input wind and current fields. The fields developed represent the most recent synthesis of current measurement and modeling results available in October 1978.

Dames & Moore, 1980, Oil spill trajectory simulation, Lower Cook Inlet-Shelikof Strait, Alaska, final report, task I: prepared for OCSEAP, Los Angeles, Calif., RU 436, 47 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

The primary objective of this study, one of a continuing series focusing on the behavior of spilled oil, was to perform trajectory simulations of spilled oil in Lower Cook Inlet and Shelikof Strait, Alaska. Trajectories of the centroid of hypothetical surface slicks originating from selected launch sites throughout the study area represented slick behavior. Physico-chemical processes such as spreading, evaporation, and sinking were neglected. Trajectory driving forces included winds and tidal and net currents.

Dames & Moore, 1980, Wind field transition matrix analysis, Lower Cook Inlet-Shelikof Strait, Alaska, final report, task I:

prepared for OCSEAP, Los Angeles, Calif., RU 436, 18 p. and appendixes. Available from NOAA/OMPA, OCSEAP.

This report describes the results of a wind field transition matrix analysis based on historical weather data used in an oil spill trajectory simulation in Lower Cook Inlet and Shelikof Strait, Alaska. This is one of a series of studies conducted by Dames & Moore to investigate the behavior of hypothetical oil spills within the Alaska Outer Continental Shelf. This study investigated the validity of using a first-order transition matrix to represent the time history of weather patterns in southern Alaska. Three basic questions were investigated: (1) How accurate is the first-order approach? (2) Is there anything to support use of a second-order matrix? and (3) Does a first-order matrix generate unrealistic sequences of weather patterns?

Dick, *Matthew, 1977, Notes on the winter seabirds of Chiniak Bay, Kodiak Island, Alaska: Part XI of Population dynamics and trophic relationships of marine birds in the Gulf of Alaska and southern Bering Sea: prepared for OSCEAP by the Fish and Wildlife Service, Anchorage, Alaska, RU 341, 20 p. and addendum. Available from NOAA/OMPA/OCSEAP.*

Observations of winter seabirds were made in Chiniak Bay, Kodiak Island, in the winter of 1976-77. Much of the discussion in this report draws comparisons between winter and summer avifauna in the area. Overall winter density appears to be one-third to one-half as great as summer density. In winter, birds tend to be distributed more evenly over the bay, especially close to shore. The bulk of the overall density of birds is comprised of anseriformes in winter and charadriformes in summer. In winter the most important activity of birds is eating, while in summer reproductive activities take a sizeable portion of time and energy. A winter oil spill might prove more fatal than a summer spill because of freezing temperatures.

Domeracki, Daniel D., Thebeau, Larry C., Getter, Charles D., Sadd, James L., and others, 1981, Sensitivity of coastal environments and wildlife to spilled oil—Alaska Shelikof Strait region: prepared for OCSEAP by RPI, Inc., Columbia, S.C., RU 59, 83 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This report is an explanatory text for a series of 40 maps that delineate the sensitivity of coastal environments of the Shelikof Strait region to oil spill impact. An environmental sensitivity index is used to rank the coastal environments on a 10-point scale. Aerial reconnaissance, site-specific studies, and literature review were used in a classification technique called the integrated zonal method to identify 10 different coastal environments. The text briefly outlines basic strategies for spill response and protection for the different environments based on their sensitivity. Biological considerations such as the location of bird colonies, seal haulouts, and shellfish areas are indicated on the maps.

Dunn, *Jean R., Kendell, Arthur W., Jr., Wolotira, Robert J., Jr., Bowerman, John H.J., and others, 1980, Seasonal composition and food web relationships of marine organisms in the nearshore zone--including components of the ichthyoplankton, meroplankton, and holoplankton: prepared for OCSEAP by the Northwest and Alaska Fisheries Center, Seattle, Wash., RU 551, 419 p. Available from NOAA/OMPA/OCSEAP.*

From fall 1977 through winter 1979, five offshore cruises were conducted over the Continental Shelf off Kodiak Island to characterize the zooplankton communities of the area, with emphasis on the meroplanktonic stages of species of commercial importance. Plankton and hydrographic data were collected at about 90 stations during each cruise. Results concerning decapod larvae obtained from plankton samplings during 12 two-week cruises in four of the major bays on the eastern side of Kodiak and Afognak islands are also reported. Several types of plankton tows were made to investigate vertical-diel distributions as well as seasonal and geographic distributions and abundances.

Feder, H.M., and Matheke, G., 1979, Distribution, abundance, community structure, and trophic relationships of the benthic infauna of the northeast Gulf of Alaska: prepared for OCSEAP by the Institute of Marine Sciences, University of Alaska, Fairbanks, Alaska, RU 5. Available from NOAA/OMPA/OCSEAP.

This study presents a qualitative and quantitative inventory of benthic species within and adjacent to identified oil-lease sites in the northeast Gulf of Alaska. Forty-one widely dispersed sites for quantitative grab sampling were established. These sites represent a reasonable nucleus around which a monitoring program could be developed. Spatial and temporal distribution patterns of selected species in the designated study area are described and observations are made of biological interrelationships, specifically trophic interactions, between components of the benthic biota. The data suggest that sufficient site and/or area uniqueness exists to permit development of monitoring programs based on species composition at selected sites, and that adequate numbers of biologically well-known and abundant species are available to permit nomination of monitoring candidates once industrial activity is initiated.

Feder, H.M., Paul, A.J., Hoberg, Max, Jewett, Stephen, and others, 1980, Distribution, abundance, community structure and trophic relationships of the nearshore benthos of Cook Inlet: prepared for OCSEAP by the Institute of Marine Science, University of Alaska, Fairbanks, Alaska, RU 5, 310 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This study included an inventory and census of dominant benthic species and their critical habitats. Information on important species in the food webs supporting the commercially harvested benthic crustaceans and their methods of feeding was also collected. Feeding studies of the zoeae of three species of crab and shrimp were initiated. Growth histories were determined for several species of long-lived, sedentary, small clams. The report concludes that oil contamination of the benthic environment in Kachemak Bay, Kamishak Bay, or the large area near the mouth of the Inlet between Shaw Island and the Barren Islands could negatively affect the populations of crab and shrimp. Some fishes could also be affected by feeding on contaminated prey organisms. However, lack of information on the effect of oil pollution on benthic species of Cook Inlet currently precludes quantitative estimations of the extent or type of damage that oil contamination could cause.

Feder, H.M., and Jewett, Stephen C., 1980, Distribution, abundance, community structure and trophic relationships of the nearshore benthos of the Kodiak Continental Shelf: prepared for OCSEAP by the Institute of Marine Science, University of Alaska, Fairbanks, Alaska, RU 5, 188 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

The objective of this study is to assemble baseline data on the biology of the invertebrates of the shallow, nearshore benthos of Kodiak Island before industrial activities begin there. The study assesses the distribution and relative abundance of epifaunal and infaunal invertebrates in selected bays, inshore areas, and offshore areas, and also determines feeding habits, develops food webs, and compiles seasonal reproductive data and other biological data, whenever possible, on dominant benthic epifaunal invertebrates.

Feder, H.M., and Jewett, Stephen C., 1978, Distribution and abundance of some epibenthic invertebrates of the northeastern Gulf of Alaska with notes on the feeding biology of selected species: prepared for OCSEAP by the Institute of Marine Science, University of Alaska, Fairbanks, Alaska, RU 5. Available from NOAA/OMPA/OCSEAP.

The objectives of this study were to obtain a qualitative and quantitative inventory of dominant epibenthic species within the study area, a description of spatial distribution patterns of selected benthic invertebrate species, and preliminary observations of biological interrelationships between selected segments of the benthic biota. Initial assessment of the data suggests that a few unique, abundant, and/or large benthic species (snow crabs, shrimps, brittle stars, sea stars) are characteristic of the areas investigated and that these species may represent organisms that could be useful for monitoring purposes. The study concludes that two biological parameters that should be addressed in conjunction with petroleum-related activities are feeding and reproductive biology of important species.

Feely, Richard A., Massoth, Gary J., Paulson, Anthony J., and Lamb, Marilyn F., 1980, Distribution and elemental composition of suspended matter in Alaskan coastal waters: prepared for OCSEAP by Pacific Marine Environmental Laboratory, NOAA, RU 152, 136 p. Available from NOAA/OMPA/OCSEAP.

This study investigated the distribution and elemental composition of suspended matter in the northeastern Gulf of Alaska, Lower Cook Inlet, the southeastern Bering Sea Shelf and Norton Sound. The study was carried out to assess the effects of crude oil contamination in coastal waters, particularly massive oil spills.

Gill, Robert, Jr., Handell, Colleen, and Peterson, Margaret, 1978, Migration of birds in Alaska marine habitats: prepared for OCSEAP by the Fish and Wildlife Service, Office of Biological Services--Coastal Ecosystems, Anchorage, Alaska, RU 340. Available from NOAA/OMPA/OCSEAP.

This report summarizes existing data on the timing, routes, patterns and magnitudes of bird migrations in Alaska OCS areas and attempts to relate these events to lease area activities. Because of limitations of the available data, emphasis was placed on species that are highly vulnerable to oil contamination, on areas of present or pending OCS mineral mining activities, and on areas that support large populations of breeding, wintering, and transient marine birds.

Griffiths, Robert P., and Morita, Richard Y., 1980, Study of microbial activity and crude oil--microbial interactions in the waters and sediments of Cook Inlet and the Beaufort Sea: prepared for OCSEAP by Oregon State University, Department of Microbiology, Corvallis, Oreg., RU 190. Available from NOAA/OMPA/OCSEAP.

This study collected baseline data on various microbial functions related to the overall productivity of Cook Inlet, Beaufort Sea, and Norton Sound ecosystems. Both long-term and short-term effects of crude oil and the dispersant Corexit 9527 on microbially mediated cycling of carbon, nitrogen, and phosphorus in the sediments and water column also were studied. An effort was made to relate the findings to management decisions concerning the production and transport of crude oil.

Handel, Colleen M., Peterson, Margaret R., Gill, Robert E., Jr., and Lensink, Calvin J., 1980, An annotated bibliography of literature on Alaska water birds: prepared for OCSEAP by the Fish and Wildlife Service, Marine Bird Section, National Fisheries Research Center, Anchorage, Alaska, RU 339. Available from NOAA/OMPA/OCSEAP.

This report is an attempt to compile all substantive references addressing water birds in Alaska. This bibliography contains 1,554 citations and is current for most journal sources through 1979 and most of 1980. The content of each paper is summarized and each citation is indexed by subject, species, and geographic location. The study includes unpublished as well as published materials. General references or papers that include information on Alaska only as part of a larger area or topic have been omitted.

Hayes, Miles O., and Ruby, Christopher H., 1979, Oil spill vulnerability, coastal morphology, and sedimentation of the Kodiak Archipelago: prepared for OCSEAP by the Coastal Research Division, Department of Geology, University of South Carolina, Columbia, S.C., RU 59, 84 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This study evaluated rates of change in coastal morphology, with particular emphasis on rates and patterns of man-induced changes, and located areas where coastal morphology is likely to be changed by man's activities. The relative susceptibility of different coastal areas was evaluated, especially with regard to potential oil spill impacts. An oil spill vulnerability index was used to evaluate 10 different types of coastal areas. The results of the study have been summarized in the text and appendixes of this report as well as on a set of 47 base maps. The maps show the oil spill vulnerability indexes as well as the position of the 127 sample and profile sites established in the study area.

Houghton, J.P., Critchlow, K.R., Lees, D.C., Czlapinski, R.D., and others, 1981, Fate and effects of drilling fluids and cuttings discharges in Lower Cook Inlet, Alaska, and on Georges Bank: prepared for OCSEAP by Dames & Moore, Seattle, Wash., with contributions from Northern Technical Services, Anchorage, Alaska, RU 602, 200 p. and appendix. Available from NOAA/OMPA/OCSEAP.

This investigation used laboratory, field, and monitoring studies to predict the fate and effects of drilling fluids and cuttings discharges. Extensive laboratory testing demonstrated that the bulk of materials present in drilling fluids are relatively nontoxic chemically but contribute to high suspended solids levels. All field and monitoring studies have shown that high rates of dilution of drilling fluids occur within a relatively short distance of the discharge and that background levels for most water quality parameters are approached within 3,280 feet (1,000 m). The study concludes that the hydrodynamic regime in the majority of Lower Cook Inlet is ideally suited to minimize the impact of drilling fluid and cuttings discharges. If the total quantity of mud released from the BLM (1976) development scenario for Lower Cook Inlet were transported to the most likely ultimate sink (Shelikof Strait) and spread evenly on the bottom, it would be undetectable chemically and insignificant biologically.

Jones, Robert D., Peterson, Margaret R., Slater, Claudia, and Burke-Ogan, Janet, 1980, The pelagic birds of Chisik and Duck Islands: prepared for OCSEAP by the Fish and Wildlife Service, Anchorage, Alaska, RU 341. Available from NOAA/OMPA/OCSEAP.

This is a 2-year study of seabird colonies on Chisik and Duck Islands, which comprise the Tuxedni Wilderness in Lower Cook Inlet. The report compiles productivity statistics concerning black-legged kittiwakes and horned puffins throughout their incubation and nestling stages to fledging. A population simulation model used to consider the implications of known kittiwake reproductive failures showed the population to be declining. The report includes general observations as well as a literature review concerning primary food fish.

Kaplan, I.R., and Venkatesan, M.I., 1981, Characterization of organic matter in sediments from Gulf of Alaska, Bering and Beaufort Seas: prepared for OCSEAP by the University of California, Institute of Geophysics and Planetary Physics, Los Angeles, Calif., RU 480, 88 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

In this study, Outer Continental Shelf surficial sediments collected from the proposed lease areas of Beaufort Sea, southeastern Bering Sea, Norton Sound, Navarin Basin, Gulf of Alaska, Kodiak Shelf, and Cook Inlet were analyzed to determine the distribution and concentration of high molecular weight hydrocarbons. The objectives of the investigation were to establish baseline hydrocarbon levels, to characterize the distribution and nature of these hydrocarbons, to assess the possible source of the hydrocarbons, and to understand the probable pathways of hydrocarbon transport in the area in case of an oil spill.

Kendall, Arthur W., Jr., Dunn, Jean R., Matarese, Ann C., Rogers, Donald E., and others, 1980, Taxonomic composition, seasonal distribution, and abundance of ichthyoplankton in the nearshore zone of the Kodiak Archipelago,

Alaska: prepared for OCSEAP by the Northwest and Alaska Fisheries Center, Seattle, Wash., RU 551, 62 p. Available from NOAA/OMPA/OCSEAP.

This report summarizes the results of an ichthyoplankton survey conducted on the Continental Shelf and in four major bays of the Kodiak Archipelago. The objectives of this survey were to determine the taxonomic, spatial, and seasonal distribution of planktonic eggs and larvae of fish of the Kodiak area to help evaluate if, when, and where petroleum exploration and development could proceed and avoid impacts to the fisheries resources of the area. Some understanding of the factors influencing the observed distributions was also sought. The waters of the shelf and bays of the Kodiak area hold a complex, diverse ichthyoplankton assemblage, and the bays and shelf of the Kodiak area are used by a wide variety of fishes during their planktonic stages. The study concludes that the effects in the Kodiak area of chronic or catastrophic events associated with petroleum development on fish population cannot be predicted from present knowledge.

Kuhn, P.M., Stearns, L.P., Salazar, E.S., and Loupee, B.J., 1977, Radiometric spectral response of oil films: prepared for OCSEAP by the National Oceanic and Atmospheric Administration, Boulder, Colo., RU 399. Available from NOAA/OMPA/OCSEAP.

This study identifies and determines the extent of oil spills on sea water. In the laboratory an infrared radiometer system was used in conjunction with simulated oil spills. Preliminary results of this research indicate that unique infrared signatures may be found for various oil types. The extent of a spill was found to be easily determined by the infrared radiometer system.

Larrance, Jerry D., and Chester, Alexander J., 1979, Source, composition, and flux of organic detritus in Lower Cook Inlet: prepared for OCSEAP by the Pacific Marine Environmental Laboratory, NOAA, RU 425, 50 p. and appendix. Available from NOAA/OMPA/OCSEAP.

In this study, a series of sediment trap deployments was combined with intensive water column sampling to obtain measurement of the production and input of organic detritus to the sea floor in relation to the bio-physical environments of Lower Cook Inlet. During four of five 1-week cruises from March through August 1978, three sediment-trap arrays were deployed in environmentally distinct areas of the Lower Cook Inlet. The samples provided measurements of downward fluxes of total particulate matter, organic carbon and nitrogen, chlorophyll a and phephorbide a, fecal pellets, and other microscopically identifiable particles including phytoplankton cells, crustacean molts, and microzooplankton. The results indicate the transfer of substantial organic matter (which presumably is a needed nutrition source for the benthos) from surface waters to the benthos, much of it via zooplankton fecal pellets. Such particles, if contaminated with oil, act as transfer agents for oil from the surface, thus affecting the benthic community.

Lees, Dennis, 1977, Reconnaissance of the intertidal and shallow subtidal biotic Lower Cook Inlet: prepared for OCSEAP by Dames & Moore, RU 417, 327 p. Available from NOAA/OMPA/OCSEAP.

This report presents the results of a reconnaissance survey of the intertidal and shallow subtidal habitats of Lower Cook Inlet conducted during May, June, July, and August 1976. This survey comprised an aerial reconnaissance of the west side of the inlet and examination of several sites in representative habitats in the intertidal and shallow subtidal zones on both sides of the inlet. In all, reconnaissances were conducted in nine general sites on the east side of the inlet and in seven on the west. The apparent patterns observed in the distribution of benthic assemblages (based on whether they import plant material to meet their energy and nutrient needs or export

plant material to supply other areas) are important in understanding the interrelationships of the Cook Inlet systems and should provide useful tools in planning resource management and petroleum development in Lower Cook Inlet.

Malins, Donald G., 1976, Assessment of available literature on effects of oil pollution on biota in Arctic and subarctic waters: prepared for OCSEAP by the National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, Wash., RU 75. Available from NOAA/OMPA/OCSEAP.

The material included in this report comprises section III of a literature review carried out by the Environmental Conservation Division of the National Marine Fisheries Service. Literature is reviewed on toxicity of crude oils and crude oil components, including heavy metals, and on the composition and toxicity of formation waters, various drilling muds, and their components. The six research papers included in this report encompass the potential sources and levels of trace metals in the marine environment and their potential biological effects in relation to petroleum drilling and transport operations in Arctic and subarctic environments. The biological effects of four metals--cadmium, lead, chromium, and nickel--on organisms were studied in detail.

McCain, B.B., Hodgins, H.O., Sparks, A.K., Gronlund, W.D., and Myers, M.S., 1980, Determine the frequency and pathology of marine fish diseases in the Bering Sea, Gulf of Alaska, Norton Sound, and Chukchi Sea: prepared for OCSEAP by the National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Seattle, Wash., RU 332, 63 p. Available from NOAA/OMPA/OCSEAP.

The overall objective of this study was to obtain baseline data on the prevalence, distribution, and characteristics of diseases presently existing in fish and invertebrates in the Bering Sea, Gulf of Alaska, Norton Sound, and Chukchi Sea. Approximately 60 species of fish were examined; of these, only 9 species were found to have pathological conditions. The types of conditions detected during the study were generally chronic conditions.

Moe, R.A., and Day, R.H., 1977, Populations and ecology of seabirds of the Koniuji Group, Shumagin Islands, Alaska: Part VI of Population dynamics and trophic relationships of marine birds in the Gulf of Alaska and Southern Bering Sea: prepared for OCSEAP by the Fish and Wildlife Service, Anchorage, Alaska, RU 341, 33 p. Available from NOAA/OMPA/OCSEAP.

This study on birds was undertaken to obtain information necessary to evaluate the potential impacts of the proposed OCS development and to provide baseline data for monitoring effects of development. The study objectives were to identify nesting colonies; to determine the approximate population and habitat requirements, productivity, and factors influencing reproductive success of individual species; and to determine food requirements and foraging areas of principal species. This is an annual report made after 1 year of research in the study area.

Muench, Robin D., and Schumacher, James D., 1980, Physical oceanographic and meteorological conditions in the northwest Gulf of Alaska: prepared for OCSEAP by the Pacific Marine Environmental Laboratory, NOAA, Seattle, Wash., RU 138, NOAA Technical Memorandum ERL PMEL-22, 218 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This report summarizes the findings of research into physical oceanographic conditions in the northwestern Gulf of Alaska. It stresses circulation features, as water circulation plays a major role in the path and dispersal of surface contaminants. The current observation program employed taut-wire moorings, drift card studies, satellite-tracked buoys, and wave radar (CODAR) observations. Temperature and salinity

observations and meteorological observations were also made. The study concludes that (1) the Alaskan Stream is a major regional oceanic circulation feature, driven principally by the wind stress curl over the Gulf of Alaska, which forces the North Pacific subarctic gyre, (2) dominant circulation on the banks south and southeast of Kodiak Island is predominantly driven by the Alaskan Stream, (3) a nearshore southwesterly flow along the Kenai Peninsula, the Kenai Current, is a baroclinic coastal current driven by the density field created by freshwater input along the Alaska coast and is at its annual minimum during spring and early summer, (4) flow through Shelikof Strait is southwesterly, with observed speeds during winter twice those in summer, (5) circulation in Lower Cook Inlet is dominated by the southwesterly flow into Shelikof Strait, which is constrained by bottom topography to traverse an arcuate east-west path across the lower Inlet, (6) currents throughout the study region are characterized by speed and direction fluctuations that have time scales between about 2 days and a week and are probably related either to meteorological factors or to propagation of ocean eddies across the shelf, (7) tidal currents vary widely in magnitude throughout the study region, and (8) winds are controlled by the interaction between large-scale northeastward migrating cyclonic low pressure systems and regional topography.

Muench, R.D., Schumacher, J.D., Hayes, S.P., and Charnell, R.L., 1978, Northeast Gulf of Alaska Program, final report: prepared for OCSEAP by the Pacific Marine Environmental Laboratory, NOAA, Seattle, Wash., RU 138. Available from NOAA/OMPA/OCSEAP.

The field program of this study, investigating physical oceanographic processes in the northeastern Gulf of Alaska, was completed in the summer of 1977. The major thrust of the field effort was to measure currents and bottom pressures. These were related to regional circulation where possible, and to coincident temperature, salinity, and weather data where appropriate. The report is intended to provide a useful working document both for environmental planning and for future, more focused, scientific endeavors in the region.

Muench, Robin D., Temple, Paul R., Gunn, John T., Hachmeister, Lon E., 1982, Coastal oceanography of the northeastern Gulf of Alaska: prepared for OCSEAP by Science Applications, Inc., Bellevue, Wash., RU 600, 137 p. Available from NOAA/OMPA/OCSEAP.

This study concerns Continental Shelf circulation as it relates to pollutant transport. The shelf regime is characterized by a large seasonally varying coastal freshwater influx, frequent vigorous along-shore wind events, and a complex bottom topography. For purpose of estimating pollution transport, the significant aspects are the following: (1) the shelf-wide general net northwesterly flow except for the location just north of Fairweather Bank where net flow was easterly, (2) the large and primarily wind-induced variability superposed upon the net flow, and (3) appreciable cross-shelf transport resulting from interaction of the net northwesterly flow with a complex bottom topography.

Patten, Samuel M., Jr., 1981, Seasonal use of coastal habitat from Yakutat Bay to Cape Fairweather by migratory seabirds, shorebirds, and waterfowl: prepared for OCSEAP by ORI, Inc., Silver Spring, Md., RU 531, Technical Report No. 1960, 146 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

The objectives of this study were to identify particularly important habitats near Yakutat and the nature and timing of their use by birds in order to develop a well-founded base for decisions concerning measures to minimize or mitigate impacts of petroleum development. In terms of the greatest number of birds observed, the most important avian habitats in the Yakutat area were (in descending order): marine beaches, rivers, coastal waters, and salt

marshes. This research indicates that areas with high numbers of individual birds and a low number of species are most sensitive to gas and oil exploration and development. These areas are important for large concentrations of birds, as major foraging areas, breeding sites, and migratory staging areas. The estuarine regions, considered particularly important because of their productivity and maintenance of high avian biomass, also are particularly vulnerable. Because of the shallow ocean slope of much of the Yakutat and Malaspina Forelands, saltwater and spilled oil potentially may extend as much as 3.1 miles (4.9 km) inland, through estuaries and up adjacent river valleys.

Patten, Samuel M., Jr., and Patten, Linda Renee, 1977, Evolution, pathobiology and breeding ecology of the Gulf of Alaska herring gull group (Larus argentatus x Larus glaucescens): prepared for OCSEAP by the Department of Pathobiology, The Johns Hopkins University, Baltimore, Md., RU 96/76, 129 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This study was a concentrated investigation of several gull colonies located in the northeast Gulf of Alaska, conducted during the summers of 1975 and 1976. The results of this investigation were compared to data gathered in previous Alaska research and to other studies in the literature. The study indicates that gull populations in the Gulf of Alaska have the potential for rapid increase with access to human garbage, sewage, and refuse associated with increased oil operations. The development of oil resources could affect gull reproduction positively through access to this food supply, or negatively through disturbance of colonies at certain critical periods in the breeding cycle.

Patten, Samuel M., Jr., and Patten, Linda Renee, 1979, Evolution, pathobiology, and breeding ecology of large gulls (Larus) in the northeast Gulf of Alaska and effects of petroleum exposure on the breeding ecology of gulls and kittiwakes: prepared for OCSEAP by the Department of Pathobiology, The Johns Hopkins University, Baltimore, Md., RU 96. Available from NOAA/OMPA/OCSEAP.

This report provides information on the evolution, breeding ecology, disease aspects, and effects of petroleum exposure on the breeding ecology of the Gulf of Alaska herring gull group (Larus argentatus x Larus glaucescens), with supporting information on the effects of petroleum exposure on the reproductive productivity of black-legged kittiwakes (Rissa tridactyla). The study indicates coastal gull populations have the potential for rapid increase with access to human garbage, sewage, and refuse associated with increased oil operations, but their colonies are sensitive to disturbance during the breeding season. Although oil spills have a potentially depressing effect on gull reproduction, the net result of increased human development in coastal Alaska will be expanding populations of large gulls, with distinctly negative implications for municipal health and sanitation, as well as population stability of other seabird species.

Pitcher, Kenneth W. and Calkins, Donald G., 1979, Biology of the harbor seal, Phoca vitulina richardsi, in the Gulf of Alaska: prepared for OCSEAP by the Alaska Department of Fish and Game, Anchorage, Alaska, RU 229, 71 p. Available from NOAA/OMPA/OCSEAP.

Biological studies of harbor seals in the Gulf of Alaska were conducted from 1975 through 1978 with the major objective of gathering information that could be used to regulate OCS developmental activities in such a manner to minimize adverse effects on harbor seal populations. Data were obtained through observations and counts of hauled-out seals, by relocating radio-tagged animals, and through analysis of specimens from collected seals. A partial catalog of major harbor seal concentrations was developed. This listing is composed primarily of haulout areas and is weak in aquatic distribution.

Polcyn, F.C., Lyzenga, D.R., and Marinello, E.I., 1977, Investigation of intertidal

zone mapping by multispectral scanner techniques: prepared for OCSEAP by the Environmental Research Institute of Michigan, Ann Arbor, Mich., RU 428, 45 p. and appendix. Available from NOAA/OMPA/OCSEAP.

This report presents preliminary results of an investigation of airborne sensing techniques for mapping and inventorying the intertidal zone along the Alaska coastline. Passive multispectral scanner data were collected at three sites in the Gulf of Alaska and were analyzed for spectral signatures. A computer was used to separate algal communities based on their spectral signature. A map-like presentation of the distribution of the communities was made by a computer-controlled ink jet printer. The technique appears promising for a broad scale description of the distribution of littoral communities.

Rice, *Dale W., and Wolman, Allen A., 1981, Summer distribution and numbers of fin, humpback, and gray whales in the Gulf of Alaska: prepared for OCSEAP by the National Marine Fisheries Service, National Marine Mammal Laboratory, Seattle, Wash., RU 592, 9 p. and appendixes. Available from NOAA/OMPA/OCSEAP.*

This study was a summer cruise survey of fin, humpback, and gray whales in the Gulf of Alaska in order to document their distribution and numbers. The survey results indicate that the populations of all species of great whales in the Gulf of Alaska have been severely depleted.

Rice, *Stanley D., Korn, Sid, and Karinen, John F., 1978, Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components: prepared for OCSEAP by the Northwest and Alaska Fisheries Center, Auke Bay Laboratory, National Marine Fisheries Service, RU 72. Available from NOAA/OMPA/OCSEAP.*

This study documents laboratory research on the effects of oil on selected Alaska marine species. The study indicates that the effects of oil are complex, species dependent, and variably modified by environmental factors. Extremely low concentrations of hydrocarbons were found to reduce the survival of marine organisms. Although there is a continuing need to test laboratory findings in the field, observations made during these studies were found to be useful in evaluating the impact of oil in the real environment and to be of use to regulatory agencies.

Rice, *Stanley D., Korn, Sid, and Karinen, John F., 1980, Lethal and sublethal effects on selected Alaskan marine species after acute and long-term exposure to oil and oil components: prepared for OCSEAP by the National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska, RU 72. Available from NOAA/OMPA/OCSEAP.*

This study compared the relative sensitivities of Arctic and subarctic organisms to oil. The sensitivities of six Arctic organisms (two fish and four invertebrates) were determined and compared with previously generated sensitivity data on subarctic organisms. The study also determined the effect of temperature on the sensitivity of Arctic animals to oil and their ability to acclimate to temperature change. The results indicate little difference in sensitivity of Arctic and subarctic animals to oil. However, the Arctic habitat is more vulnerable and, once changed, is less able to adjust. Although temperature had no effect on the sensitivity of Arctic animals to oil, lower environmental temperatures in the Arctic would result in oil persisting longer after a spill due to lower volatility and biodegradation of oil components and possible immobilization in ice.

Robertson, D.E., and Abel, K.H., 1979, Natural distribution and environmental background of three heavy metals in Alaskan shelf estuarine areas: prepared for OCSEAP by Battelle Pacific Northwest Laboratories, Richland, Wash., RU 506. Available from NOAA/OMPA/OCSEAP.

This study presents data that help describe the natural distribution and en-

vironmental background of trace metals in Alaska shelf and estuarine areas selected for offshore oil exploration and recovery, and it provides baseline information against which future environmental disturbances can be assessed. Trace metals were measured on sediment, suspended particulate matter, seawater samples, and biological samples of shelf and intertidal marine organisms by means of neutron activation analysis.

Rogers, Brenda J., Wangerin, Mark E., Garrison, Kathryn J., and Rogers, Donald E., 1980, Epipelagic meroplankton, juvenile fish, and forage fish: distribution and relative abundance in coastal waters near Yakutat: prepared for OCSEAP by the University of Washington, College of Fisheries, Fisheries Research Institute, Seattle, Wash., 100 p. Available from NOAA/OMPA/OCSEAP.

Because the ichthyoplankton and meroplankton components of the zooplankton communities of Yakutat are virtually unstudied, this investigation draws from studies in other areas. Inferences are made as to the distribution and relative abundance of these species based on seasonability, reproductive biology, and available fisheries information.

Rogers, Donald E., 1977, Determination and description of knowledge of the distribution, abundance, and timing of salmonids in the Gulf of Alaska and Bering Sea: a supplement to the final report: prepared for OCSEAP by the Fisheries Research Institute, College of Fisheries, University of Washington, Seattle, Wash., RU 353, 9 p. Available from NOAA/OMPA/OCSEAP.

The objective of this study was to describe the annual variation in abundance and seasonal timing of the migrations of adult and juvenile (smolt) salmon in the nearshore waters of Bristol Bay since 1951. Statistics on Bristol Bay salmon were collected by the National Marine Fisheries Service and Fisheries Research Institute during the 1950's and since then by the Alaska Department of Fish and Game. In most years there is either a large abundance of smolts or a large abundance of adults. Years in which there are very large numbers of sockeye salmon occur at 4- or 5-year intervals. Juvenile pink salmon are usually present only in odd-numbered years and adult pink salmon are usually present only in even-numbered years. Salmon are present in Bristol Bay from May through September; however, they are most abundant in June and July.

Roller, N.E.G., and Polcyn, F.C., 1977, Airborne multispectral mapping of the intertidal zone of southern Alaska: prepared for OCSEAP by the Environmental Research Institute of Michigan, Ann Arbor, Mich., RU 428, 105 p. and appendixes.

This report represents the completion of phase II of a study undertaken to investigate the use of airborne passive multispectral remote-sensing techniques for surveying intertidal habitats (see Polcyn, Lyzenga, and Marinello). The overall goal was to determine the cost-effectiveness of computer-processed airborne multispectral scanner data for intertidal mapping in Alaska. Multispectral analysis was performed on a data set collected by a low-flying aircraft at three sites. It is possible to separate vegetation into broad spatial zones representing either species of algae, species associations, or vegetation density classes. Clustering techniques were found to be most effective.

Ronholt, Lael L., Shippen, Herbert H., and Brown, Eric S., 1977, Demersal fish and shellfish resources of the Gulf of Alaska from Cape Spencer to Unimak Pass, 1948-1976: a historical review: prepared for OCSEAP by the National Marine Fisheries Service, RU 174, 4 vols., 955 p. and vol. 4. Available from NOAA/OMPA/OCSEAP.

This study provides a historical review of demersal fish and shellfish resources in the Gulf of Alaska from Unimak Pass to Cape Spencer and presents the results of resource assessment surveys. The objectives of these surveys are to define the distribution and relative abundance of demersal fish and shellfish resources available to otter

trawls; to estimate the standing stock and size composition of the principal species; to define the composition of the demersal fish communities by area and depth; and, for principal species, to collect data on length-weight relationships, age, and sexual maturity. Both systematic and stratified random sampling approaches were used in these surveys.

Rosenthal, Richard J., 1978, Preliminary observations on the distribution, abundance, and food habits of some nearshore fishes in the northeastern Gulf of Alaska: prepared for OCSEAP by Alaska Coastal Research, Homer, Alaska, RU 542. Available from NOAA/OMPA/OCSEAP.

This study, carried out between 1974 and 1977, is based on direct observations of fishes living in both exposed and protected habitats of the north Gulf Coast/Prince William Sound region. Specimens were collected and their stomachs analyzed for food items. Dietary trends are identified and trophic interactions or links in the food web between the fishes and their prey are presented. Numerical data were also collected on relative abundance and occurrence in the nearshore zone during August 1977. Major habitat types are described and their substrate type, depth, and vegetation are correlated with summer distribution of inshore pelagic and demersal species.

Rosenthal, Richard J., 1980, Shallow water fish assemblages in the northeastern Gulf of Alaska: habitat evaluation, species composition, abundance, spatial distribution, and trophic interaction: prepared for OCSEAP by Alaska Coastal Research, Homer, Alaska, RU 542, 84 p. Available from NOAA/OMPA/OCEAP.

This study was designed to provide a detailed description and ecological analysis of the fishes of the northeastern Gulf of Alaska and their characteristic habitats. Baseline information on fish abundance, density, biomass, and habitat utilization patterns was gathered. Efforts also were made to identify important food web links and dietary trends among the conspicuous species. Marked seasonal changes were recorded in species richness, density, and spatial distribution. Most of the fish were found to be quite flexible in their feeding habits, capitalizing on the most abundant prey.

Sanger, Gerald A., and Jones, Robert D., Jr., 1981, The winter feeding ecology and trophic relationships of marine birds in Kachemak Bay, Alaska: prepared for OCSEAP by the Fish and Wildlife Service, National Fishery Research Center, Migratory Bird Section, Anchorage, Alaska, RU 341, 123 p. Available from NOAA/OMPA/OCSEAP.

The winter feeding ecology of oldsquaw, white-winged scoters, common murres, and marbled murrelets was studied on Kachemak Bay, Alaska, from November 1977 through April 1978. The report concludes that birds wintering in Kachemak Bay appear to be at high risk from both acute and chronic oil spills. Most of the wintering community of birds are either waterfowl or alcids, the two major groups of birds most susceptible to oiling. Pollution that interferes substantially with the production of organic detritus, particularly from the extensive beds of kelp, could have more serious long-term consequences to the birds than direct oiling. In general, any potential threats to the bird community from petroleum activities needs to be evaluated in terms of the pattern of ocean currents.

Severinghaus, N.C., and Nerini, M.K., 1977, An annotated bibliography of marine mammals of Alaska: prepared for OCSEAP by the National Marine Fisheries Service, Seattle, Wash., RU 67/68/69/70. Available from NOAA/OMPA/OCSEAP.

This annotated bibliography was developed to aid in assessing baseline characteristics of marine mammals in Alaska as part of OCSEAP. It provides a comprehensive review of major published and unpublished literature on distribution and abundance of marine mammals of Alaska with respect to specific species and areas and serves as a resource base to guide researchers, managers, and administrators. The report includes area, species, and subject indexes.

Shaw, D.G., 1981, HC: natural distribution and dynamics of Alaskan OCS: prepared for OCSEAP by the University of Alaska, Institute of Marine Science, Fairbanks, Alaska, RU 275, 33 p. Available from NOAA/OMPA/OCSEAP.

This study provides baseline data on the ambient hydrocarbons of the water, sediment, and biota of Cook Inlet, the Gulf of Alaska, and the Beaufort Sea. An experimental model of the transport of oil to the benthos by absorption and sedimentation with suspended material was developed during the course of the study. In addition a theoretical model for the transport of oil to the benthos by incorporation into fecal pellets after ingestion by copopods was developed.

Smith, Ronald L., Paulson, Alan C., and Rose, John R., 1978, Food and feeding relationships in the benthic and demersal fishes of the Gulf of Alaska and Bering Sea: prepared for OCSEAP by the Institute of Marine Science, University of Alaska, Fairbanks, Alaska, RU 284. Available from NOAA/OMPA/OCSEAP.

This study was carried out to construct a detailed picture of the food and feeding relationships of the fishes in these two study areas, in order to develop an ability to predict the impact of oil development activities on the fishes in these two areas. This study, coupled with others designed to study acute and chronic toxic effects on the fish populations, will help establish the predictive base necessary to make management decisions.

Sowles, Arthur L., Hatch, Scott A., and Lensink, Calvin J., 1978, Catalog of Alaskan seabird colonies: prepared for OCSEAP by the Fish and Wildlife Service, Office of Biological Services, RU 338/341/343, 32 p., maps, and appendixes. Available from NOAA/OMPA/OCSEAP.

This catalog is a summary of data on the location, size, and species composition of seabird colonies along the Alaska coast. It is intended to provide the best information available as a basis for land and resource management decisions affecting seabirds and their terrestrial habitats and to identify gaps in present knowledge of seabird populations in order to foster the collection of new information. The information presented was compiled from a number of sources, including published and unpublished literature and communications from amateur ornithologists, professional biologists, and laymen.

Vogal, Allan H., and McMurray, Gregory, 1982, Seasonal population density distribution of copepods, euphausids, amphipods, and other holoplankton on the Kodiak Shelf: prepared for OCSEAP by VTN Oregon, Inc., Wilsonville, Oreg., RU 608, 216 p. Available from NOAA/OMPA/OCSEAP.

This study analyzed over 800 zooplankton samples collected from four bays and the Continental Shelf off the Kodiak archipelago for holoplankton species composition, distribution, and abundance. The results of this analysis were compared to the distribution of marine animals belonging to higher trophic levels in an effort to assess the significance of selected holoplankters to the pelagic food chain.

Ward, Larry G., Moslow, Thomas F., Hayes, Miles O., and Finkelstein, Kenneth, 1980, Oil spill vulnerability, coastal morphology, and sedimentation of the Outer Kenai Peninsula and Montague Island: prepared for OCSEAP, RU 59. Available from NOAA/OMPA/OCSEAP.

This report discusses the results of an extensive study of the geomorphology, sedimentology, and oil spill vulnerability of the outer Kenai Peninsula and

Montague Island shorelines. Major emphasis is placed on the application of an oil spill vulnerability index. Large segments of the shoreline are high-risk environments with respect to oil spill residence time. In nearly 60 percent of the study area, any oil spilled would have residence times from 1 to more than 10 years. The remaining 40 percent of shoreline has considerably lower risk areas. Any oil spilled in these environments would be cleaned by natural processes quite rapidly.

Warner, J.S., Margard, W.L., and Anderson, J.W., 1979, Activity-directed fractionation of petroleum samples: prepared for OCSEAP by Battelle Columbus Laboratories, Columbus, Ohio, RU 500, 35 p. Available from NOAA/OMPA/OCSEAP.

This project developed a fractionation and bioassay scheme that can be applied to oil samples to assess the potential biological hazards of the various components that remain after an oil spill. Two in vitro bioassay tests and an in vivo test were studied to assess toxicity and mutagenicity of oil fractions. These were (1) the Ames bacterial mutagenicity test, (2) a mammalian-cell toxicity test, and (3) a mysids toxicity test. All three tests can be run using no more than a total of 30 milligrams of material. In the course of developing the fractionation and bioassay protocol, samples of fresh Prudhoe Bay crude oil, weathered Prudhoe Bay crude oil, and shale oil were fractionated and bioassayed. The bioassay data obtained indicated that the aromatic hydrocarbon fractions are the most toxic fractions and probably represent the greatest biological hazard of any fraction in an oil spill situation.

Whipple, Jeannette A., Yocom, Thomas G., Smart, D. Ross, Cohen, Meryl H., and others, 1978, Transport, retention, and effects of the water-soluble fraction of Cook Inlet crude oil in experimental food chains: prepared for OCSEAP by the Southwest Fisheries Center, Tiburon Laboratory, NMFS, Tiburon, Calif., RU 389, 46 p. Available from NOAA/OMPA/OCSEAP.

The fate and effects of chronic concentrations of the water-soluble fraction of crude oil in marine food chains were investigated in this study. The general objective of the study was to determine the accumulation and passage of petroleum constituents in experimental marine food chains and the effects of petroleum exposures on the test organisms. The termination of funding prevented the study of several contrasting food chains that was originally intended to be included.

Wiens, John A., Heinemann, Dennis, and Hoffman, Wayne, 1978, Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska: prepared for OCSEAP by Oregon State University, Corvallis, Oreg., RU 108, 178 p. and appendixes. Available from NOAA/OMPA/OCSEAP.

This project studied the population and community dynamics and energetics of marine birds and assessed oil development impacts on bird populations. A standardized method for performing a transect census of marine birds from shipboard at sea was used to calculate density estimates. Several conditions were encountered that tended to decrease the accuracy and/or precision of these estimates. Partial solutions to these sampling problems are suggested. The census results and other sampling activities are discussed, observations of feeding, flock composition, and organization are presented, and potential impacts of petroleum development are assessed.

Zimmerman, Steven T., Hanson, Joyce L., Fujioka, Jeffrey T., Calvin, Natasha I., and others, 1979, Intertidal biota and subtidal kelp communities of the Kodiak Island area: prepared for OCSEAP by the Northwest and Alaska Fisheries Center Auke Bay Laboratory, NMFS, Auke Bay, Alaska, RU 78. Available from NOAA/OMPA/OCSEAP.

This report is an analysis of intertidal data from sites in the Kodiak Island area of the western Gulf of Alaska. The distributions and abundances of principal intertidal plants and invertebrates are described at about 40 sites in the Kodiak Island region. Littoral zonation in the region is compared with published descriptions of areas elsewhere in the north Pacific and with Stephenson and Stephenson's universal scheme. Comparison of species composition and biomass on adjacent transects at two sites indicated that spatial variability within sites was high, obscuring seasonal patterns and confounding between-site comparisons. Densities of biota were lower at sites affected by frequent physical disturbance. An aerial survey indicated that intertidal biological cover is heaviest in the northeastern and southern sections of the region around Kodiak Island. Therefore, special care should be taken to protect these areas from oil pollution.

Not all the OCSEAP research projects funded by the Bureau of Land Management have resulted in final reports (abstracted above). Therefore, a comprehensive inventory of OCSEAP investigations funded through fiscal year 1982 is provided below. The citations include the name of the principal investigator(s), funding dates, title of investigation, and, in parentheses, the research unit (RU) number. Results of these investigations are reported periodically in annual and quarterly reports of principal investigators, available from NOAA/OMPA/OCSEAP in Juneau.

OCSEAP Studies in the Gulf of Alaska (Lease Sale 55) Area

Anderson, George, and Lam, Ronald, 1976, A description and numerical analysis of the factors affecting the processes of production in the Gulf of Alaska (RU 58).

Arneson, Paul, and Schneider, Karl, 1977-80, Identification and documentation of coastal migratory bird habitats in Alaska (RU 3).

Atlas, Ronald, 1976, Assessment of potential interaction of micro-organisms and pollutants resulting from petroleum development on the Outer Continental Shelf in the Gulf of Alaska (RU 30).

Bang, Frederick, and Patten, Samuel, 1976, 1978, Effects of petroleum exposure on the breeding and ecology of the Gulf of Alaska herring gull, gull group Larus argentatus and Larus glaucescens (RU 96).

Barrick, Donald, 1975-77, Current mapping radar program (RU 48).

Bartonek, James, and Lensink, Calvin, 1976-77, Catalog of seabird colonies in Alaska (RU 338).

Biswas, N.N., 1981, Compilation of a homogenous earthquake catalogue for the Alaska-Aleutian region (RU 586).

Braham, Howard, and Mercer, Roger, 1976-78, 1981, Seasonal distribution and relative abundance of marine mammals in the western Gulf of Alaska (RU 68).

Burrell, D.C., 1976, 1978, Site-specific studies of heavy metals (RU 162).

Cacchione, David, and Drake, Donald, 1977, Bottom and nearbottom sediment dynamics (RU 430).

Caldwell, R., 1975-76, Acute and chronic toxicity of seawater extracts of Alaskan crude oil to zoeae of Dungeness crab, Cancer magister Dana (RU 183).

Cannon, Jan, 1975-76, The environmental geology and geomorphology of the Gulf of Alaska coastal plain (RU 99).

Carlson, Robert, 1975-76, Seasonality and variability of stream flow important to Alaskan nearshore coastal area (RU 111).

Chesler, Steven, 1976, Trace hydrocarbon analysis in previously studied matrices

and methods development for (a) trace hydrocarbon analysis in sea ice and at the sea-ice-water interface, and (b) analysis of individual high molecular weight aromatic hydrocarbons (RU 43).

Cimberg, R., 1980, Habitat requirements and expected distribution of Alaskan coral (RU 601).

Cline, Joel, 1976-77, Identification of natural and anthropogenic petroleum sources utilizing low molecular weight hydrocarbons, C1-C4. I. Cook Inlet. II. Tarr Bank. III. Kodiak Shelf (RU 153).

Damaker, David, 1976, Plankton of the Gulf of Alaska (RU 156, 164b).

Dieter, Dolly, 1976, Research vessel ACONA and marine support (RU 351).

English, Thomas S., 1976, Alaska marine ichthyoplankton key (RU 349).

English, Thomas S., 1976, Plankton of the Gulf of Alaska (RU 156/164a).

Favorite, Felix, 1976, Physical oceanography of the Gulf of Alaska (RU 357).

Fay, Francis, 1978-80, Morbidity and mortality of key marine mammal species (RU 194).

Feder, Howard, 1975-76, 1978-80, Distribution, abundance, community structure, and trophic relationships between benthos of the northeast Gulf of Alaska from Yakutat Bay to Cross Sound (RU 5).

Feder, Howard, 1976, Distribution, abundance, diversity, and productivity of benthic organisms in the Gulf of Alaska (RU 281).

Feder, Howard, 1976, Summarization of existing literature and unpublished data on the distribution, abundance, and productivity of benthic organisms on the Gulf of Alaska and Bering Sea (RU 282, 301).

Feely, Richard, and Cline, Joel, 1975-77, The distribution, composition, transport, and hydrocarbon absorption characteristics of suspended matter in the Gulf of Alaska, Lower Cook Inlet, and Shelikof Strait (RU 152).

Galt, Jerry, 1976-80, Numerical studies of the Alaska region (RU 140, 146/149).

Gentry, R. and Kooyman, G., 1976-79, Effects of oil pollution on marine mammals (RU 71).

Hall, John, 1977-78, A survey of cetaceans of Prince William Sound and adjacent regions of the Gulf of Alaska (RU 481).

Hampton, Monty, 1975-76, Faulting and instability of shelf sediments, western Gulf of Alaska (RU 327).

Hansen, Donald, 1977-78, Langrangian surface current measurement (RU 217).

Hayes, Miles, and Boothroyd, Jon, 1975-76, Coastal morphology and sedimentation, Gulf Coast of Alaska (RU 59).

Hayes, S.P., Charnell, R.L., Schumacher, J.D., Muench, R.D., and Moojeld, H., 1975-76, 1978, Gulf of Alaska Shelf circulation (RU 138, 139/147).

Kaiser, Rodney, 1976-77, Razor clam distribution and population assessment study (RU 24).

Kaplan, Ian R., and Reed, Walter, 1977, Characterization of organic matter in sediments from the Gulf of Alaska, Bering Sea, and Beaufort Sea (RU 480).

Laevastu, Taivo, 1976, Preparation of hydrodynamical numerical and 3-parameter small-mesh atmospheric models for coastal waters of Alaska (RU 235).

Lahr, John, Page, Robert, and Stephens, Chris, 1976, 1978, 1980, Earthquake activity and ground shaking in and along the eastern Gulf of Alaska (RU 210).

Larrance, Jerry, 1976, Phytoplankton and primary productivity of the Gulf of Alaska (RU 146, 164c).

Law, Ed, 1976, Establish and service marine baseline data base for the Alaska MEA program (RU 362).

Lees, Dennis, 1976, 1978-79, Ecological studies of intertidal and shallow subtidal *habitats in Lower Cook Inlet and the northeast Gulf of Alaska region (RU 417).*

Lensink, Calvin, 1976-79, Seasonal distribution and abundance of marine birds (RU 337).

Lensink, Calvin, 1976, Review and analysis of literature and unpublished data on marine birds (RU 339).

Lensink, Calvin, and Bartonek, James, 1976, Migration of birds in Alaskan coastal and marine habitats subject to influence by OCS development (RU 340).

Lensink, Calvin, and Bartonek, James, 1975-76, Population dynamics of marine birds (RU 342).

Lensink, Calvin, and Bartonek, James, 1976, Preliminary catalog of seabird colonies (RU 343).

Lensink, Calvin, Sanger, Donald, and Gould, Patrick, 1975-77, 1979, Population dynamics and trophic relationships of marine birds in the Gulf of Alaska (RU 341).

Malins, Donald, Reichart, W., and Roubal, W., 1976, Identification of major processes in biotransformation of petroleum hydrocarbons and trace metals (RU 74).

McCain, Bruce, Hodgins, Bruce, Sparks, Albert, and Gronlund, William, 1976, 1978, Determine the frequency and pathology of marine fish diseases in the Bering Sea, Gulf of Alaska, and Beaufort Sea (RU 332).

McCray, Peter, 1976, Yakutat Bay benthos study (Yakutat Bay demersal fish and shellfish study) (RU 23).

Merrell, Theodore, and O'Clair, Charles, 1975-78, Littoral studies in the Gulf of Alaska and Bering Sea (RU 78).

Meyers, Herb, 1976, Seismicity of the Beaufort Sea and Gulf of Alaska (RU 352).

Molnia, Bruce, 1976, 1978-80, Erosion, deposition, faulting, and instability of shelf sediments--eastern Gulf of Alaska (RU 212).

Morita, Richard, and Griffith, Robert, 1975-76, Baseline study of microbial activity in the Beaufort Sea and Gulf of Alaska and analysis of crude oil degradation by psychrophylic micro-organisms (RU 190).

Morrow, James, 1976, Preparation of illustrated keys to skeletal remains and otoliths of forage fishes--Gulf of Alaska and Bering Sea (RU 285).

Muench, R.D., 1981, Coastal oceanography of the Gulf of Alaska (RU 600).

Myres, Timothy, 1975-76, Ecology and behavior of Southern Hemiphere Shearwaters (genus Puffins) and other seabirds, when over the Outer Continental Shelf of the Bering Sea and Gulf of Alaska during the northern summer (RU 239).

Patten, S., 1980, Seasonal use of coastal habitats from Yakutat Bay to Cape Fairweather for migratory seabirds, shorebirds, and waterfowl (RU 591).

Pereyra, Walter, and Nelson, Martin, 1976, Review and evaluation of historical data base and nonsalmonid pelagic fishery resources of the Gulf of Alaska shelf and slope (RU 64).

Pereyra, Walter, and Ronholt, Lael, 1976-77, Baseline studies of demersal resources of the eastern and western Gulf of Alaska shelf slope--a historical review (RU 174).

Pitcher, Kenneth, and Calkins, Donald, 1976-79, Biology of the harbor seal, Phoca vitulina richardsi, in the Gulf of Alaska (RU 229).

Pitcher, Kenneth, Calkins, Donald, and Schneider, Karl, 1976-80, Population assessment, ecology, and trophic relationship of Stellar sea lions in the Gulf of Alaska (RU 243).

Polcyn, Fabian, 1976, Intertidal algal analysis (RU 428).

Reynolds, Michael, 1977-80, Coastal meteorology in the Gulf of Alaska (RU 367).

Rice, Dale W., 1981, Habitat use by humpback, gray, and fin whales in the Gulf of Alaska (RU 592).

Rogers, D., 1980, Epipelagic meroplankton, forage fish, and juvenile fish: distribution and abundance in the Yakutat area (RU 603).

Rosenthal, R., 1977-79, Ecology of nearshore fishes in the northeast Gulf of Alaska (RU 542).

Royer, Thomas, 1976-80, Circulation and water masses in the Gulf of Alaska (RU 289).

Schneider, Karl, 1976, Assessment of the distribution and abundance of sea otters along the Kenai Peninsula, Kamishak Bay, and Kodiak Archipelago (RU 240).

Shaw, D.G., 1975-77, Natural distribution and dynamics on the Outer Continental Shelf--task statement 275, 276, and 294 (RU 275).

Smith, Ronald, 1976, Acute toxicity--Pacific herring roe in the Gulf of Alaska (RU 123).

Smith, Ronald, 1976-77, Food and feeding relationships in benthic and demersal fishes of the Gulf of Alaska and Bering Sea (RU 284).

Wadham, P., 1980, Development and initial application of software to seismic hazard analysis of the Gulf of Alaska (RU 590).

Wiens, John, 1975-76, Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska (RU 108).

Wise, James, 1977, Marine climatology of the Gulf of Alaska, the Bering Sea, and the Beaufort Sea (RU 347).

Zimmerman, Steve, and Merrell, Theodore, 1977, Littoral studies: Gulf of Alaska and Bering Sea (RU 78).

OCSEAP Studies of the Cook Inlet/Shelikof Strait (Sale 60) Area

Anderson, J., 1976-79, The accumulation of organic constituents and heavy metals from petroleum impacted sediments by detritivores (RU 454).

Arneson, Paul, 1978-79, Identification and documentation of coastal migratory bird habitats in Alaska (RU 3).

Atlas, Ronald, 1978-80, Assessment of potential interactions of micro-organisms and pollutants from petroleum development in Lower Cook Inlet and Beaufort Sea (RU 29).

Atlas, Ronald, 1977, Microbial communities in Lower Cook Inlet (RU 30).

Barrick, Donald, Frisch, A. Shelby, and Weber, Robert, 1978-79, Lower Cook Inlet surface current studies using HF readers (RU 48).

Biswas, N.N., 1981, Compilation of homogenous earthquake catalogue for the Alaskan-Aleutian region (RU 586).

Blackburn, James, and Jackson, Peter, 1977-79, Seasonal composition and food web relationships of marine organisms in the nearshore waters of Lower Cook Inlet, including fishes and benthic epifauna (RU 512).

Boersma, P., 1980-82, Storm-petrel stomach oils as an indicator of environmental change (RU 598).

Burrell, David, 1977-78, Distribution and dynamics of heavy metals in Alaskan shelf environments subject to oil development (RU 162).

Cline, Joel, 1977-80, Characterization and source identification of anthropogenic and natural low molecular weight petroleum hydrocarbons in Cook Inlet and Norton Sound, Alaska (RU 153).

Drake, David, and Cacchione, David, 1978-79, Bottom and near-bottom sediment dynamics in Lower Cook Inlet (RU 430).

English, Saunders, 1977-79, Lower Cook Inlet meroplankton (RU 424).

Fay, Francis, 1978-79, Morbidity and mortality of marine mammals (RU 194).

Feder, Howard, 1977-79, Distribution, abundance, and trophic relatinships of nearshore benthos of Kodiak Shelf, Cook Inlet, and northeast Gulf of Alaska (RU 5).

Feely, Richard, 1977-80, Distribution, composition, and deposition of suspended matter in Lower Cook Inlet and Norton Sound, Alaska (RU 152).

Flagg, Loren, and Rosenthal, Richard, 1976, An ecological assessment of the littoral zone along the outer coast of the Kenai Peninsula (RU 127).

Galt, Jerry A., 1977-80, Alaska numerical modeling (RU 140).

Gentry, R., and Kooyman, G., 1976-79, Effects of oil pollution on marine mammals (RU 71).

Griffiths, Robert, and Morita, Richard, 1977-81, Study of microbial activity and crude oil microbial interaction in waters and sediments of Cook Inlet, Norton Sound, and the Beaufort Sea (RU 190).

Hampton, Monty, 1978-81, Shallow faulting, bottom instability, and movement of sediment in Lower Cook Inlet and western Gulf of Alaska (RU 327).

Hayes, Miles, 1980, Determination of oilspill vulnerability of the shorelines of the Alaska Peninsula along Shelikof Strait and the coast of Norton Sound (RU 59).

Hoskin, Charles, 1977-78, Grain size analysis and data reduction of Bering Sea bottom sediments (RU 291).

Hoskin, Charles, 1977-78, Grain size analysis of sediment from Alaskan Continental Shelves (RU 290).

Houghton, J., 1980-81, Oil rig monitoring and effects of drilling muds: literature review (RU 602).

Kaiser, Rodney, 1977, Razor clam distribution and population study (RU 24).

Kaplan, Ian R., 1978, 1980, Distribution and dynamics of petroleum components in sediments of the Alaska OCS areas (RU 480).

Karinen, John, and Rice, Stanley, 1980-81, Sublethal effects on selected Alaskan marine organisms after acute and long-term exposure to oil and oil components (RU 72).

Larrance, Jerry, 1978-79, Composition and source of organic detritus in Lower Cook Inlet (RU 425).

Lees, Dennis, 1978-79, Ecological studies of intertidal and shallow subtidal habitats in Lower Cook Inlet and the northeast Gulf of Alaska region (RU 417).

Lensink, Calvin, 1979, Seasonal distribution and abundance of marine birds (Ru 337).

Lensink, Calvin, Sanger, Gerald, and Gould, Patrick, 1977-80, Population dynamics of marine birds in Lower Cook Inlet (RU 341).

Malins, Donald, 1980-81, Sublethal effects of petroleum hydrocarbons including biotransformations as reflected by morphological, chemical, physiological, pathological, and behavioral indices (RU 73).

Payne, James, 1981-82, Oil weathering experiments--subarctic (RU 597).

Pitcher, Kenneth, and Calkins, Donald, 1977-78, Biology of the harbor seal, Phoca vitulina richardsi, in the Gulf of Alaska (RU 229).

Pitcher, Kenneth, and Calkins, Donald, 1977-79, Population assessment, ecology, and trophic relationships of Stellar sea lions in the Gulf of Alaska (RU 243).

Reed, R.K., Muench, R.D., Charnell, R.L., Schumacher, James, and Hayes, Stanley, 1978-79, Northwest Gulf of Alaska oceanographic processes (RU 138).

Reynolds, Robert, 1978, 1980, Coastal meteorology (RU 367).

Robertson, David, and Abel, Keith, 1978, Trace metal baseline studies of the Aleutian, Kodiak, and St. George Basin Outer Continental Shelf sites (RU 506).

Royer, Thomas, 1978-80, Circulation and water masses in the Gulf of Alaska (RU 298).

Schleuter, Roger, 1979-80, Oilspill dispersion analysis (RU 436).

Schneider, Karl, 1976, Assessment of the distribution and abundance of sea otters along the Kenai Peninsula, Kamishak Bay, and the Kodiak Archipelago (RU 240).

Shaw, D.G., 1977-79, Hydrocarbons: natural distribution and dynamics on the Alaskan Outer Continental Shelf (RU 275).

Van Baalen, Chase, 1981, Biodegradation of aromatic hydrocarbons by high latitude microalgae and cyanobacteria (RU 607).

Wise, James, 1977, Marine climatology of the Gulf of Alaska, the Bering Sea, and Beaufort Sea (RU 347).

OCSEAP Studies in the Kodiak (Lease Sale 61) (Formerly Lease Sale 46) Area

Barrick, Donald, 1977, The current-mapping radar program (RU 48).

Bartonek, James, and Lensink, Calvin, 1977, Catalog of seabird colonies in Alaska (RU 338).

Biswas, N.N., 1981, Compilation of homogenous earthquake catalogue for the Alaska-Aleutian region (RU 586).

Blackburn, James, 1977, Demersal finfish resource assessment in selected estuary systems of Kodiak Island (RU 486).

Blackburn, James, and Jackson, Peter, 1979, Seasonal relationship of principal juvenile and adult marine finfish species inhabiting the nearshore (RU 552).

Boersma, P., 1980-81, Storm-petrel stomach oils as an indicator of environmental change (RU 598).

Braham, Howard, and Mercer, Roger, 1977-78, 1981, Seasonal distribution and relative abundance of marine mammals in the western Gulf of Alaska (RU 68).

Cline, Joel, 1977, Identification of natural and anthropogenic petroleum sources utilizing low molecular weight hydrocarbons, C1-C4. I. Cook Inlet. II. Tarr Bank. III. Kodiak Shelf (RU 153).

Davies, J.N., 1981-82, Seismotechtonic analysis of volcanic hazards (RU 16).

Dunn, Jean, Kendall, Arthur, and Wolotira, Robert, 1979, Seasonal composition and food web relationship of marine organisms in the nearshore zone including components of the ichthyoplankton (RU 551).

Dunn, Jean, and Wolotira, Robert, 1979-80, Taxonomic composition, seasonal distribution, and abundance of ichthyoplankton and decapod crustacea larvae in the nearshore zone of the Kodiak Archipelago, Alaska (RU 551).

Fay, Francis, 1979, Morbidity and mortality of marine mammals (RU 194).

Feder, Howard, 1977, Distribution, abundance, and diversity of the epifauna benthic organisms in two bays of Kodiak Island (RU 517).

Feder, Howard, 1977-80, Distribution, abundance, and trophic relationships of ben-

thos of the northeast Gulf of Alaska from Yakutat Bay to Cross Sound (RU 5).

Feely, Richard, and Cline, Joel, 1977, Distribution composition, transport, and hydrocarbon absorption characteristics of suspended matter in the Gulf of Alaska, Lower Cook Inlet, and Shelikof Strait (RU 152).

Galt, Jerry, 1977-80, Numerical studies of the Alaska region (RU 140).

Gentry, R., and Kooyman, G., 1976-79, Effects of oil pollution on marine mammals (RU 71).

Hampton, Monty, 1977-81, Shallow faulting, bottom instability, and movement of sediment in Lower Cook Inlet and western Gulf of Alaska (RU 327).

Hansen, Donald, 1977-78, Langrangian surface current measurements (RU 217).

Hartt, Allan, 1977, Assessment of fish biota in pelagic and littoral waters of three bays on the southeast coast of Kodiak Island (RU 485).

Hoskin, Charles, 1977-78, Grain size analysis and data reduction of Bering Sea sediments (RU 291).

Hoskin, Charles, 1977-78, Grain size analysis of sediments from Alaskan Continental Shelves (RU 290).

Kaiser, Rodney, 1977, Razor clam distribution and population assessment study (RU 24).

Kaplan, Ian R., and Reed, Walter, 1977, Characterization of organic matter in sediment from the Gulf of Alaska, Bering Sea, and Beaufort Sea (RU 480).

Kienle, Jurgen, and Pulpan, Hans, 1975, 1977-82, Seismic and volcanic risk studies--western Gulf of Alaska (RU 251).

Latham, Gary, 1980, Portable array of ocean bottom seismometers (RU 579).

Lensink, Calvin, 1977-79, Seasonal distribution and abundance of marine birds (RU 337).

Lensink, Calvin, Sanger, Gerald, and Gould, Patrick, 1977-79, Population dynamics and trophic relationships of marine birds in the Gulf of Alaska (RU 341).

McMurray, G., 1980-81, Seasonal population density and distribution of copepods, euphausids, amphipods, and other holoplankton on the Kodiak Shelf (RU 608).

Pitcher, Kenneth, and Calkins, Donald, 1977-79, Biology of the harbor seal, Phoca vitulina richardsi, in the Gulf of Alaska (RU 229).

Pitcher, Kenneth, and Calkins, Donald, 1977-79, Population assessment, ecology, and trophic relationships of Stellar sea lions in the Gulf of Alaska (RU 243).

Reynolds, Robert, 1977-78, 1980, Coastal meteorology (RU 367).

Rice, Dale W., 1981, Habitat use by humpback, gray, and fin whales in the Gulf of Alaska (RU 592).

Rogers, Donald, and Kendall, Art, 1979-80, Seasonal composition and food web relationships of marine organisms in the nearshore zone of Kodiak Island, including ichtyoplankton, zooplankton, and fish (RU 553).

Royer, Thomas, 1977-80, Circulation and water masses in the Gulf of Alaska (RU 289).

Schneider, Karl, 1977, Assessment of the distribution and abundance of sea otters along the Kenai Peninsula, Kamishak Bay, and Kodiak Archipelago (RU 240).

Schumacher, James, and Hayes, Stanley, 1978-80, Gulf of Alaska study of mesoscale oceanographic processes (RU 138).

Shaw, D.G., 1977, Natural distribution and dynamics on the Alaskan Outer Continental Shelf-task statement 275, 276, and 294 (RU 275).

Wiens, John, 1979-80, Simulation modeling of marine birds population energetics, con-

sumption, and sensitivity to perturbations (RU 108).

Wise, *James, 1977, Marine climatology of the Gulf of Alaska, the Bering Sea, and Beaufort Sea (RU 347).*

Zimmerman, Steve, and Merrell, Theodore, 1977, Littoral studies: Gulf of Alaska and Bering Sea (RU 78).

U.S. Geological Survey

The U.S. Geological Survey (USGS) programs in Alaska encompass a broad range of activities. The results of studies carried out under these programs are generally first released through the open literature and subsequently published in open-file reports or other USGS publications. There are two offices in Alaska where Survey publications can be purchased, in Anchorage and in Fairbanks; however, open-file reports are available only at the Anchorage location:

Public Inquiries Office
508 Second Avenue
Anchorage, AK 99501
(907) 277-0577.

Each month the U.S. Geological Survey publishes a catalog, **New Publications of the Geological Survey,** which contains a list of new reports and maps released during the month. These lists are compiled into a single volume at the end of the year. Most open-file reports and water resource investigations can be ordered from:

Open-File Services Section
Box 25425, Federal Center
Denver, CO 80225.

Some of these reports also are available from:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161.

One of the best sources of information on current USGS programs in Alaska is USGS Circular 843, entitled **The U.S. Geological Survey in Alaska--1981 Programs,** which can be obtained from the Public Inquiries Office in Anchorage.

Hampton, M.A., Bouma, A.H., Pulpan, H., and vonHuene, R., 1979, Geo-environmental assessment of the Kodiak Shelf, Western Gulf of Alaska in Proceedings, 1979, Offshore Technology Conference, volume 1, held April 30-May 3, 1979, in Houston, Texas, 12 p. Available from Offshore Technology Conference, 6200 North Central Expressway, Dallas, TX 75206.

This paper reports on federally funded geological and geophysical studies conducted on the Kodiak Shelf. Seismic-reflection surveys, limited sidescan sonar, and underwater photography and television work were used in these studies. Several environmental conditions, principally related to the structural tectonic setting and the distribution and movement of sediment are of concern to resource development on the shelf.

Holden, K.D., 1980, Isopach map of upper Holocene marine sediments, Outer Continental Shelf, Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2032, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248 from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

This report (five maps and seven cross sections) is one of six on the surface and near-surface geologic environment of Shelikof Strait, Alaska. This series was developed in preparation for Oil and Gas Lease Sale 60 of the Outer Continental Shelf of Lower Cook Inlet, scheduled for September 1981. The information presented in these six reports was interpreted from 1,589 miles

(2,557 km) of multi-sensored high-resolution geophysical data collected in 1979 by Nekton, Inc., for the U.S. Geological Survey. The tracklines along which data were collected are shown on each map.

This map shows the distribution and thickness of probable upper Holocene marine sediments in Shelikof Strait. This information was interpreted primarily from side-scan sonar, fathometer, 3.5-kHz piezoelectric profiler, and an electromechanical profiler or, alternatively, low-energy sparker data. This unit was chosen for mapping because it is seismically distinct and because it probably has geotechnical properties that differ from those of the underlying sediments.

Hoose, P.J., Holden, K.D., and Lybeck, L., 1980, Isopach map of Holocene marine sediments, Outer Continental Shelf, Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2033, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248 from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

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This map shows the distribution and thickness of the probable Holocene marine sequence. The Holocene sequence was chosen for isopaching because it is seismically mappable and because its geotechnical properties apparently differ from those of the underlying sediments. No geotechnical data were available to corroborate the seismic interpretation.

Hoose, P.J., and Whitney, J., 1980, Map showing selected geologic features on the Outer Continental Shelf, Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2035, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248 from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

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This map shows the structural and stratigraphic features of Shelikof Strait that have been interpreted to be potentially hazardous to exploratory drilling and oil and gas production. Two types of faults--deep subsurface faults and shallow faults--are shown on the map, along with major synclines and anticlines, possible shallow gas accumulations, areas that show evidence of sediment mass movement, and one buried channel.

Magoon, L.B., Bouma, A.H., Fisher, M.A., Hampton, M.A., and others, 1979, Re-

source report for proposed OCS sale no. 60--Lower Cook Inlet-Shelikof Strait: Menlo Park, Calif., U.S. Geological Survey Open-File Report 79-600. Available from USGS Open-File Services Section.

This report summarizes the framework geology, petroleum geology, resource assessment, sale outline, environmental geology, and time frame and infrastructure for development of the Lower Cook Inlet and the Shelikof Strait for the proposed Lease Sale 60. The report cautions that additional data are needed on the framework geology and petroleum geology in the Shelikof Strait to provide a better resource assessment, and that more geoenvironmental information is required for an adequate geohazard map.

Reed, K.M. (ed.), 1981, The U.S. Geological Survey in Alaska--1981 programs: prepared for the U.S. Geological Survey, Geological Survey Circular 843, 111 p. Available from the Anchorage Public Inquiries Office.

This circular describes the Fiscal Year 1981 programs and projects of the U.S. Geological Survey in Alaska. A brief description of the Alaska operations of each office and division of the Survey is followed by project descriptions arranged by geographic regions in which the work takes place. A directory at the end of this booklet lists project chiefs and summarizes other general information. A listing of cooperating agencies is also included.

A companion circular, 844, consists of articles describing significant accomplishments of the Survey's topical and field investigations in Alaska during 1980.

Whitney, J. and Holden, K.D., 1980, Bathymetric map of the Outer Continental Shelf of Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2031, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248, from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

This report (five maps and seven cross sections) is one of six on the surface and near-surface geologic environment of Shelikof Strait, Alaska. This series was developed in preparation for Oil and Gas Lease Sale 60 of the Outer Continental Shelf of Lower Cook Inlet, scheduled for September 1981. The information presented in these six reports was interpreted from 1,589 miles (2,557 km) of multi-sensored high-resolution geophysical data collected in 1979 by Nekton, Inc., for the U.S. Geological Survey. The tracklines along which data were collected are shown on each map.

This bathymetric map was constructed by hand digitizing, computer posting, and hand contouring high-resolution seismic reflection data. Intermediate contours are not shown in very steep areas.

Whitney, J., Holden, K.D., and Lybeck, L., 1980, Isopach map of Quaternary glacial-marine sediments, Outer Continental Shelf, Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2034, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248, from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

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Shown on this isopach map are probable Quaternary sediments of Shelikof Strait, comprising a marine sequence of probable Holocene age and a glacial unit of probable Pleistocene age. The information presented will be useful in petroleum exploration drilling. These units were identified from acoustic data.

Whitney, J.P., Hoose, J., Smith, L.M., and Lybeck, L., 1980, Geologic cross sections of the Outer Continental Shelf, Shelikof Strait, Alaska: Anchorage, Alaska, U.S. Geological Survey Open-File Report 80-2036, scale 1:250,000, one sheet. Available from USGS Open-File Services Section. The original data are available to the public as Sale 60, Data Set AK-18248, from the National Geophysical and Solar-Terrestrial Data Center (address: NOAA/EDS/NGSDC, Code D-621, Boulder, CO 80302).

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These seven cross sections, representative of the geology of Shelikof Strait, are displayed at a 25:1 vertical exaggeration. The slope distortion diagram provided can be used to determine true slope angles. Four acoustically distinct geologic units were recognized in the high-resolution geophysical data. The map reference shows the actual location of the cross-section lines as well as actual positions along individual lines. Also shown on the map are the locations of the lease blocks in the southern part of oil and gas Lease Sale 60.

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

The National Oceanic and Atmospheric Administration conducts the Outer Continental Shelf Environmental Assessment Program for the Bureau of Land Management. A discussion of the program and summaries of OCSEAP final reports and synthesis reports are included in the section on the Department of the Interior, Bureau of Land Management.

Muench, R.D., Schumacher, J.D., and Pearson, C.A., 1981, Circulation in the Lower Cook Inlet, Alaska: prepared by the Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration, Seattle, Wash., Technical memo., 34 p. Available from NTIS (PC A03/MF A01).

This paper presents and discusses new data that have allowed a better definition of the regional flow field in the Lower Cook Inlet region. These data include current observations from taut-wire moorings, drogued surface buoy trajections, doppler-shift radar surface current observations, and hydrographic measurements, and they were obtained during an intensive field program in 1977-78. This field program was conceived primarily to aid in prediction of spilled contaminant fates and trajectories because of the projected petroleum exploration and development in Lower Cook Inlet.

OTHER STUDIES

Arctic Environmental Information and Data Center, 1981, Current research profile for Alaska, 1980: Anchorage, Alaska, 487 p. Available from Information Services, Arctic Environmental Information and Data Center, 707 A Street, Anchorage, AK 99501.

This report contains abstracts of research in physical, biological, and related social sciences conducted during 1980. Research projects are divided into 28 categories. Each entry lists principal investigator, telephone number, affiliation, and address; co-investigator (if any) and affiliation; funding agency, funding period, and funding amount; geographic location of research in Alaska; objectives of research; and key subject words. Indexes are keyed to investigator, affiliation, funding agency, subject, region, and geographic location.

Glossary

Definitions presented in this glossary describe terms as they have been used in this summary report. The glossary is intended for general reference only: for detailed descriptions of technical or specialized terms, the reader should seek a reference in the field of particular interest. Abbreviations and acronyms are presented in tabular form on p. iv.

Sources used in compiling this glossary were other Office of Outer Continental Shelf Information summary reports and indexes, Webster's Third International Dictionary, the American Geological Institute's Dictionary of Geological Terms, and Langenkamp's Handbook of Oil Industry Terms and Phrases (2nd ed.).

Anticline - An upfold or arch of stratified rock in which the beds or layers bend downward in opposite directions from the crest or axis of the fold.

Application for permit to drill (APD) - A document submitted by lease operators for review and approval by the USGS. This application, submitted in conjunction with the exploration plans and prior to development and production plans, includes an operational plan for a detailed casing, mud, and cementing program for a specific drilling operation.

Arch - A trench system; an anticline.

Basement horizon - Basement rocks.

Basement rock - Rock in the earth's crust beneath all sedimentary rocks.

Basin - A depression of the earth in which sedimentary materials accumulate or have accumulated, usually characterized by continuous deposition over a long period of time; a broad area of the earth beneath which the strata dip, usually from the sides toward the center.

Batholith - A great mass of intruded igneous or metamorphosed rock found at or near the surface of the earth.

Bed - A rock mass, usually of greater horizontal thickness than vertical or near-vertical thickness, bounded (especially on its upper side) by material with different physical properties.

Bedform - Any deviation from a flat bed generated by the flow on the bed of an alluvial channel.

Block - A geographical area of approximately 9 square miles (5,693 acres or 2,304 hectares), which is used in official BLM protraction diagrams or leasing maps.

Bonus - Money paid by the lessee for the execution of an oil and gas lease.

Btu - British thermal unit, a measure of thermal energy.

CEIP - Coastal Energy Impact Program, administered by the Office of Coastal Zone Management of the National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

Cenozoic - The latest of the four eras into which geologic time, as recorded by stratified rocks at the earth's crust, is divided; it extends from the close of the Mesozoic era (63 million years ago) to the present.

Clastic - Consisting of fragments of rocks or organic structures that have been moved individually from their places of origin.

Conditional resource estimate - Developed for use in an environmental impact statement, this estimate assumes that favorable geologic conditions exist and that oil and gas are present in traps within the proposed lease sale area.

Conglomerate - A cemented clastic rock containing rounded gravel- or pebble-sized fragments.

Continental Margin - A zone separating the emergent continents from the deep sea bottom.

Continental Offshore Stratigraphic Test (COST) well - A well drilled to gather information about the stratigraphic formation present, the general character of the rocks, their porosity, and their permeability.

Continental Shelf - A broad, gently sloping, shallow feature extending from the shore to the Continental Slope.

Continental Slope - A relatively steep, narrow feature paralleling the Continental Shelf; the region in which the steepest descent to the ocean bottom occurs.

Contingency plan - A plan for possible offshore emergencies prepared and submitted by the oil or gas operator as part of the plan of development and production.

Cretaceous - The third and latest (from about 138 million years ago to about 63 million years ago) of the periods included in the Mesozoic era.

Development - Activities that take place following exploration for, discovery of, and delineation of minerals in commercial quantities, including but not limited to geophysical activity, drilling, platform construction, and operation of all directly related onshore support facilities; and that are for the purpose of ultimately producing the minerals discovered.

Diapir - A piercing fold; an anticlinal fold in which a mobile core, such as salt, has broken through the more brittle overlying rocks.

Discovery - The initial find of significant quantities of hydrocarbons.

Drilling mud - A special mixture of clay, water, or refined oil, and chemical additives pumped downhole through the drill pipe and drill bit. The mud cools the rapidly rotating bit; lubricates the drill pipe as it turns in the well bore; carries rock cuttings to the surface; serves as a plaster to prevent the wall of the bore hole from crumbling or collapsing; and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control downhole pressures that may be encountered.

Economically recoverable resource estimate - An assessment of the hydrocarbon potential that takes into account (1) physical and technological constraints on production and (2) the influence of costs of exploration and development and market price on industry investment in OCS exploration and production.

Enhanced recovery techniques - Recovery methods for crude oil that include water flooding, steam and gas injection, micellular-surfactant, steam drive, polymer, miscible hydrocarbon, carbon dioxide, and steam soak methods. Enhanced recovery techniques are not restricted to secondary or even tertiary projects: some fields require the application of one of the above methods even for initial recovery of crude oil.

Environmental impact statement (EIS) - A statement required by the National Environmental Policy Act of 1969 or similar State law in relation to any action significantly affecting the environment.

Erosion/scour - A loosening or dissolution of the seabed by high-velocity bottom currents, particularly those caused by storms. Erosion and scour can mobilize sand and result in significant horizontal crest and trough displacements. Lateral migration of the crest can "strand" platform supports or wellhead plumbing by eroding the surrounding support materials.

Exploration - The process of searching for minerals. Exploration activities include (1) geophysical surveys where magnetic, gravity, seismic, or other systems are used to detect or infer the geologic conditions conducive to the accumulation of such minerals and (2) any drilling, except development drilling, whether on or off known geological structures. Exploration also includes the drilling of a well in which a discovery of oil or natural gas in paying quantities is made and the drilling of any additional well after such a discovery that is needed to delineate a reservoir and to enable the lessee to determine whether to proceed with development and production.

Exploration plan - (See **plan of exploration**).

Fault - A fracture in the earth's crust accompanied by a displacement of one side of the fracture with respect to the other.

Field - An area within which hydrocarbons have been concentrated and trapped in economically producible quantities in one or more structural or stratigraphically related reservoirs.

Fracturing (hydraulic fracturing) - A method of stimulating production from a formation of low permeability by inducing fractures and fissures into the formation through application of very high fluid pressure to the face of the formation, forcing the strata apart.

Geochemical - Of or relating to the science dealing with the chemical composition of and the actual or possible chemical changes in the crust of the earth.

Geologic hazard - A feature or condition that may seriously jeopardize offshore oil and gas exploration and development activities. It may necessitate special engineering procedures or relocation of the proposed development.

Geologic province - An area throughout which geological conditions have been similar or that is characterized by particular structural, petrographic, or physiographic features.

Geologic trap - An arrangement of rock strata, involving their structural relations or varied lithology and texture, that favors the accumulation of oil and gas.

Geomorphic - Of or pertaining to surface landforms.

Geomorphology - The science of surface landforms and their interpretation on the basis of geology and climate.

Geophysical - Of or relating to the physics of the earth, especially the measurement and interpretation of geophysical properties of the rocks in an area.

Geophysical survey - The exploration of an area in which geophysical properties and relationships unique to the area are measured by one or more geophysical methods.

Hazards - (See **geologic hazard**).

Homoclinal - Characterized by beds dipping uniformly in one direction.

Hydrocarbon - Any of a large class of organic compounds containing primarily carbon and hydrogen, comprising paraffins, olefins, members of the acetylene series, alicyclic hydrocarbons, and aromatic hydrocarbons, and occurring in many cases in petroleum, natural gas, coal, and bitumens.

Hydrodynamics - A branch of science that deals with the cause and effect of regional subsurface migration of fluids.

Intrusion - A body of igneous rock resulting from solidification of the intruding magma; the plastic injection of masses of salt or shale into overlying rocks; magma, shale, or salt injected into overlying rocks.

Jurassic - The middle period (from about 205 million years ago to about 138 million years ago) of the three periods comprising the Mesozoic era.

Land use - The function for which people employ an area of land.

Lease - A contract authorizing exploration for and development and production of minerals; the land covered by such a contract.

Lease sale - The public opening of sealed bids made after competitive auction for leases granting companies or individuals the right to explore for and develop certain minerals within a defined period of time.

Lease term - For oil and gas leases, a period of either 5 years or up to and exceeding 10 years (when a longer period is necessary to encourage exploration and development in areas because of unusually deep water or other adverse conditions (see **primary term**)).

Lithology - The physical character of a rock, generally as determined megascopically or with the aid of a low-power magnifier.

Mass movement - Unit movement of a portion of the land surface. Mass movement, or slumping, can occur where unconsolidated sediments are distributed over a steep gradient.

Mesozoic - One of the grand divisions or eras of geologic time, following the Paleozoic era and succeeded by the Cenozoic era (from about 240 million years ago to about 63 million years ago); the Mesozoic era comprises the Triassic, Jurassic, and Cretaceous periods.

Metamorphosis - The process by which the physical and chemical characteristics of rock are altered by exposure to heat and pressure in the earth's crust.

Mudstone - The lithified equivalent of mud, similar to shale but more massive and less indurated.

Net profit share - A bidding system for leasing tracts on the OCS that uses the cash bonus as the bid variable and requires a fixed annual rental payment and net profit share payments at a rate that is constant for the duration of the lease.

Organic matter - Material derived from plant or animal organisms.

Outer Continental Shelf (OCS) - All submerged lands that comprise the Continental Margin adjacent to the United States and seaward of State offshore lands. The OCS has been subject to Federal jurisdiction and control since enactment of the Submerged Lands Act of 1953 (43 U.S.C. 1301 and 1302).

Permeability - The ability to transmit fluids.

Petroleum - An oily, flammable bituminous liquid that occurs in many places in the upper strata of the earth, either in seepages or in reservoirs; essentially a complex mixture of hydrocarbons of different types with small amounts of other substances; any of various substances (as natural gas or shale oil) similar in composition to petroleum.

Plan of exploration - A plan based on all available relevant information about a leased area that identifies, to the maximum extent possible, all the potential hydrocarbon accumulations and wells that the lessee(s) proposes(s) to drill to evaluate the accumulations within the entire area of the lease(s) covered by the plan. Under 30 CFR 250.34-1, all lease operators are required to formulate and obtain approval of such plans by the Manager of the Minerals Management Service before exploration activities may commence.

Platform - A steel or concrete structure from which offshore wells are drilled.

Plutonic - Relating to igneous rock formed beneath the earth's surface by consolidation from magma.

Porosity - The capability to contain fluids within void spaces in rock.

Primary term - The initial period of oil and gas leases, normally 5 years (see lease term).

Production - Activities that take place after the successful completion of any means for the removal of minerals, including such removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and work overdrilling.

Proprietary information - Geologic and geophysical data and immediate derivatives thereof that cannot be released to the general public because of Federal law, regulations, or statutes, or because of contractual requirements.

Recoverable resource estimate - An assessment of oil and gas resources that takes into account the fact that physical and technological constraints dictate that only a portion of resources or reserves can be brought to the surface.

Refining - Fractional distillation, usually followed by other processing (as cracking).

Relief - The elevations or inequalities of a land surface.

Reserve estimate - An assessment of the portion of the identified oil or gas resource that can be economically extracted.

Reserves - Portion of the identified oil or gas resource that can be economically extracted.

Reservoir rock - The rock material in which hydrocarbons accumulate, or whose characteristics are conducive to hydrocarbon accumulation.

Resource - Concentration of naturally occurring solid, liquid, or gaseous materials in or on the earth's crust.

Revenue sharing - A proposed system of sharing Federal revenues generated by hydrocarbon development on the OCS with coastal States.

Rig - Equipment used for drilling an oil or gas well.

Risked resource estimate - An assessment of oil or gas resources that has been modified to take into account the uncertainty of the estimate and to account for the possibility that economically recoverable resources may not be found within the area of interest.

Risked resources for leased lands - An assessment of oil or gas resources that has been modified to take into account (1) physical and technological constraints on production; (2) the influence of the costs of exploration and development and market price on industry investment in OCS exploration and production; and (3) the uncertainty of the estimate and to account for the possibility that economically recoverable resources may not be found within the area of interest.

Royalty - A share of the minerals (oil and gas) produced from a property by the owner of the property.

Sandstone - A sedimentary rock made up of sand-size grains that usually consist of quartz more or less firmly united by some cement (as silica, iron oxide, or calcium carbonate).

Sediment - Material or a mass of material deposited (as by water, wind, or glaciers).

Sedimentary rocks - Rock formed of mechanical, chemical, or organic sediment.

Seismic - Pertaining to, characteristic of, or produced by earthquakes or earth vibration; having to do with elastic waves in the earth.

Semisubmersible - A type of drilling rig mounted on an offshore barge-like vessel; when on location, the vessel's hull is submerged by flooding its compartments, leaving the derrick and its equipment well above the water line.

Siltstone - A very fine-grained consolidated clastic rock composed predominantly of particles of silt grade.

Slumping - (See **mass movement**).

Source bed - Rocks containing relatively large amounts of organic matter that is transformed into hydrocarbons.

Source rock - The geological formation in which oil, gas, and/or other minerals originate.

Stratigraphic sequence - A succession of sedimentary beds of interregional extent, chronologically arranged with the older beds below and the younger above.

Stratigraphic test - Hole drilled to determine the local stratigraphic section or the position of a key bed; term generally applied to holes considerably deeper than core holes.

Stratigraphic trap - A geologic feature that includes a reservoir, capable of holding oil or gas, that is formed from a change in the character of the reservoir rock. Such a trap is harder to locate than a structural trap because it is not dependent on structural closure and is thus not readily revealed by geological or geophysical surveys.

Stratum (pl.,strata) - A tabular mass or thin sheet of sedimentary rock formed by natural causes and made up usually of a series of layers lying between beds of other kinds.

Streamlining - A proposed system to shortening the Federal leasing process.

Strike - The direction or bearing of a horizontal line in the plane of an inclined stratum, fault, or other structural plane (for example, the axial plane of an anticline).

Strike-slip-fault - A fault in which the net movement is practically parallel to the direction of the fault trend.

Structural trap - A geologic feature that includes a reservoir, capable of holding oil or gas, that is formed from crustal movements in the earth that fold or fracture rock strata in such a manner that oil or gas accumulating in the strata are sealed off and cannot escape. In some cases "structure" may be synonymous with structural trap.

Subsidence - Movement in which there is no free side and surface material is displaced vertically downward with little or no horizontal component; a sinking of a large part of the earth's crust.

Subsistence - The minimum (as of food and shelter) necessary to support life; a source or means of obtaining the necessities of life.

Subsurface geology - The study of structure, thickness, facies, correlation, etc. of rock formations beneath land or seafloor surfaces.

Summary report - Document prepared by the Department of the Interior pursuant to 30 CFR 252.4 that is intended to inform affected State and local governments as to current OCS reserve estimates, projections of magnitude and timing of development, transportation planning, and general location and nature of nearshore and onshore facilities.

Supply boat - Vessel that ferries food, water, fuel, and drilling supplies and equipment to a rig and returns to land with refuse that cannot be disposed of at sea.

Surge tank - A tank on a flow line whose function is to receive and neutralize sudden intermittent rises or surges in the stream of liquid.

Swapping - Exchange of crude oil among companies to facilitate refining when one company's production is closer to the other's refinery, or vice versa.

Syncline - A fold in rocks in which the strata dip inward from both sides toward the axis.

Tectonic - Of or pertaining to the rock structure and external forms resulting from the deformation of the earth's crust.

Tertiary - The earlier of the two geologic periods comprised in the Cenozoic era.

Tract - The geographic and legal extent of a single lease area; a convenient way of numbering blocks offered for sale.

Trap - A geologic feature that permits the accumulation and prevents the escape of accumulated fluids (hydrocarbons) from the reservoir.

Treatment facility - A facility that separates hydrocarbons from water, emulsions, and other impurities.

Triassic - The earliest (from about 240 million years ago to about 205 million years ago) of the three geologic periods comprised in the Mesozoic era.

Trough -An elongate and wide depression, with gently sloping borders.

Truncated - Terminated abruptly as if cut or broken off.

Tsunami - A great wave generated by submarine crustal displacement or landslides; associated with major earthquakes and volcanic eruptions. Also called a "seismic sea wave."

Turbidite - Sediments deposited by a turbidity current.

Ultra-large crude carrier (ULCC) (sometimes called a supertanker) - A tanker in excess of 300,000 dwt.

Ultramafic - Ultrabasic; rocks containing virtually no feldspar or quartz and composed essentially of ferromagnesian silicates, metallic oxides and sulfides, and/or native metals.

Unconformity - A chronologic gap in the rock record caused by the removal of surficial strata prior to the deposition of any additional material; it is generally caused by a period of structural uplift and erosion.

Undiscovered resources - Quantities of oil and gas estimated to exist outside known fields.

Unit - Administrative consolidation of OCS leases held by two or more companies but explored, developed, and/or produced by one operator for purposes of conservation, eliminating duplication of operations, and/or maximizing resources recovered.

Unitization - A process by which two or more lease holders allow one company to serve as the operator for exploration, development, and/or production of the affected leases.

Vapor balance recovery system - A system to recover the vapor displaced from production tanks or the hold of a vessel being filled with a liquid hydrocarbon.

Volcaniclastic - A consolidated sedimentary rock composed of volcanic rock fragments.

Volcanism - Volcanic activity.

Well stream - Continuous flow of oil from a well.

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Outer Continental Shelf Oil and Gas Information Program:
Gulf of Alaska Summary Report 3

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