

1989 Annual Report on Alaska's Mineral Resources

U.S. GEOLOGICAL SURVEY CIRCULAR 1040



Prepared in cooperation with the Bureau of Land Management, the Fish and Wildlife Service, the Minerals Management Service, the National Park Service, the U.S. Bureau of Mines, the U.S. Forest Service, and the Department of Energy, as mandated by Section 1011 of the Alaska National Interest Lands Conservation Act, Public Law 96-487, of December 2, 1980



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**1989 Annual Report on
Alaska's Mineral Resources**



Frontispiece. The Boundary Creek area of the Juneau gold mining district, a region of interest to both Federal minerals agencies and private exploration companies. Photograph by A. Clough.

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JILL L. SCHNEIDER, Editor

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the Fish and Wildlife Service, the Minerals Management Service,
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Lands Conservation Act, Public Law 96-487, of December 2, 1980

A summary of mineral resource activities in Alaska for the year 1988

U.S. GEOLOGICAL SURVEY CIRCULAR 1040

DEPARTMENT OF THE INTERIOR
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Acronyms and Abbreviations

| | |
|--------|---|
| AAPG | American Association of Petroleum Geologists |
| ADGGS | Alaska Division of Geological and Geophysical Surveys |
| AFOC | Alaska Field Operations Center |
| A-J | Alaska-Juneau mine |
| AMRAP | Alaska Mineral Resource Assessment Program |
| ANILCA | Alaska National Interest Lands Conservation Act |
| ANWR | Arctic National Wildlife Refuge |
| ANGTS | Alaska Natural Gas Transportation System |
| AORIS | Arctic and Offshore Research Information System |
| APA | Alaska Power Authority |
| ATTO | Alaska Technology Transfer Office |
| BLM | Bureau of Land Management |
| B/MIS | Bibliographic/Management Information System |
| CAMA | Central Arctic Management Area |
| CIRI | Cook Inlet Region, Incorporated |
| DOE | Department of Energy |
| DST | Deep stratigraphic test |
| EIS | Environmental Impact Statement |
| EEZ | Exclusive Economic Zone |
| FLMPA | Federal Land Management and Policy Act |
| FPGP | Favorable Petroleum Geological Province |
| FWS | Fish and Wildlife Service |
| MAS | Minerals Availability System |
| MILS | Minerals Industry Location System |
| MMS | Minerals Management Service |
| MRDS | Mineral Resources Data System |
| NEPA | National Environmental Policy Act |
| NPRA | National Petroleum Reserve in Alaska |
| NPS | National Park Service |
| NURE | National Uranium Resource Evaluation |
| OCS | Outer Continental Shelf |
| PCB | Polychlorinated biphenyl |
| PGM | Platinum-group metals |
| REE | Rare-earth element |
| SEMS | Seafloor Earthquake Measurement System |
| SEPM | Society of Economic Paleontologists and Mineralogists |
| TACT | Trans-Alaska Crustal Transect |
| TAGS | Trans-Alaska Gas System |
| TAPS | Trans-Alaska Pipeline System |
| USBM | U.S. Bureau of Mines |
| USFS | U.S. Forest Service |
| USGS | U.S. Geological Survey |

1989 Annual Report on Alaska's Mineral Resources

Jill L. Schneider, *Editor*

SUMMARY

Section 1011 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980 requires that "On or before October 1, 1982, and annually thereafter, the President shall transmit to Congress all pertinent public information relating to minerals in Alaska gathered by the United States Geological Survey, Bureau of Mines, and any other Federal agency." This report has been prepared in response to that requirement.

This circular is the eighth in a series of annual ANILCA reports. The report provides information about current Alaskan mineral projects and events during 1988; the emphasis is on Federal activity. The report addresses both onshore and offshore areas of Alaska.

The U.S. Geological Survey (USGS), the U.S. Bureau of Mines (USBM), and the Minerals Management Service (MMS) are the principal Federal agencies that publish information about mineral resources in Alaska. Their reports and data are commonly used by other Federal agencies in decisionmaking on land use, access, environmental impacts, and mining claim evaluation. The time required for sample analysis, data synthesis, and the publication process is lengthy, so scientific reports are generally issued a year or more after the initial sample and data collection. Other sources of information include Federal and State publications, trade and professional journals, newspaper articles, presentations at public meetings and hearings, and press releases.

Information is provided for two broad categories of minerals: energy resources and nonfuel-mineral resources.

Energy Resources

OIL AND GAS

Oil and gas, the most valuable commodities in Alaska, increased production in 1988 to 738 million barrels of oil and 188 billion cubic feet of dry natural gas. Oil prices fell during the year to their lowest level in December, but started to recover in early 1989. In a

marked departure from past practice, BP Exploration now sets the contract price of oil at the beginning of each month, based on the previous month's average spot market price.

The Alaska Oil and Gas Commission issued 157 drilling permits in 1988; 135 development wells and 5 exploratory wells were drilled. Seismic exploration is underway at Granite Point, Kuparuk River, and Yukon Flats.

Activity on the North Slope remained strong, with four producing oil fields, and several others under development. The Prudhoe Bay, Kuparuk River, Lisburne, and Endicott fields produced almost 95 percent of the State's total oil. The Trans-Alaska Pipeline System (TAPS) currently carries 2.1 million barrels of this oil daily. In south-central Alaska, four of the Cook Inlet region's gas fields—Beluga, Kenai, McArthur River, and North Cook Inlet—produced 90 percent of the State's dry natural gas.

The State of Alaska conducted two competitive onshore lease sales on the North Slope in 1988. High bids totaling \$20.8 million were offered for 465,000 acres of land. The MMS held three competitive lease sales on the Outer Continental Shelf (OCS) of Alaska in the Beaufort Sea, Chukchi Sea, and North Aleutian Basin planning areas. High bids totaling \$688 million were accepted for 3.4 million acres. Bids from a 1984 MMS lease sale in the Navarin Basin area were refunded due to disputed claims of jurisdiction at the Soviet-American boundary.

Other MMS activities include joint studies with other Federal and State mineral agencies. The MMS and USGS completed a national inventory and assessment of oil and gas resources. Cooperative studies between the MMS and State of Alaska targeted the Arctic National Wildlife Refuge (ANWR) and the continental margin of the Beaufort Sea.

The USGS continued its energy-resource studies on the North Slope of Alaska, including a compilation of geologic reports on the National Petroleum Reserve in Alaska (NPRA) and research on natural-gas hydrates. Elsewhere in the State, work continues on the geology and petroleum potential of the sedimentary basins of interior Alaska and on the petroleum source potential of Alaska's coals.

In 1988, the Bureau of Land Management (BLM) completed the ANILCA 1001 Central Arctic Management Area (CAMA) report. The report has been sent to Congress as required by ANILCA. BLM also completed oil and gas assessments on six national wildlife refuges for the Fish and Wildlife Service (FWS). BLM geologists, either independently or with other agencies, continued their ongoing minerals studies throughout Alaska, with special focus on the North Slope, ANWR, and the Steese/White Mountains area. It is expected that several of these studies will be issued as open-file reports in 1989.

In keeping with its mission to protect fish, wildlife, and habitat, the FWS monitored petroleum-related activities and the cleanup of polychlorinated-biphenyl(PCB)-contaminated materials in the Kenai National Wildlife Refuge. The FWS issued special use permits for geologic work in four refuges, and reviewed permit applications to the U.S. Army Corp of Engineers in order to recommend measures to minimize habitat losses. In addition, final management plans were released for lands in three national wildlife refuges.

The Department of Energy (DOE) continued developing a computerized data base of Arctic energy-related technical information. DOE sponsored seminars to present new technological petroleum research findings, coordinated interagency petroleum research, and studied the applicability of recovery techniques to petroleum reservoirs in the Arctic. Research focused on ice-island generation and drift paths in the Beaufort Sea, responses of sea-floor soils to strong earthquakes, and gas-hydrate reservoirs.

Arctic National Wildlife Refuge.—During 1988, the FWS and BLM completed a proposed oil and gas management plan for the 1002 area of the ANWR. A draft legislative environmental impact statement (EIS) was issued, and public hearings were held, on the issue of Native land exchanges between the ANWR and other refuges in Alaska. The proposed exchanges were recommended by the Secretary of the Interior in a Record of Decision, January 1989.

The BLM and FWS continued to respond to public and Congressional inquiries regarding oil and gas potential of the 1002 area. To better address these questions, BLM scientists continue to supplement their ANWR studies by reviewing offshore geological and geophysical information.

COAL AND PEAT

1988 was the second consecutive year of record coal production in Alaska. As the fourth most valuable mineral commodity in the State, 1.55 million tons of coal

was produced at an estimated worth of \$44.3 million. This is an increase of 5 percent by value over 1987. Slightly more than one-half of total production was exported to Korea and Japan.

All commercial coal production presently comes from the Usibelli Coal Company's single mine in central Alaska. In the future, two more mines may be operating: Diamond Alaska has received final approval for mining at its Beluga site on the west side of Cook Inlet, and permitting is underway for the Wishbone Hill mine in the Matanuska Valley.

The USGS continued its coal program with an assessment of the coal resources on the North Slope, geochemical analyses of coal from the Healy coal fields, and an investigation of the thickest known coal bed in Alaska, the Death Valley coal seam on the Seward Peninsula.

Other Federal coal activity in 1988 included BLM management of a coal lease in the Jarvis Creek field near Delta Junction, USBM-sponsored studies for revegetating abandoned coal mine properties, and comments by the FWS regarding the EIS and subsequent permitting at the Beluga field.

Alaska's peat production rebounded dramatically in 1988 to 55,000 cubic yards, up 20 percent from 1987's declining levels. Peat is used primarily as an agricultural soil conditioner, with minor amounts burned for heat in some villages.

URANIUM

As in 1987, no uranium ore was produced in Alaska during 1988. The production of uranium in Alaska is not economically feasible at this time due to high exploration and production costs, and the currently depressed market for uranium.

Exploration research for uranium was continued by the USGS at a low level; most of the activity relates to previously collected data. Two reports were issued: a study of uranium occurrences in the Iditarod quadrangle, and a paper related to the Death Valley uranium deposit on the Seward Peninsula.

GEOTHERMAL RESOURCES

Geothermal resources in Alaska are associated with widespread young volcanic activity in the southern part of the State. During 1988, the test well at Makushin Volcano near Dutch Harbor and Unalaska was plugged; economic conditions do not allow development of the geothermal resources at this time. The USGS continued mapping at the Emmons Lake caldera near Cold Bay.

Nonfuel-Mineral Resources

METALLIC MINERALS

Alaska's mineral industry expanded significantly in 1988 in terms of dollars spent and minerals extracted. Exploration expenditures nearly tripled from \$15.7 million in 1987 to \$44.5 million in 1988. Major construction occurred at the Greens Creek and Red Dog mines during the year, and development expenditures more than doubled from \$100.3 million in 1987 to \$269.7 million in 1988. The total value of metals produced increased 8 percent in 1988 to \$114.1 million. As the second most valuable commodity in the State, 265,500 ounces of gold were produced in 1988, a 16 percent increase in volume over 1987.

In the exploration for precious metals, industry activity focused on lode gold mines. Final evaluation was completed at the Golden Zone mine north of Anchorage. Exploration drilling was performed at the Rock Creek prospect near Nome on the Seward Peninsula. Ongoing evaluation continues at the Shumagin prospect on Unga Island. Finally, the possibility of reopening the Alaska-Juneau, Chichagof, Hirst-Chichagof, Jualin, and Kensington mines in southeastern Alaska was explored.

Industry activity also included continued successful development of the Red Dog zinc-lead-silver deposit in northwest Alaska, completion of plans for opening the Greens Creek silver-zinc-lead mine on Admiralty Island in southeast Alaska, and continued studies at the Quartz Hill molybdenum deposit in southeastern Alaska. Once in production, the Greens Creek mine will be the largest silver producer in the United States, and the Red Dog mine will be the largest zinc-lead producer in the Western World.

The Alaska Mineral Resource Assessment Program (AMRAP) continues to be the focus of USGS mapping and mineral resource assessment within Alaska. In late 1987 and early 1988, USGS scientists released major reports on the metallogeny of metalliferous lode deposits and placer districts of Alaska; initiated and continued research, field studies, and report-writing for mineral assessments of 26 1:250,000-scale quadrangles; and performed specialized geologic studies at a detailed scale for 31 projects in the State. Two proposals are being considered for joint study between the USGS and the Far East Branch of the USSR Academy of Sciences.

The Trans-Alaska Crustal Transect (TACT) program and the interagency cooperative study of the White Mountains National Recreation Area are other important USGS programs. During 1988, work on the TACT program included detailed geologic mapping; magnetotelluric, seismic refraction, and reflection surveys; and interpretation, publication, and presentations of project findings. Reports released on research from the White

Mountains National Recreation Area included publications on sample analyses, placer gold deposits, and mineral resource assessment.

The USBM updated a computerized mineral deposit data base, published an economic feasibility study for the Juneau gold belt, and released reports on land availability for mineral exploration in western and southwestern Alaska. Mineral assessment programs were carried out in the Valdez Creek and Juneau mining districts, the White Mountains, and the Chugach National Forest. Minerals assessment of the Tongass National Forest was completed and provided to the USFS for use in developing the Tongass Land Management Plan. Geologists evaluated critical and strategic mineral deposits at 22 locations in the State.

The USBM also established a Technology Transfer Office in Anchorage, staffed by professionals with backgrounds in mining and metallurgy. This office works actively with various Federal and State agencies, universities, industry, and individuals on technology issues and needs.

The BLM issued draft EIS's analyzing the impacts of placer mining on four watersheds in interior Alaska. Six mineral patents were issued, and 216 mining operations were active on BLM-administered lands. The FWS monitored for contaminants in the drainages below active mines at fifteen locations, and also identified environmental concerns at three other mining localities in the State. The MMS has proposed a competitive OCS mineral lease sale of gold-bearing placers in Norton Sound south of Nome.

The National Park Service (NPS) reviewed mining plans of operations in four park units, conducted claim validity exams, and inventoried natural and cultural resources on mining claims within park boundaries. Reclamation of disturbed land was initiated on 27 acres of abandoned mining claims in the Denali National Park and Preserve. The NPS also released for public review three court-ordered draft EIS's on the cumulative effects of mining in three park units.

The U.S. Forest Service (USFS) validated mining claims at Greens Creek and completed the final EIS for the Quartz Hill mine. Evaluations of development potential are underway at various abandoned gold mines in the Juneau gold belt. Work continued on revision of the land management plan for the Tongass National Forest and management area planning for the Chugach National Forest.

INDUSTRIAL MINERALS

The production of building stone rose sharply in 1988, due mainly to infrastructure development at several sites around the State. Operators mined 3.6 million

tons valued at \$24.6 million, more than double the 1987 levels. Sand and gravel production recovered slightly from its 1987 slump, with 17.2 million tons produced; it remains the third most valuable mineral commodity in the State with an estimated value of \$48.8 million. The export of glacial ice to Japan is a new, but rapidly growing, enterprise.

The BLM issued three permits and made four mineral material sales. The FWS permitted and monitored several small sand and gravel operations throughout the State. The USFS sold 191,000 tons of sand, gravel, and quarried stone for use in the construction of timber sale roads, breakwaters, and airports.

INTRODUCTION

Section 1011 of ANILCA of 1980 requires that "On or before October 1, 1982, and annually thereafter, the President shall transmit to Congress all pertinent public information relating to minerals in Alaska gathered by the United States Geological Survey, Bureau of Mines, and any other Federal agency." The USGS has been delegated as the lead agency in responding to this requirement. This circular, the eighth in its series, synthesizes information made public in 1988.

The USGS and the USBM are the principal Federal agencies that generate information about onshore mineral resources in Alaska; the MMS is the prime agency reporting on resource activities in Alaska's coastal waters. Their data, analyses, and reports are used by other agencies in decisionmaking on land use, access, environmental impacts, and mining claim evaluation.

As used herein, the term "public information" includes results of Federal projects as published in Government reports and professional and trade journals; talks by representatives of Federal and State agencies and industry at symposia, conferences, and other public forums; and proceedings volumes, press releases, and newspaper articles. References of pertinent information are listed at the end of this report; appendix 1 lists the published reports cited, as well as other pertinent literature selections. Data from the annual summary of industrial mineral activity in Alaska, published by the Alaska Division of Geological and Geophysical Surveys (ADGGS), are used in parts of this report.

This report focuses on energy resources (oil, gas, coal, peat, uranium, and geothermal) and nonfuel-mineral resources (metallic and industrial minerals).

The next several pages describe the current mineral programs of land-management and other Federal agencies in Alaska. The roles of these agencies as they relate to minerals are discussed in appendix 2. The distribution of lands under Federal management are shown in figure 1.

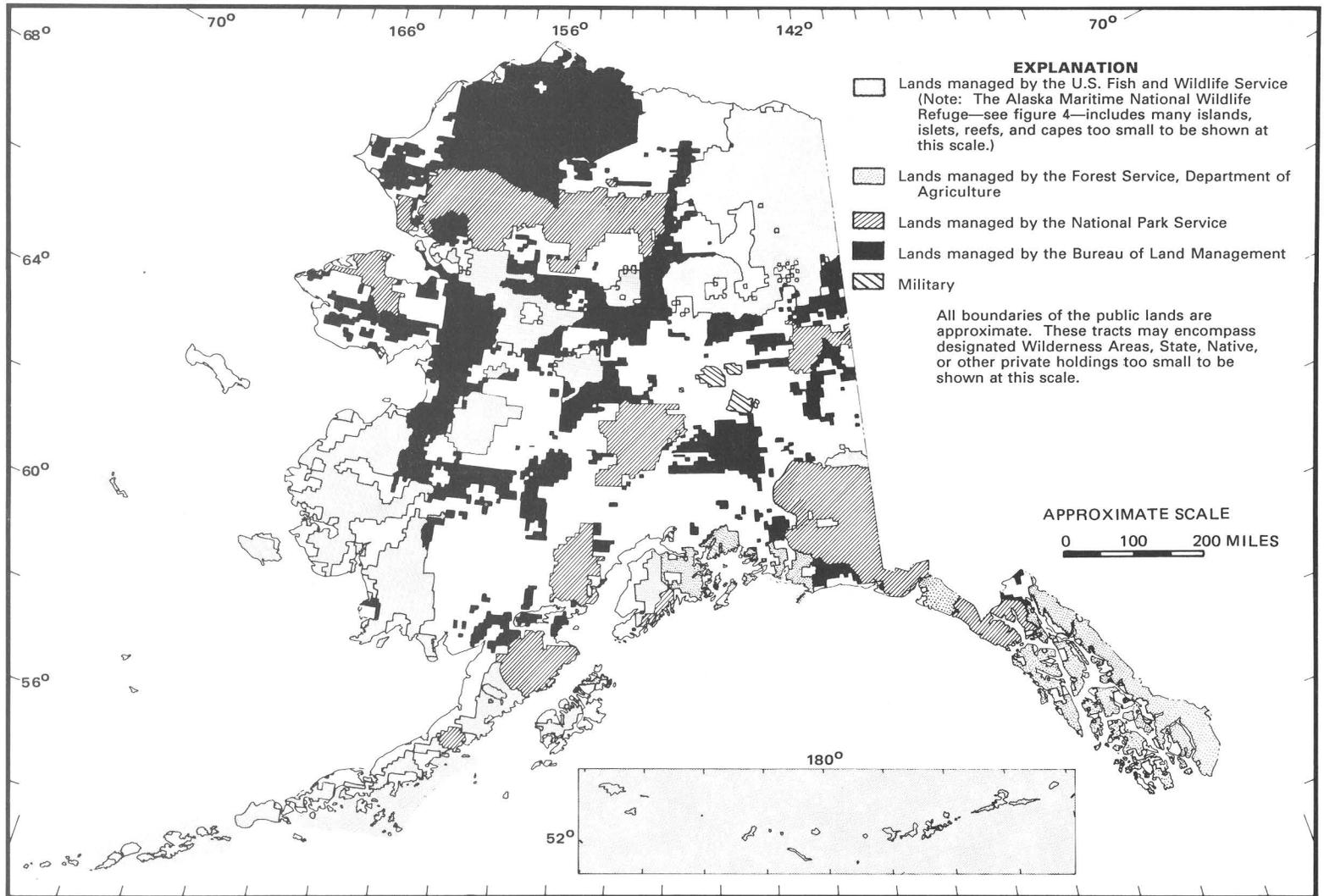
MINERAL PROGRAMS

Department of the Interior

U.S. GEOLOGICAL SURVEY

As directed by Section 1010 of ANILCA, the Secretary of the Interior requires an assessment of "the oil, gas, and other mineral potential on all public lands in the State of Alaska in order to expand the data base with respect to the mineral potential of such lands." AMRAP is one of the major responses of the USGS to this legislation. The goal of this program is a systematic investigation of Alaska's mineral resources through four progressively more detailed levels of study. Studies at levels I and II are general and cover large areas. Studies at level III draw on many geologic disciplines to produce resource assessments at scales of 1:250,000 and 1:125,000 (fig. 2). Level IV studies consist of detailed studies of specific mining districts, mineral deposits, or topics related to the genesis of mineral deposits. In 1988, level III studies were underway in 26 quadrangles, and a total of 31 level IV studies were in progress. These studies are used to help determine the distribution and potential of national mineral and energy endowments and to aid in formulating policy affecting resource and land management, and in improving resource assessment technology to minimize potential impacts from development. These studies also help industry locate new mineral deposits by developing concepts, models, and techniques to identify such deposits. USGS publications are frequently used by industry as a source of information about known mineral deposits in the State.

The USGS performs its work in Alaska through several programs in addition to AMRAP. Among the programs active in 1988 were: (1) the Earthquake Hazards Reduction Program, which seeks to mitigate earthquake losses through providing data and evaluations for land-use planning, engineering, and emergency preparations; (2) the Volcano Hazards Program, which includes studies on the assessment, reduction, and prediction of volcanic hazards; (3) the Geologic Framework Program, involving both general and specialized research on the regional geology of Alaska; (4) studies of mineral resources on public lands; (5) the Development of Assessment Techniques Program, whose goal is improvement of the ability to identify and evaluate mineral resources; (6) the Strategic and Critical Minerals Program, for identifying the potential of these resources to meet national military and economic needs; (7) the Sedimentary Basins Program, which conducts studies of depositional, structural, diagenetic, and thermal processes to predict and evaluate water, mineral, and petroleum resources; and (8) the Geothermal Investigations Program, which focuses on studies of the nature, distri-



Base from maps prepared by the Bureau of Land Management in 1987.

Figure 1. Federal land ownership in Alaska (boundaries as of June 1988).

bution, and energy potential of these resources nationally. In addition, the TACT program is a multidisciplinary approach to study the Earth's crust along a corridor from the Pacific Ocean to the Arctic Ocean. This program is coordinated with the Trans-Alaska Lithosphere Investigation, which utilizes earth scientists from the Alaska Division of Geological and Geophysical Surveys (ADGGS), the University of Alaska, other universities, and private industry. The mineral-related aspects of many of these programs are more fully described in later sections of this report.

Economic-geologic information for mineral occurrences in the United States and worldwide is available through the USGS Mineral Resources Data System (MRDS) computerized files. In Alaska, recently updated records focusing on metallic minerals contain 2,051 entries for forty 1:250,000-scale quadrangles in the south-central and southeastern areas of the State. Data in these files include mineral-deposit size, type, description, location, reserves, and pertinent literature references for known or potentially locatable mineral resources (see Leonard and Huber, 1987). Geologic information from the Alaska MRDS files can be used to complement

economically oriented data from the Mineral Availability and Mineral Industry Location Systems computerized files of the U.S. Bureau of Mines, discussed in the next section. Further MRDS information can be obtained from Donald F. Huber, Central and Western Regional Representative, U.S. Geological Survey, MS 984, 345 Middlefield Road, Menlo Park, CA 94025.

U.S. BUREAU OF MINES

During 1988, the Alaska Field Operations Center (AFOC) and Alaska Technology Transfer Office (ATTO) of the USBM were active in the programs listed below; further information on the scope and nature of these programs can be found in appendix 2.

Mineral land assessment.—The USBM's major emphasis in Alaska is to develop areal and commodity-oriented mineral assessments. A major part of this program focuses on evaluations of mining districts in the State, with assessments of the type, quantity, distribution, reserves, and beneficiation potential of specific mineral deposits. The program also centers on critical and strategic mineral studies throughout Alaska. USBM geolo-

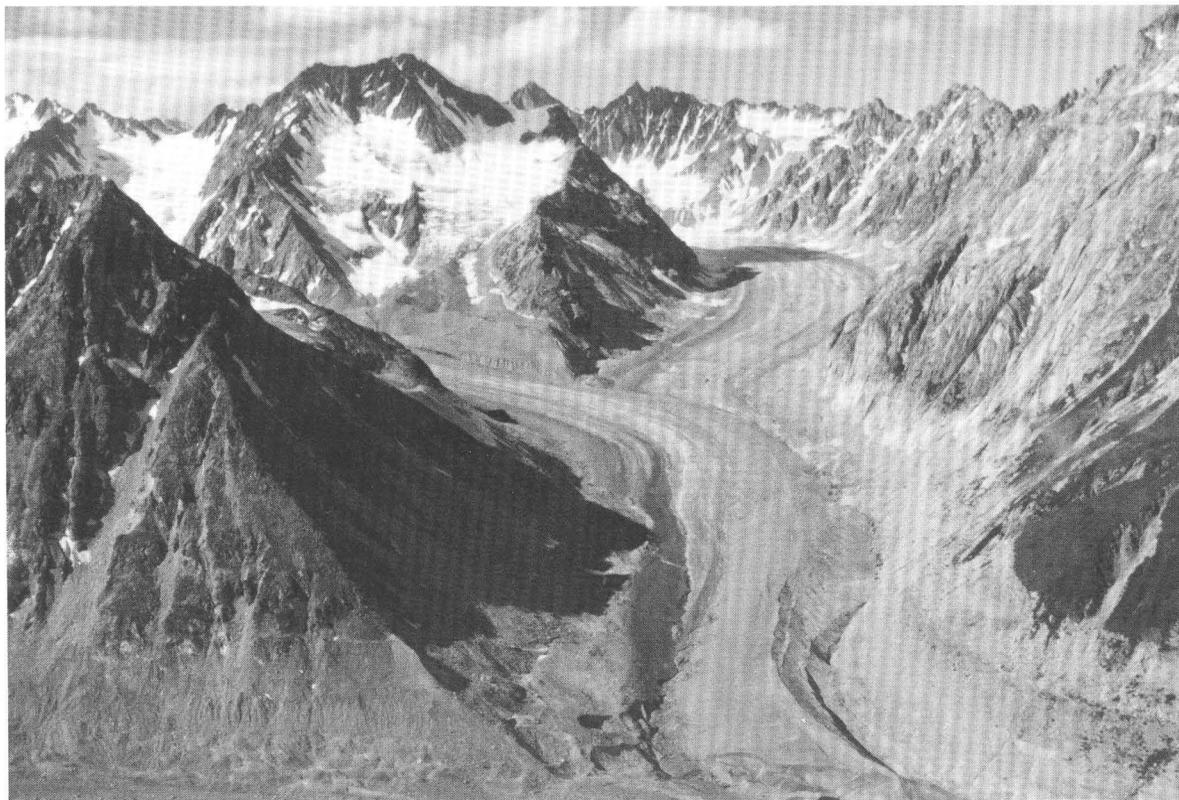


Figure 2. Glacial tributary of Neacola River in southeast part of Lime Hills quadrangle, site of 1:125,000-scale USGS level III AMRAP studies. Photograph by B. Gamble

gists locate, map, and estimate the size and grade of mineral deposits; they also collect samples for metallurgical research (fig. 3).

Minerals availability.—The two computerized components of this program are the Minerals Availability System (MAS) and the Minerals Industry Location System (MILS) data bases. The MAS contains information on reserve estimates, mineral extraction and beneficiation methodologies, environmental constraints on mining, and cost analyses for selected major mineral deposits. The MILS lists basic information on the identification and location of known mineral deposits.

Policy analysis.—This program compiles analyses of mineral data with respect to local and national needs. Technical, institutional, political, social, and economic parameters are used to identify mineral issues.

State mineral activities.—A USBM Alaskan State Mineral Officer compiles and analyzes mineral data to report on activities and trends within Alaska's mining industry.



Figure 3. U.S. Bureau of Mines geologist preparing for underwater sampling in Kuskokwim Bay near Platinum, southwestern Alaska. Photograph by K. Lamal.

Minerals research.—Minerals research in Alaska includes efforts associated with mineral land assessment activities, as well as providing assistance to other governmental agencies, industry, and academia to alleviate problems in mining, milling, and refining of ore. AFOC and ATTO cooperate with Bureau and university research centers to solve mineral-utilization problems. Bulk samples of ores from various parts of Alaska have been sent to the USBM research centers in Albany, Oregon, and Salt Lake City, Utah, to determine characterization and beneficiation properties related to recovery of the minerals. Samples containing tungsten, gold, tin, tantalum, columbium, platinum, chromium, and rare earth elements are now being evaluated.

The USBM's Alaska Technology Transfer Office, located in Anchorage, is responsible for working with other Federal agencies, the State, universities, and industry on technology issues and needs, conducting technology transfer briefings, and facilitating work with USBM research centers throughout the United States.

BUREAU OF LAND MANAGEMENT

The principal activities of the BLM that are related to Alaska's onshore mineral and energy resources are: (1) development of the terms and conditions, through the planning process and environmental review, in accordance with the applicable statutes, for mineral exploration and development on BLM lands, (2) issuance of mineral leases and management of lease activity on Federal lands, coordinating with the responsible surface managing agency where appropriate, (3) recording of mining claims and determination of the validity of claims for mineral patents, and (4) regulation of mining activities on BLM lands to protect the environment. The BLM is also responsible for enforcing environmental and technical stipulations of the Agreement and Grant of Right-of-Way for the Trans-Alaska Pipeline System (TAPS). The overall goal is to maintain a continuous supply of energy while ensuring that unnecessary or undue degradation of the public lands does not occur. In addition, the BLM issues land-use authorizations and conducts mineral and material sales to support preconstruction activities for the planned natural-gas pipeline and other projects.

Administrative responsibilities for minerals require close coordination with other surface-management agencies. Generally, in the case of onshore leases, the BLM issues leases and integrates leasing with other land uses in cooperation with the surface-management agency. After a lease is issued, the BLM assumes jurisdiction of exploratory and development activities in cooperation with the land manager to assure proper surface and subsurface protections.

FISH AND WILDLIFE SERVICE

Mineral activities on FWS land in Alaska must conform to the agency's mission of protecting fish and wildlife, and their habitats. In Alaska, FWS activities include administration of 77 million acres of national wildlife refuge land; fish and wildlife research; law enforcement; and habitat protection through agency review of, and comments on, permit requests, environmental impact statements, and other items. The FWS has an environmental-contaminants program that includes sampling and reporting on contaminants in waters, sediments, and organisms affected by oil and gas exploration and development, placer mining, and other mineral activities.

The locations of the 16 national wildlife refuges managed by the FWS in Alaska are shown in figure 4.

MINERALS MANAGEMENT SERVICE

The primary mission of the Minerals Management Service (MMS) is to manage development of mineral resources on the Federal Outer Continental Shelf (OCS). Management efforts are largely focused on leasing of offshore areas for oil and gas exploration and development. However, the MMS also has the authority to lease the OCS for ocean mining of hard minerals.

Prior to an OCS lease offering, the MMS appraises the economic worth of leasable offshore areas and assesses environmental risks associated with development of resources on or beneath these lands. Following a lengthy process of public review and comment, the MMS selectively makes these lands available to interested parties through competitive OCS lease sales designed to ensure the receipt of fair market value for the leases.

The MMS regulates postlease exploration, development, and production activities to ensure that operations are conducted in a safe and environmentally acceptable manner. The MMS conducts inspections of operations to ensure compliance with applicable laws, regulations, and lease terms. Lastly, the MMS is responsible for the collection and accounting of royalty and rental revenues generated by leased properties. At present, no development or production of mineral resources is occurring on the Alaskan OCS.

The MMS does not manage exploration and development of mineral commodities onshore in Alaska. It is responsible, however, for the collection of royalties, bonus payments, and lease rentals generated from onshore Federal and certain Native lands. Productive leases in the Swanson River oil and gas field provide the bulk of this kind of revenue.

The MMS conducts regional studies of the geologic history and petroleum potential of Alaska's offshore

basins for the National Resource Assessment, the MMS-USGS inventory of America's oil and gas resources. The MMS also prepares specialized studies of wells which were drilled as part of the Deep Stratigraphic Test (DST) well program. Results of these studies have been published as part of the MMS OCS report series. A list of titles is provided elsewhere in this circular. Copies of these reports may be obtained from the regional office library in Anchorage.

NATIONAL PARK SERVICE

The National Park Service (NPS) does not manage minerals in the same sense as other Federal agencies because the vast majority of park units are closed by law to leasing, disposition, and mineral location. The NPS is directed by its Organic Act, and other Federal law, to protect park resources and, more specifically, to protect them from significant adverse impacts that can result from mineral exploration and development activities. The NPS minerals management programs are related to the protection of park resources by regulation of activities relating to the exercise of valid existing rights. Valid existing rights are State, Native, and other private mineral or fee lands, or interests in lands whose ownership was typically established at the time the park unit was created. Examples of valid existing rights which are regulated by NPS are patented or valid unpatented mining claims, and non-Federal oil and gas rights.

NPS minerals management activities include mineral examinations to determine claim validity; evaluation of proposed plans of operations for completeness; engineering analysis; and impact assessment of proposed plans of operations, bonding, and compliance monitoring of approved operations. In Alaska, major programs have been undertaken to survey, aerially photograph, and map mining claims; to prepare topographic maps of mining claims (1 inch = 100 feet; 10-foot contour interval); to perform hydrological monitoring; to reclaim abandoned or acquired mining claims; and to conduct reclamation research. Guidelines for NPS management and regulation of mineral-related activities are discussed in appendix 2.

Department of Agriculture

U.S. FOREST SERVICE

Under a memorandum of understanding with the BLM, the USFS jointly administers the general mining laws on its own lands in Alaska. An example of this joint responsibility is the patent issued to U.S. Borax and Chemical Co. for mining claims at their Quartz Hill deposit near Ketchikan. The USFS recommended issu-

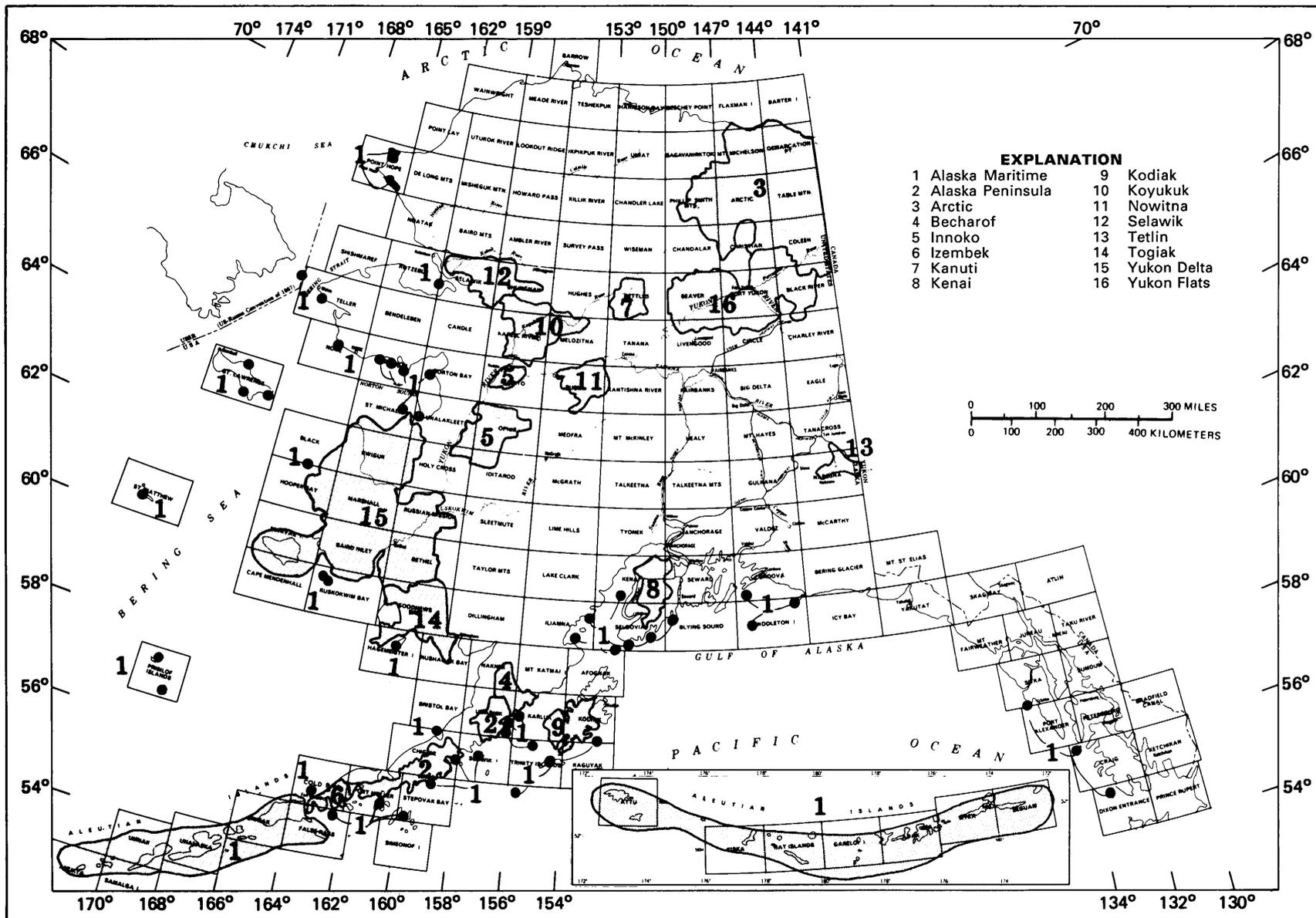


Figure 4. National wildlife refuges in Alaska. 1:250,000-scale quadrangles are outlined and labeled.

ance of this patent on the basis of favorable findings in a mineral report prepared by USFS mineral examiners.

The USFS cooperates with Department of the Interior agencies, particularly the BLM, in issuing mineral leases and assuring mitigation of surface impacts of lease activities. The USFS also cooperates with the State of Alaska and the private sector in development of energy and mineral resources on inholdings. One such inholding is the Bering River coal field, under consideration for possible development by Chugach Alaska, Inc., and others in a consortium.

In Alaska, 23 million acres of land is administered by the USFS (fig. 1), whose regional office is in Juneau. Offices for the Chugach National Forest are in Anchorage, Girdwood, Seward, and Cordova, and for the Tongass National Forest in Sitka, Ketchikan, and Petersburg.

Department of Energy

In Alaska, the DOE is focusing its efforts on petroleum, coal, and geothermal resources. The DOE in Alaska administers current petroleum acts and congressional mandates relating to energy, monitors grants, and oversees contracts for energy-resource studies. DOE funding helps to support USGS resource-assessment studies and research by the ADGGS and the University of Alaska.

To develop a better understanding of both conventional and unconventional petroleum resources and to provide fundamental information to accelerate use of these resources, the DOE focuses on investigating resources and technologies that continue to expand the body of essential basic scientific knowledge of conventional and heavy petroleums, shale oil, tar sands, gas hydrates, and deep-source gas. Gas hydrates, deep-source gas, and Arctic offshore energy are specific targets of DOE research in Alaska.

The DOE is working to evaluate Alaskan coal in terms of its contribution to the total resources of the Nation. Coal research currently centers on utilization methods suitable to Alaskan coals and conditions.

The DOE has established several computerized data bases, including the Arctic and Offshore Research Information System (AORIS), which is designed to provide scientific oil- and gas-related information for use by the Arctic energy community. AORIS (utilizing both the personal computer (PC) and VAX mainframe versions) is composed of a directory of 85 energy-related data bases, a bibliography containing approximately 9,000 citations, and a quantitative data base containing approximately 1,100 data sets, in both tabular and graphical formats, on sea-ice characteristics.

The DOE closed its regional office in Anchorage in 1985. Requests for information about DOE Alaskan activities should be addressed to the office listed below.

Contacts For Further Information

DEPARTMENT OF THE INTERIOR

Bureau of Land Management

Michael Penfold, State Director
Federal Building
222 W. Seventh Avenue, No. 13
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Fish and Wildlife Service

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Anchorage, AK 99503-6119

Minerals Management Service

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National Park Service

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Alaska Regional Office
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U.S. Bureau of Mines

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Alaska Field Operations Center
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U.S. Geological Survey

Donald Grybeck, Chief
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DEPARTMENT OF AGRICULTURE

U.S. Forest Service

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Alaska Region
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DEPARTMENT OF ENERGY

Hydrocarbon resources

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ENERGY RESOURCES

Oil and Gas Resources

OVERVIEW OF PRODUCTION AND PRICES

In 1988, as in the previous several years, oil and gas were the most valuable commodities produced in Alaska. Alaska's two oil-producing areas, the Arctic North Slope and the Cook Inlet (fig. 5), provided a total of 738 million barrels (1 barrel = 42 gallons) of oil, 188 billion cubic feet of dry natural gas, and 1,765 billion cubic feet of casinghead gas in 1988 (Alaska Oil and Gas Conservation Commission Bulletin, February 1989). This represents an increase over 1987 of about 3.1 percent for oil and 14.6 percent for gas. Production increases on the North Slope offset production declines from the Cook Inlet. The rate of oil production in Alaska at the end of 1988 amounted to 2.02 million barrels per day (bbl/d) (Alaska Oil and Gas Conservation Commission Bulletin, February 1989), or about 25 percent of the United States daily production. The 1988 production data indicate that Alaska's daily oil production of 2.02 million bbl/d surpassed that of Texas, with 1.9 million bbl/d (Petroleum Information, Alaska Report, v. 34, no. 3; Oil and Gas Journal, v. 86, no. 9).

The oscillation of world oil prices that began in late 1985 continued into 1988 (fig. 6). The price between December 1985 and July 1986 declined from a high of about \$27 per barrel to a low of \$9 per barrel (Petroleum Information, Alaska Report, v. 32, no. 27). However, in August of 1987, the price of North Slope crude delivered to the west coast had increased to \$18.75 per barrel. During 1988, the price of North Slope crude oil fell to a low of \$10.68 in December, but by January 1989, had increased to \$13.35 (table 1). Alaska is especially vulnerable to crude oil prices because 83 percent of the State's current revenue is derived from royalties and taxes paid on State-owned oil and gas leases, the value of which fluctuates with oil prices (Alaska Division of Geological and Geophysical Surveys, 1986). The sensitivity of oil prices on exploration and production was reflected in many industry activities; the Milne Point oil field, the third field to produce on the North Slope, went into

“warm” shutdown in late 1986 due to depressed prices, but resumed production in April of 1989 when prices had rebounded (Oil and Gas Journal, v. 87 no. 12).

BP Exploration (formerly Standard Alaska Production Company) has stated that the company will set the contract price of oil at the beginning of each month, based on the previous month's spot market average; this will give more stability to the price. Therefore, the contract price on May 11, 1988, is the average spot market price for North Slope crude in April (table 1) (Petroleum Information, Alaska Report, v. 34, no. 19).

EXPLORATION

By mid-December 1988, the State had issued 157 drilling permits for the year; these included 134 development wells, 9 exploratory wells onshore and offshore, and 14 service wells (Petroleum Information, Alaska Report, v. 34, no. 51).

An agreement among Doyon Native Corporation, Exxon, and Amoco for exploration of 1.3 million acres was reached, with Exxon beginning 275 miles of geophysical work in the Yukon Flats area (fig. 5) in February 1988 (Petroleum Information, Alaska Report, v. 34, no. 3).

On the west side of Cook Inlet, a three-year seismic program was initiated (Petroleum Information, Alaska Report, v. 34, no. 39). Northern Geophysical of America, a joint venture involving Denver-based Prospex Inc., has completed the first of three phases in a seismic survey program northwest of the Granite Point oil field near McArthur River (loc. G, fig. 5). The first phase included 25 line-miles of land seismic work. The second phase, started November 1988, covered 250 line-miles to the south of the first phase. The third phase will be 289 line-miles, for a total of 564 line-miles in the area. The seismic work is in preparation for Alaska's oil and gas lease sale tentatively scheduled for June 1989.

PRODUCTION ACTIVITY

Industry activities for onshore Alaska in 1988 included further delineation of a new oil field and oil production startup in another field, both on the North Slope, as well as geophysical and geological surveys, and the drilling of five exploratory wells (fig. 5, table 2) and 135 development wells (Oil and Gas Journal, v. 87, no. 5). Development drilling was concentrated primarily on the North Slope in four producing and several developing fields. Three of the exploratory wells are located on the North Slope; the other two are in the Cook Inlet area. Little information has been released to the public, but some information is made available through private

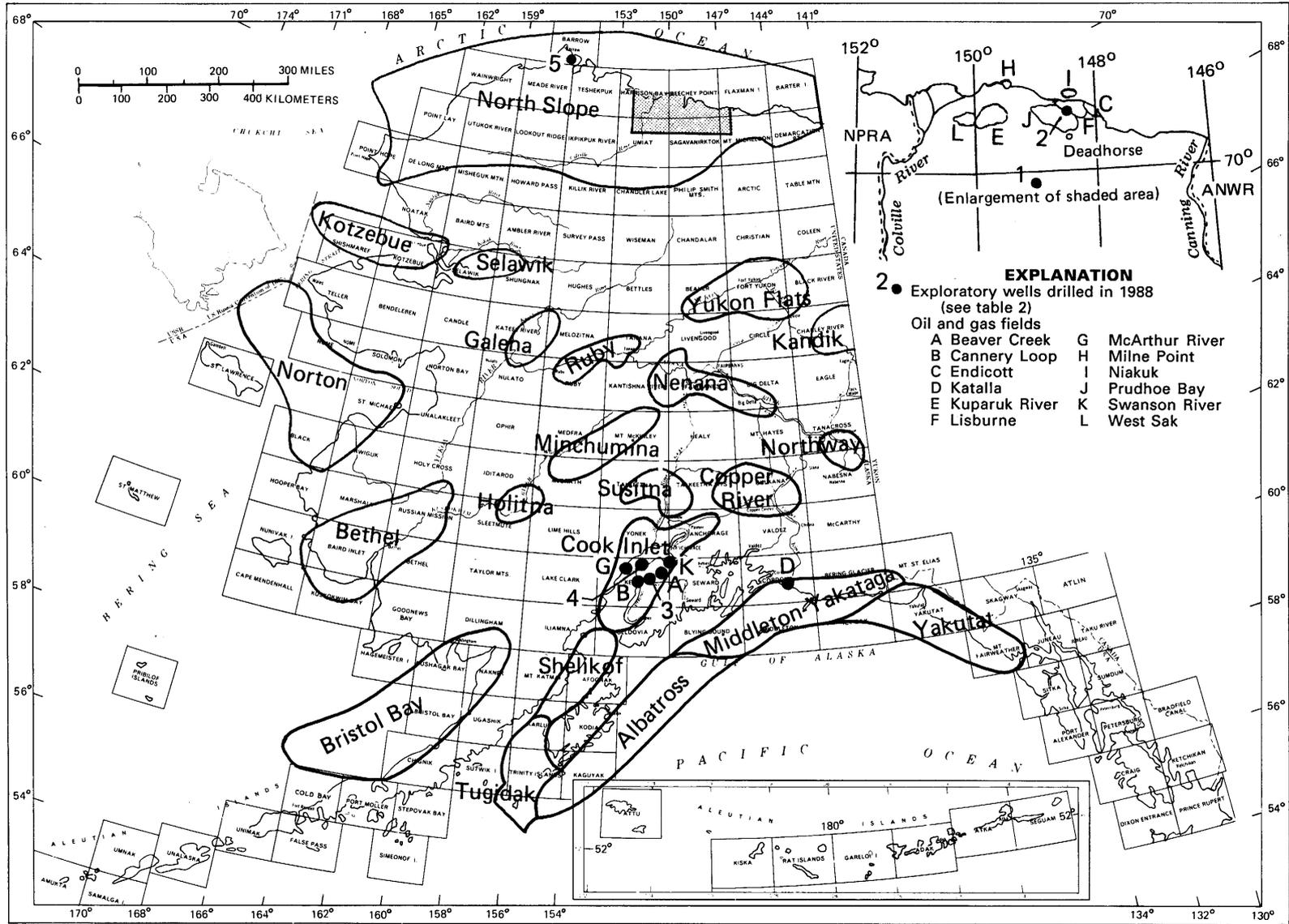


Figure 5. Locations of exploratory wells drilled in 1988, oil and gas fields, and possible petroleum-bearing sedimentary basins. Basins adapted from unpublished map by C.E. Kirschner, U.S. Geological Survey. 1:250,000-scale quadrangles are outlined and labeled.

Table 1. Fluctuation of the price of Alaska North Slope crude oil

[Data from the Petroleum Information Alaska Reports; BP Exploration's Alaska North Slope contract crude oil price represents 95 percent of production; WC, delivered to west coast; GC, delivered to Gulf of Mexico]

| Date | Cost per barrel | |
|----------|--------------------|---------|
| | WC | GC |
| 12/30/87 | \$14.50 | \$15.50 |
| 3/2/88 | 13.75 | 14.75 |
| 3/9/88 | 12.75 | 13.75 |
| 3/30/88 | 13.75 | 14.75 |
| 4/20/88 | 15.25 | 16.25 |
| 15/11/88 | 14.83 | 15.83 |
| 6/8/88 | ² 14.51 | 15.51 |
| 7/6/88 | 13.81 | 14.81 |
| 8/3/88 | 13.34 | 14.34 |
| 9/7/88 | 13.15 | 14.15 |
| 10/5/88 | 11.92 | 12.92 |
| 11/2/88 | 10.77 | 11.77 |
| 12/7/88 | 10.68 | 11.68 |
| 1/4/89 | 13.35 | 14.35 |

¹New contract price based on average of spot market price for Alaska North Slope crude for prior month. The price will be set at the beginning of each month (Petroleum Information, Alaska Report, v. 34, no. 19).

²Price not confirmed.

subscription services, such as the weekly Petroleum Information Alaska Report.

North Slope

Barrow gas field.—The boundary for the Barrow gas field was expanded with a gas pool discovery in the field area (Oil and Gas Journal, v. 86, no. 8). The North Slope Borough No. 6 well (fig. 5, table 2) produced at a rate of 693,000 cubic feet per day through 10/64-inch choke when tested in April 1988. The well, located in sec. 6, T. 21 N., R. 17 W., Umiat Meridian, was drilled to a depth of 2,564 ft. to the Sag River Sandstone and tested in the interval from 2,178 to 2,228 ft. in the Barrow sands (Petroleum Information, Alaska Report, v. 34, no. 31).

Prudhoe Bay field.—The Prudhoe Bay field, the world's 19th largest producer (Tiratsoo, 1984) and largest field in the United States, produces at a rate of 1.5 million bbl/d. The majority working interest in the field is held by BP Exploration (50 percent), Arco (22 percent), and Exxon (20 percent) (Wall Street Journal, September 27, 1988).

Prudhoe Bay's central gas facility is taking 4.0 billion cubic feet of produced gas (120 percent of design), separating out 55,000 bbl/d of natural gas liquids (109 percent of design), and reinjecting more than 330 million standard cubic feet of gas per day (Oil and Gas Journal, v. 86, no. 22). Construction and startup in late 1986 of this facility, the largest of its kind in the world, was done months ahead of schedule and at 75 percent of the estimated cost.

The daily production at Prudhoe Bay was expected to drop to 1.45 million bbl/d in late 1988 due to transportation problems and unexpected repairs to facilities (Petroleum Information, Alaska Report, v. 34, nos. 39 and 42). The gas-handling capacity needs to be raised from a current four billion cubic feet per day to five billion cubic feet per day by 1990 to allow for increased gas production for each barrel of oil produced. This will cost \$350 million, but will allow oil production to be maintained at 1.5 million bbl/d in 1990 (Wall Street Journal, September 27, 1988).

BP Exploration scheduled and approved 50 development wells and 22 workover wells for the main Prudhoe Bay field in 1988 (Petroleum Information, Alaska Report, v. 34, no. 3). BP Exploration plans to develop the Eileen/West End area, a separate fault-block in the Prudhoe Bay field with 20 development wells at a cost of \$300 million. This portion of the field is estimated to contain 110 million barrels of recoverable oil and is expected to produce 65,000 bbl/d by 1990 (Anchorage Daily News, June 1, 1988; The Anchorage Times, May 27, 1988).

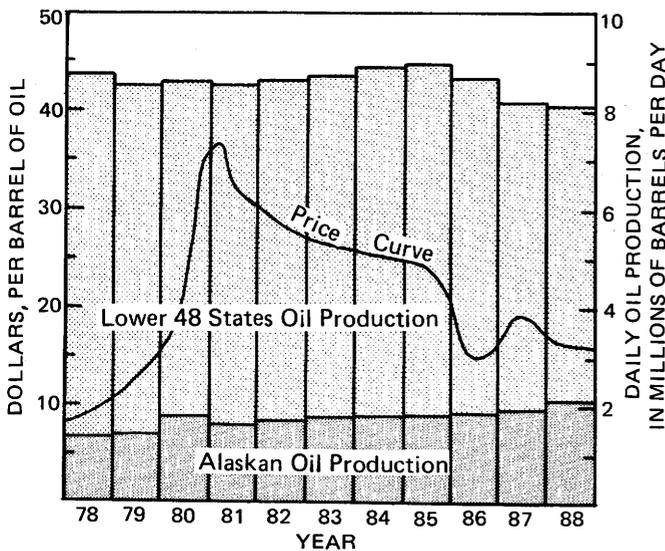


Figure 6. Average annual United States oil production and worldwide price of oil for 1978–1988.

Table 2. Onshore Alaska exploratory wells drilled in 1988

[See figure 5 for locations. UM, Umiat Meridian; SM, Seward Meridian; tight hole, no information available]

| Well No. | Company | Well name | API No. | Location Sec.-T.-R. | Total depth (in ft) | Date completed | Remarks |
|----------|------------------------|------------------|--------------|---------------------|---------------------|----------------|------------|
| 1 | Arco Alaska | Pipeline State 1 | 50-223-20016 | 33-6N-13E,UM | ? | 3/28/88? | Tight hole |
| 2 | Arco Alaska | Pt. McIntyre 3 | 50-029-21779 | 16-12N-14E,UM | 13,164 | ? | Tight hole |
| 3 | Arco Alaska | Moose River 1 | 50-133-20399 | 1-5N-9W,SM | 15,500 | ? | Tight hole |
| 4 | Unocal | Cannery Loop 4 | 50-133-20387 | 4-5N-11W,SM | 16,500 | 3/30/88 | Gas |
| 5 | North Slope Borough | S. Barrow 6 | 50-023-20026 | 6-21N-17W,UM | 2,564 | 3/30/88 | Gas |

The Hurl State project is designed to develop a fault block in the southwestern part of the Prudhoe Bay field. The project will take two years to complete at a cost of about \$85 million. A gravel pad will be built to hold three 60-ton modules and include space for 16 production wells and 4 water injection wells. Drilling is expected to start in the third quarter of 1989. Initial production will be 5,000 bbl/d of oil, increasing to 14,000 bbl/d in 1991. About 37 million barrels of oil will be recovered (Petroleum Information, Alaska Report, v. 34, no. 52).

Kuparuk River/West Sak oil fields.—The Kuparuk River field (loc. E, fig. 5) is the second largest oil field in the United States; it produced about 112 million barrels of oil in 1988, or an average of about 307,000 bbl/d (table 3). Compared to 1987, field production increased with the addition of 62 producing wells on 3 new, and 4 existing, drill sites. A daily production record was set on February 20, 1988, at 321,827 barrels of oil. Higher production rates are attributed to additional wells in the field, a fieldwide waterflood project, and temperatures that dipped as low as minus 37 °F, increasing the efficiency (horsepower production) of the gas-fired turbines used to power the oil through the pipeline from the field to pump station 1 of the Trans-Alaska Pipeline System (Petroleum Information, Alaska Report, v. 34, no. 8; Oil and Gas Journal, v. 86, no. 9).

Arco Alaska began work on a 3-dimensional seismic project in the Kuparuk River unit to further delineate the field. The work will span a 3-year period at a cost of \$20 million and will cover an area of 270 square miles. This will be a winter operation starting in November 1988; completion is scheduled for May 1990. Western Geophysical, the contractor, will use six vibroseis-equipped tracked vehicles (Petroleum Information, Alaska Report, v. 34, no. 10; Oil and Gas Journal, v. 86, no. 10).

Arco Alaska has applied to the Alaska Department of Natural Resources to expand the Kuparuk River unit by an additional 10,192 acres, for a total of 396,592 acres. The acreage is included in three tracts acquired by Arco Alaska (75 percent) and Amerada Hess (25 percent) in

State lease sale 45A held in September 1985. Arco Alaska also requested a postponement of the scheduled contraction of the unit to allow time to develop the necessary technology to tap the oil in the West Sak field that overlies the Kuparuk Formation of Carmen and Hardwick (1983). To date, industry has spent \$200 million on exploration, delineation, and production research in the West Sak oil field (Petroleum Information, Alaska Report, v. 34, no. 25). Because the West Sak reservoirs contain heavy oil, Arco Alaska argues that a 6-year postponement is the “minimum adequate time” required to develop the necessary technology to effectively produce the oil (Petroleum Information, Alaska Report, v. 34, no. 25).

Arco Alaska filed a permit application with the U.S. Army Corps of Engineers which would allow the placement of 89,000 cubic yards of gravel on 31 acres for construction of a road and drillsite to test production methods for shallow West Sak heavy-oil reservoirs. Drillsite location is planned for secs. 14 and 23, T. 11 N., R. 10 E., Umiat Meridian, in the Kuparuk River field. If approved, one well can be drilled in winter 1989. If production tests are successful, 24 more wells will be drilled to an average depth of 3,500 ft. The West Sak field is estimated to contain 15 to 25 billion barrels of oil in place, of which about 10 percent is recoverable (Petroleum Information, Alaska Report, v. 34, no. 44).

Gwyder Bay unit.—Conoco Inc. is seeking to transfer interest in 27,000 acres on two lease holdings in the Gwyder Bay unit to Arco Alaska. Leased in October 1979, other working interest owners are Arco Alaska, Chevron USA, Exxon, Hamilton Brothers, Mobil, and Occidental. An election will be held by the working interest holders to choose a new operator (Petroleum Information, Alaska Report, v. 34, no. 50).

Lisburne field.—The Lisburne field (loc. F, fig. 5) became the fourth field to start production on the North Slope on December 15, 1986.

Arco Alaska decided against building a gravel causeway to the offshore portion of the Lisburne field in favor of developing that part of the field with directional

Table 3. Alaskan oil fields with reserves exceeding 50 million barrels

[bbl, barrel; from Oil and Gas Journal, v. 87, no. 5, p. 69]

| Field | Discovery date | Original reserves | 1988 production | Cumulative production Jan. 1, 1988 | Estimated remaining reserves | Estimated number of wells |
|----------------------------|----------------|-------------------|-----------------|------------------------------------|------------------------------|---------------------------|
| x1,000 bbl | | | | | | |
| North Slope | | | | | | |
| Endicott | 1978 | 368,000 | 36,098 | 43,098 | 324,902 | 37 |
| Kuparuk River | 1969 | 1,498,432 | 112,055 | 503,397 | 994,945 | 328 |
| Lisburne | 1967 | 211,289 | 14,600 | 35,600 | 175,689 | 49 |
| Milne Point ¹ | 1969 | 101,000 | 0 | 10,572 | 89,428 | 19 |
| Niakuk ² | 1985 | 58,000 | 0 | 0 | 58,000 | - |
| Point Thomson ³ | 1977 | 350,000 | 0 | 0 | 350,000 | - |
| Prudhoe Bay | 1967 | 9,586,683 | *576,335 | *6,053,018 | 3,533,665 | 691 |
| Seal Island ⁴ | 1984 | 300,000 | 0 | 0 | 300,000 | - |
| Ugnu ⁵ | 1969 | 15,000,000 | 0 | 0 | 750,000 | - |
| Umiat | 1946 | 70,000 | 0 | 0 | 70,000 | - |
| West Sak | 1971 | *2,000,000 | 0 | 0 | 2,000,000 | - |
| Cook Inlet | | | | | | |
| Granite Point | 1965 | 125,748 | 2,787 | 109,535 | 16,213 | 29 |
| McArthur River | 1965 | 564,000 | 7,040 | 529,040 | 34,960 | 76 |
| Middle Ground Shoal | 1962 | 161,152 | 2,737 | 155,889 | 5,263 | 42 |
| Swanson River | 1957 | 218,336 | 2,154 | 209,490 | 8,846 | 29 |

¹Under "warm" shut-in for 1987, before it could attain peak flow of 30,000 bbl/d (Oil & Gas Journal, v. 85, no. 4, p. 68).²Anchorage Daily News, Dec. 16, 1987; Petroleum Information, Alaska Report, v. 33, no. 51.³Oil and Gas Journal, v. 81, no. 11, p. 30.⁴Includes about 30.66 million bbl of condensate.⁵Includes about 138.66 million bbl of condensate.⁶Minerals Management Service OCS Information Report, MMF-85-0022, p. 28-31.⁷Oil in place for lower Ugnu (6-11 billion bbl) and upper Ugnu (5-8 billion bbl), Werner, 1987.⁸Recoverable reserves are estimated to be 10 percent of 15-25 billion bbl of oil (Petroleum Information, Alaska Report, v. 34, no. 25).

drilling (Anchorage Daily News, February 12, 1988). Arco Alaska, with Nabors Alaska drilling rig 28E, has set a new North Slope directional drilling record at the LG1-4 well. With a combination of techniques, the well was kicked out at 500 feet rather than the usual 2,000 feet, and with a vertical depth of 9,200 feet, departed from the true vertical depth of 11,700 feet. The technique required aluminum drill pipe, polymer drilling mud systems, improvements in synthetic diamond drill bits, and downhole motors (Petroleum Information, Alaska Report, v. 34, no. 28).

Endicott field.—The Endicott field (loc. C, fig. 5) exceeded expectations of BP Exploration for daily oil production with an average of 115,000 bbl/d and peaks as high as 125,000 bbl/d. Only 100,000 bbl/d had been predicted (Oil and Gas Journal, v. 86, no. 9).

Niakuk field.—The Niakuk field (loc. I, fig. 5) is about one mile offshore in the Beaufort Sea, between Prudhoe Bay to the south and the Endicott field to the

east. BP Exploration acquired the State leases in sale number 18, held in 1967. The field is estimated to contain 58 million barrels of recoverable oil and 30 billion cubic feet of natural gas. Proposed development plans call for a 6,600-foot causeway to an existing manmade exploration island—Niakuk No. 4—that would serve as a drilling and production base for the field. Included in the plan is a 350-foot bridged breach near the shore for fish passage (Petroleum Information, Alaska Report, v. 34, no. 14).

Cook Inlet

General.—The Cook Inlet region is Alaska's main gas production area, with 90 percent of 1988 production coming from four fields. The Kenai field produced 86 billion cubic feet of gas, North Cook Inlet produced 45 billion, Beluga produced 25 billion, and McArthur River produced 12 billion.

Chevron USA transferred operatorship (but not ownership interests) of the Swanson River oil field and

the Beluga gas field to Arco Alaska (Petroleum Information, Alaska Report, v. 34, no. 51). Chevron USA has transferred to Unocal its interest in, and operator status of, four gas units: Birch Hill, Stump Lake, Ivan River, and North Fork. The fields are presently shut-in, but are capable of gas production. Birch Hill, located in T. 9 N., R. 9 W., Seward Meridian, includes one well on 150 acres that could produce gas from the Tyonek Formation. The Stump Lake unit in T. 14 N., R. 8 W., Seward Meridian, includes one well on 70 acres that could produce gas from the Beluga Formation. The Ivan River unit in T. 13 N., R. 9 W., Seward Meridian, includes 2 wells on 2,418 acres that could produce gas from the Tyonek Formation. The North Fork field in T. 4 S., R. 14 W., Seward Meridian, includes one well on 50 acres that could produce gas from the Tyonek Formation (Petroleum Information, Alaska Report, v. 34, no. 51).

Kenai Peninsula.—On the Kenai Peninsula, Unocal set an Alaskan depth record for 13–5/8 inch casing to a depth of 8,234 feet in the deep wildcat well, Cannery Loop 4 (fig. 5, table 2) (Oil and Gas Journal, v. 86, no. 5). The well was completed in the Miocene “Beluga and Upper Tyonek” zones of local usage. The Cannery Loop field is currently generating 30 million cubic feet of gas per day for fertilizer production. Three wells are producing on 1,280 acres (Petroleum Information, Alaska Report, v. 34, no. 23).

Arco has been approved to be the new operator for the Falls Creek gas field (Petroleum Information, Alaska Report, v. 34, no. 50). The field covers 630 acres and includes one shut-in well. Chevron and Borealis Resources were the two previous operators of the field (Petroleum Information, Alaska Report, v. 34, no. 50).

Mountain Alaska Energy plans to build a pipeline to supply residents of Homer with natural gas produced from the North Fork gas field. North Fork field is estimated to contain about 1 trillion cubic feet of gas. The 16-mile, 6-inch line is estimated to cost \$3.5 to \$4 million (Petroleum Information, Alaska Report, v. 34, no. 23).

McArthur River field.—In the McArthur River field, well M-26 on the Steelhead platform blew out in December, 1987 (Petroleum Information, Alaska Report, v. 34, no. 8), when a gas leak ignited while crews were setting 13 5/8-inch casing at 2,265 feet (Petroleum Information, Alaska Report, v. 34, no. 14). Early in 1988, Marathon Oil Co. proposed to pump cement downhole in order to seal the well (Petroleum Information, Alaska Report, v. 34, no. 8). In May 1988, Diamond M Company's *Falcon*, a semisubmersible drilling rig under contract to Marathon and Unocal, arrived in Cook Inlet and prepared to drill a relief well. *Falcon* anchored 500 feet southeast of the Steelhead platform to drill a well to intersect the M-26 well (Petroleum Information, Alaska Report, v. 34, no. 20). The well—Unocal, Relief McArthur River 1, sec. 33, T. 9 N., R. 13 W., Seward

Meridian—spudded May 18, 1988 (Petroleum Information, Alaska Report, v. 34, no. 33). The relief well intercepted the M-26 well at 1,200 feet and pumped in a cement plug from 1,200–2,265 feet to bring the well under control. *Falcon* was released on August 2, 1988 (Petroleum Information, Alaska Report, v. 34, no. 33). The M-26 gas well blowout on Steelhead platform created a crater 170 feet by 250 feet across and at least 30 feet deep near the B-1 leg (one of the 4 platform legs). The crater, which required about 40,000 cubic yards of gravel to fill, came within 12 feet of both the A-1 and B-2 legs (Petroleum Information, Alaska Report, v. 34, no. 37).

STATE ACTIVITY AND LEASE SALES

During 1988, State agencies conducted two onshore competitive oil and gas lease sales (fig. 7, table 4), monitored and supervised lease development, collected lease rents and production royalties, and conducted numerous geologic and geophysical studies relating to oil and gas resource evaluation and land classification. These studies are only briefly reported in this circular. The Alaska Department of Natural Resources' Information Circular 31, “Oil and Gas Resources of Alaska,” presents an overview of the history of exploration and development, current prospects, resource estimates, and the State's leasing program. For Federal studies, the reader is directed to USGS Bulletin 1903 entitled “Geologic Studies in Alaska by the U.S. Geological Survey, 1988.”

At the two competitive State lease sales, a total of \$20.8 million was offered in high bids to acquire approximately 465,000 acres for future exploration. At least eight oil companies and several independent investors participated in these sales. The terms of the leases, which in 1988 were all on State lands, can be obtained from the Lease Administration Office, Alaska Department of Natural Resources, 555 Cordova Street, Anchorage, AK 99501. For further information about State petroleum-related activities, readers should contact the Alaska Division of Oil and Gas, 3601 C St., Anchorage, AK 99503, or obtain Information Circular 31 from the Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys (appendix 2).

TRANSPORTATION

The last Trans-Alaskan pipeline construction camp, Old Man Camp, was closed out in 1988 (Alaska Journal of Commerce and Pacific Rim Reporter, January 18, 1988). The camp is on Federal land, and was named for the Kanuti River, an Athabascan word that roughly translates as “old man.”

In February 1988, the Trans-Alaskan pipeline delivered the 6-billionth barrel of oil to the port of

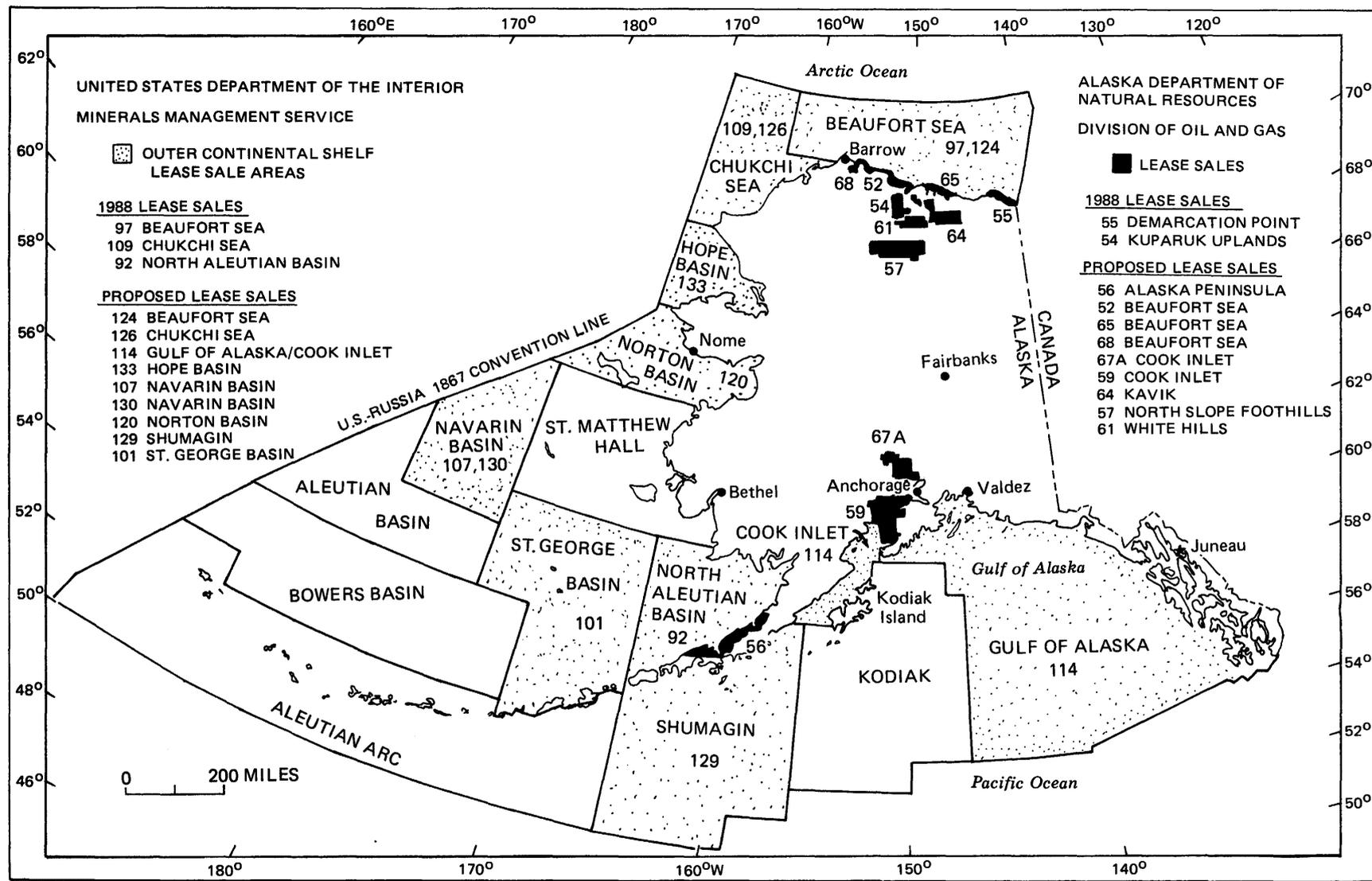


Figure 7. Areas of oil and gas lease sales and Alaska OCS Region planning areas (area boundaries based on Minerals Management Service protraction diagrams, November 1986).

Table 4. State of Alaska onshore oil and gas lease sales, 1988

[Areas shown in fig. 7; all sales were conducted by the State of Alaska, Department of Natural Resources, Division of Oil and Gas; data from Petroleum Information, Alaska Report, v. 34, no. 40]

| Sale name - - - - - | Kuparuk Uplands | Demarcation Point |
|--------------------------------------|-----------------|-------------------|
| Sale number - - - - - | 69A | 55 |
| Sale date (month/day/year) | 09/28/88 | 09/28/88 |
| Cash bonus bid with fixed royalty of | 12.5 pct | 12.5 or 16.67 pct |
| Total number of bids received | 104 | 52 |
| Tracts offered | 155 | 55 |
| Acreage offered | 775,555 | 201,707 |
| Tracts sold | 75 | 25 |
| Acreage sold | 368,490 | 96,632 |
| Total high bonus bids | \$6,119,135 | \$14,700,602 |
| Total exposure (sum of all bids) | \$7,351,906 | 20,925,528 |
| Average high bonus bid per acre | \$16.61 | \$152.13 |
| Highest bid for a tract | \$643,507 | \$3,661,000 |
| Highest bid per-acre | \$111.72 | \$2,592.78 |

Valdez (Petroleum Information, Alaska Report, v. 34, no. 8). In June of 1977, the pipeline carried only 300,000 barrels of oil per day, but now carries 2.1 million barrels of oil per day.

The tanker *Chevron Mississippi* became the 8,000th vessel to load North Slope crude oil in early May 1988 (Petroleum Information, Alaska Report, v. 34, no. 19). This was its 141st trip to the pipeline terminal in Valdez. Since 1977, an average of over two vessels per day have taken on North Slope crude oil in Valdez.

Pacific Texas Pipeline Company has started to stockpile 42-inch pipe in Midland, Texas, for the planned 1,030-mile southwest pipeline from Los Angeles to Texas. The line will carry North Slope crude from an artificial island in Los Angeles Harbor to Midland. The pipeline would have 10 pump stations along the route and be able to move 900,000 barrels per day. Project cost is estimated at \$1.6 billion. Executives at Pacific Texas are negotiating with Alaska producers for at least 300,000 barrels per day. Eight days would be saved, and \$1 to \$3 per barrel in transportation costs, compared to shipping the oil to the Panama Canal, across the canal zone by pipeline, and then to the gulf coast by tanker. Presently, only BP Exploration ships oil to the gulf coast, as Arco Alaska refines all its oil on the west coast (Petroleum Information, Alaska Report, v. 34, no. 52).

ACTIVITY BY FEDERAL AGENCIES

Minerals Management Service

Leasing Activity

Since 1976, the Department of the Interior has held 15 OCS oil and gas lease sales on the continental shelves offshore Alaska. In these sales, over 17,000

blocks, each approximately 5,700 acres in area, were offered. Of these, approximately 1,500 blocks were leased by industry for cash bonus bids totaling over \$6.4 billion. Approximately 1,000 leases remain active at present; the remainder have expired or have been relinquished.

Three major offshore sales were held in 1988 in the Beaufort Sea, Chukchi Sea, and North Aleutian Basin planning areas (fig. 7). Proceeds from these three sales collectively exceeded \$688 million. All OCS sale terms are cash bonus bidding with a royalty fixed at 12.5 percent. Awarded leases carry a 10-year term.

Sale 97, Beaufort Sea planning area.—Sale 97 was the fourth lease offering (table 5) held in the Beaufort Sea planning area within the past 9 years. However, it was the first offering of leases in the planning area west of Point Barrow. The first two sales, held in 1979 and 1982, were limited to the vicinity of Prudhoe Bay.

The decline in revenues from Beaufort Sea sales held since 1982 reflects uncertainties surrounding world petroleum market trends and discouraging results of recent exploratory drilling. In addition, bidding in more recent sales has focused upon less attractive prospects which lie farther offshore and in more costly logistical environments.

Sale 97 was held on March 16, 1988. Over 18 million acres divided into 3,344 lease blocks were offered. Sixteen companies exposed a total of \$139,194,672 in competitive bidding on 218 tracts. The highest bid for a single tract was \$23,388,000. All high bids were accepted, except for 16 blocks which are subject to a Canadian claim of jurisdiction. These bids were deemed adequate, but were neither accepted nor rejected until the United States determines that it is in its best interest to do so.

Table 5. Proceeds from lease sales in the Beaufort Sea planning area

| | |
|-----------------------------|--------------------|
| ¹ Sale BF (1979) | \$488,691,138.00 |
| Sale 71 (1982) | \$2,055,632,335.65 |
| ² Sale 87 (1984) | \$866,860,327.00 |
| ² Sale 97 (1988) | \$114,631,636.00 |

¹Held jointly with the State of Alaska; total revenues \$1,056,082,635.00.

²These figures do not include the 20 blocks affected by a Canadian claim of jurisdiction (sale 87, 4 blocks; sale 97, 16 blocks).

Sale 109, Chukchi Sea planning area.—OCS sale 109 was the first lease offering ever held in the Chukchi Sea planning area. Originally scheduled for 1985 as OCS sale 85, it was deleted from the sale schedule in 1984. Sale 85 was rescheduled as Sale 109 and held on May 25, 1988.

Approximately 25 million acres divided into 4,566 parcels were offered in sale 109. Sixteen companies competed in bidding on 351 tracts, altogether exposing \$666,232,384. The most successful competitor was Shell Western Exploration and Production, Inc., which, either bidding alone, or in partnership with Conoco, Inc., and with Elf Aquitaine, acquired 164 tracts at a cost of approximately \$368.3 million. The sum of accepted high bonus bids was \$478,032,631. A single bid on one tract was rejected, and 350 leases were awarded. The highest bid for a single tract was \$16,138,000.

Sale 92, North Aleutian Basin planning area.—OCS sale 92 was the first lease sale ever held in the North Aleutian Basin planning area. Two earlier proposed sales, OCS sale 51 in October 1977 and OCS sale 75 in April 1983, were deleted from the sale schedule in response to concerns raised by the State of Alaska. A North Aleutian Basin sale was eventually rescheduled for January 15, 1986, as OCS sale 92. The district court prohibited further conduct of the sale after sealed bids had already been submitted to the MMS. On October 11, 1988, after nearly 3 years of litigation, all legal barriers to sale 92 were removed, and the bids were opened and read.

Over 5.6 million acres of OCS lands divided into 990 lease blocks were offered in sale 92. Nine companies exposed a total of \$114,067,500 in competitive bidding on 23 tracts. Accepted high bonus bids totaled \$95,439,500. All high bids were accepted, and leases were awarded for all tracts receiving bids. The highest bid for a single tract was \$24,360,000.

Refund of bids, Navarin Basin planning area.—In OCS sale 83, held on April 17, 1984, industry acquired 163 leases in the Navarin Basin for high bonus bids totaling \$516,317,331. An additional 17 blocks, which lie within an area affected by a Soviet claim of jurisdiction,

received total high bids of \$108,174,000. The bids for blocks within this disputed area were determined to be adequate, but were neither accepted nor rejected. A total of \$21,634,800, representing one-fifth of the bonus bids (submitted with the principal bid), were deposited in an interest-bearing escrow account. In December 1988, the Secretary of the Interior concluded that it was no longer in the interest of the United States to retain these bids, so the Department of the Interior rejected the high bids, liquidated the account, and returned the funds plus interest (\$29.3 million) to the participants.

The area of disputed jurisdiction lies along the northwest edge of the Navarin Basin planning area. It is enclosed by two alternative interpretations of the location of the line which connects two fixed coordinates as described in the 1867 purchase agreement between Russia and the United States. The United States argues that the treaty intended the fixed points to be linked by a line drawn as if scribed along a radius hinged at the Earth's center (that is, a great circle). This line is identified as the "U.S.-Russia 1867 Convention Line" in figure 7. The Soviet Union instead maintains that the line follows a "rhumb line," or constant compass bearing, between the two points (that is, a straight line on a Mercator projection). Thus drawn, the two conflicting interpretations of the 1867 treaty enclose a lens-shaped disputed zone 15,400 square nautical miles (approximately 13 million acres) in area.

Lease Status and Future Sales

In the 12 years since OCS leasing programs were initiated on the Alaskan Outer Continental Shelf, 1,477 leases have been issued, and 14 Deep Stratigraphic Test (DST) wells and 69 exploratory wells have been drilled. Most of the exploratory wells have been permanently plugged and abandoned; eight wells have been classified as "producing." As defined in MMS regulations at 30 CFR 250.11, a "producing" well is one from which oil, gas, or both, can be produced in quantities sufficient to yield a return in excess of the cost, after completion of the well, of producing the hydrocarbons at the wellhead. All producing leases in the Alaskan OCS occur within the Beaufort Sea planning area (table 6).

A total of 458 leases across the Alaskan OCS have been relinquished or have expired, leaving 1,019 leases still active as of December 1988. The status of 20 additional blocks in the Beaufort Sea planning area remains undetermined subject to questions of U.S.-Canadian jurisdiction.

To date, over 1 million line-miles of geophysical data have been acquired by private and public concerns in Alaskan OCS planning areas. Approximately 3,200 line-miles of seismic reflection data were gathered in 1988, mostly in the Cook Inlet, Beaufort Sea, and Chukchi Sea planning areas.

Table 6. Producing leases, Beaufort Sea planning area

| Lease well number | Well-prospect name | Number of wells |
|-------------------|--------------------|-----------------|
| OCS-Y 0181 | Seal Island | 1 |
| OCS-Y 0191 | BF-37 | 2 |
| OCS-Y 0195 | Tern | 1 |
| OCS-Y 0196 | Tern | 1 |
| OCS-Y 0197 | Tern | 1 |
| OCS-Y 0370 | Sandpiper | 1 |
| OCS-Y 0371 | Sandpiper | 1 |
| OCS-Y 0849 | Hammerhead | 2 |

Beaufort Sea planning area.—In the Beaufort Sea planning area, a total of 574 leases have been acquired in four separate sales held in 1979, 1982, 1984, and 1988. Twenty-two leases will expire by the end of 1990; an additional 96 leases will expire in 1992. The approaching expirations may stimulate accelerated drilling activity. A fifth lease offering, OCS sale 124, is presently scheduled for 1991.

Twenty exploratory wells have been drilled in Federal waters in the Beaufort Sea planning area. Two of these wells were drilled in 1988: the Amoco Belcher #1 (OCS-Y 0917 #1) well (suspended), and the Tenneco Aurora #1 (OCS-Y 0943 #1) well (plugged and abandoned). The Tenneco well was located just offshore ANWR and may yield important data on the petroleum potential of ANWR and of the Kaktovik basin offshore to the north. It is anticipated that drilling operations will resume on the Belcher well in 1989. Data from both wells remain proprietary at this time. As of December 1988, site preparations were in progress for the Chevron Karluk #1 well (OCS Y-0194 #1), which will be drilled from a manmade spray ice platform located on State submerged lands. Chevron proposes an undirected well which is expected to drill into the Federal OCS.

Cook Inlet planning area.—In the Cook Inlet planning area, a total of 100 leases were acquired in three sales held in 1977, 1981, and 1982. All have been relinquished or have expired.

Thirteen exploratory wells and one DST well were drilled in the Lower Cook Inlet and Shelikof Strait prior to 1988. All were permanently plugged and abandoned.

Gulf of Alaska planning area.—In the Gulf of Alaska planning area, a total of 112 leases were awarded in three OCS sales held in 1976, 1980, and 1981. All of these leases have been relinquished or have expired. A joint offering of leases in the Lower Cook Inlet and the Gulf of Alaska shelf (OCS sale 114) is presently scheduled for March 1992.

Twelve exploratory wells and one DST well were drilled in the Gulf of Alaska prior to 1988. All of these wells were permanently plugged and abandoned.

Navarin Basin planning area.—In the Navarin Basin planning area, a total of 163 leases were acquired in a single sale in 1984. Bids for seventeen blocks in an area of disputed jurisdiction were recently refunded, with interest. Sixty-three leases remained active as of December 1988; the remainder have been relinquished.

Eight exploratory wells and one DST well were drilled in the Navarin Basin prior to 1988. These wells were all permanently plugged and abandoned.

Norton Basin planning area.—In the Norton Basin planning area, a total of 59 leases were acquired in a single sale held in 1983. All but 13 leases had been relinquished by December 1988. Six exploratory wells and two DST wells, all permanently plugged and abandoned, were drilled in the Norton Basin prior to 1988.

St. George Basin planning area.—In the St. George Basin planning area, a total of 96 leases were awarded in a single sale held in 1983. Only 34 leases remained active as of December 1988. Ten exploratory wells and two DST wells, all permanently plugged and abandoned, were drilled in the St. George Basin prior to 1988.

National Resource Assessment

In the autumn of 1986, the Minerals Management Service and the U.S. Geological Survey jointly launched a national inventory of oil and gas resources. The USGS evaluated the resource potential of onshore areas and State of Alaska waters extending 3 miles from shore. The MMS was responsible for a similar assessment of offshore areas extending from the 3-mile limit to approximately 200 nautical miles seaward to include the OCS Exclusive Economic Zone (EEZ). Personnel from both agencies met in 1986 and 1987 to review and coordinate the geologic concepts driving the assessment, particularly in adjacent areas of responsibility which were considered to share geologic continuity.

The preliminary results of the assessment have been published as a peer-review working paper in U.S. Geological Survey Open-File Report 88-373. The 1987 assessment updates a similar inventory published by the USGS as Circular 860 in 1981, although the MMS conducted an interim update study in 1985 (OCS Report, MMS 85-0012). The 1987 study is presently undergoing peer review by several organizations, and the final results will probably be published in 1989.

The role of the Alaska OCS region in this study was to estimate the amount of oil and gas resources which remain undiscovered on the continental shelves offshore Alaska. Several OCS planning areas extend far seaward of the continental margins to include areas of deep oceanic basins. On the basis of logistical, economic, and geologic considerations, areas seaward of the continental shelves in Alaska were considered to offer only negligible resources. In addition, some planning areas were

redrawn in order to obtain geologically rational assessment provinces (figure 8).

The results of the 1987 study and the two previous assessments (1980, 1985) of the Alaskan OCS are summarized in table 7. Two kinds of numbers are presented in the table: (1) the conditional-mean-oil quantity can be viewed as an average of the amount of oil the province would contain if one could safely assume that oil is present in economic quantities; (2) the risked-mean-oil quantity is obtained by integrating conditional values with informed judgments about the chances that any producible hydrocarbons are present at all. Both address only that oil which occurs in accumulations of sufficient size to justify development. As the table shows, it is quite possible for a province to offer large conditional resources but very low risked resources. The risked-mean-oil values are most useful for ranking the assessed provinces in terms of relative prospectiveness. Gas was not considered an economic commodity in the context of present economic realities.

Because of changes in assessment provinces and because of fundamental differences between the methodologies used by the MMS and USGS in each assessment, precise numerical comparisons of the results of the three assessments summarized in table 7 are unwarranted. Relative comparisons, however, may be legitimately drawn, and, to a certain extent, document changing perceptions of prospectiveness in each province.

Most provinces have experienced an apparent decline in estimates for undiscovered, economically recoverable resources. This in part reflects the fact that exploratory drilling in response to an ambitious leasing campaign has generally shown that earlier estimates were overly optimistic. This is particularly true for the Lower Cook Inlet, St. George, and Navarin assessment provinces. However, the Kodiak, Shumagin, Hope, Chukchi, and Beaufort assessment provinces have experienced modest increases in estimated conditional resources. This is generally a consequence of the acquisition of new geologic or geophysical data, which allowed the identification of new structures or otherwise optimized key elements of the appraisal.

Joint State-Federal Studies

In 1975, the Minerals Management Service (then Conservation Division, U.S. Geological Survey) and the State of Alaska initiated joint studies of surface geology along certain coastal areas of Alaska where geologic data were of mutual interest, and where such data promised insights into the petroleum potential of adjacent onshore and offshore areas (fig. 8). Past joint ventures have investigated such areas as the Gulf of Alaska, Cook Inlet, Kodiak Islands (Kodiak shelf), Seward Peninsula-Kuskokwim drainage (Norton Basin), Pribilof Islands

(St. George Basin), Alaska Peninsula (North Aleutian Basin), Waring Mountains (Hope/Selawik Basins), and the northeast Brooks Range (Kaktovik Basin). Since 1984, the cooperative work has been funded by grants from the Studies Related to Continental Margins Program, sponsored by the MMS and administered by the Bureau of Economic Geology, University of Texas at Austin. In recent years, the focus of the joint studies has shifted to the Arctic Slope and the Arctic National Wildlife Refuge (ANWR).

In December 1987, the State of Alaska completed a study of the surface geology and stratigraphy of the Sadlerochit and Shublik Mountains in the ANWR, carried out under cooperative agreement No. 14-12-0001-30296. The resulting treatise consists of a series of reports which present geologic maps, cross sections, and detailed measured sections of key stratigraphic units. These have been published separately by the State of Alaska Division of Geological and Geophysical Surveys (ADGGS) as Public Data Files 86-86 and 87-27. Continuing cooperative studies of Arctic Alaska are focusing on fission-track studies as a tool for quantification of the thermal evolution of the Beaufort continental margin (fig. 8), particularly as it bears on the maturation history of key source-rock sequences. Some early results of this work have been published separately by the ADGGS as Public Data File 88-42 (O'Sullivan, 1988).

U.S. Geological Survey

The North Slope continues to be the focus of most USGS studies related to onshore oil and gas resources (table 8). Many of the studies are part of the Evolution of Sedimentary Basins Program, the Gas-Hydrate Program, or the Ellesmerian Petroleum System Project. South of the Brooks Range, petroleum studies are supported by the Alaska Mineral Resource Assessment Program.

The fourth annual McKelvey Forum, entitled "Roles of Geological Research in the Assessment of Energy Resources—1988," was held February 29 and March 1-2, 1988, in Denver, Colorado. This forum was established to improve communication between the U.S. Geological Survey and the earth science community. This year's forum included several oral and poster presentations on results of research related to energy resources in Alaska; abstracts are published in USGS Circular 1025 (Carter, 1988).

Alaska Petroleum Resources

The following discussion on petroleum resources is taken from a paper by L.B. Magoon included in the Decade of North American Geology volume on Alaska being published by the Geological Society of America:

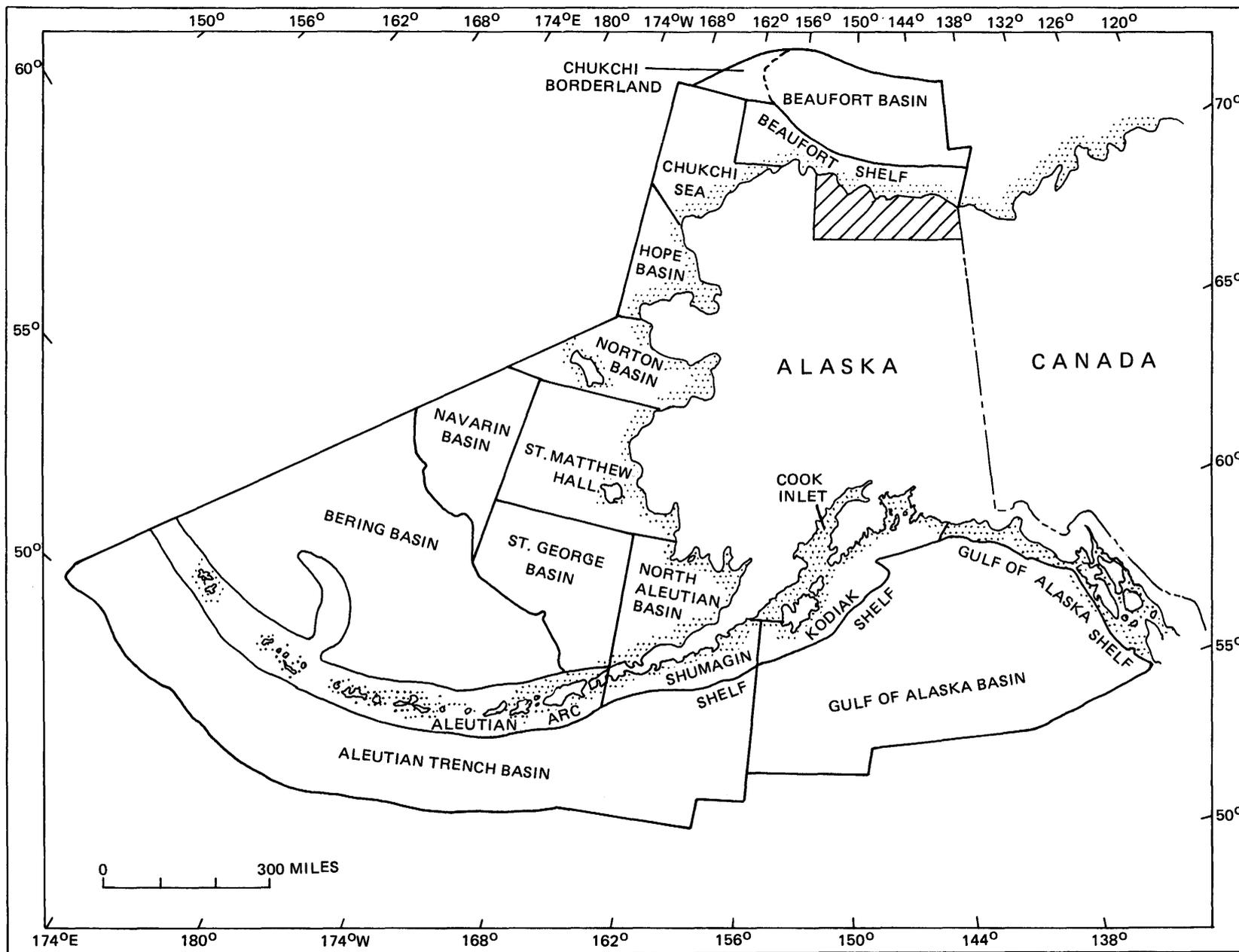


Figure 8. Offshore geologic province boundaries (bold lines; dashed where approximately located) for national assessment and location of 1988 joint Federal-State studies (lined area).

Table 7. Trends in offshore Alaska's resource assessments, 1980-1987

[Values indicate estimated undiscovered economically recoverable oil in billions of barrels: Sources USGS Circular 860; MMS OCS Report 85-0012; unpublished 1987 MMS data]

| Province | 1980 (USGS) | | 1985 (MMS) | | 1987 (MMS) | |
|------------------|--------------------------|-------------|--------------------------|-------------|--------------------------|-------------|
| | World oil price \$29/bbl | | World oil price \$28/bbl | | World oil price \$18/bbl | |
| | Conditional mean | Risked mean | Conditional mean | Risked mean | Conditional mean | Risked mean |
| Gulf of Alaska | 1.04 | 0.30 | 0.54 | 0.04 | 0.87 | 0.04 |
| Kodiak | .74 | .20 | .15 | .01 | .53 | .02 |
| Lower Cook Inlet | .61 | .40 | .21 | .01 | .17 | NEGL |
| Shumagin | .32 | NEGL | .05 | NEGL | .28 | NEGL |
| North Aleutian | .99 | .20 | .36 | .08 | .61 | .01 |
| St. George | 1.48 | .40 | 1.69 | .37 | .39 | .01 |
| Navarin | 2.47 | .80 | 4.80 | 1.30 | 1.14 | .03 |
| Norton | .71 | .20 | .64 | .09 | .58 | NEGL |
| Hope | .31 | NEGL | .17 | NEGL | .66 | NEGL |
| Chukchi | 4.81 | 1.40 | 2.68 | .54 | 2.73 | .57 |
| Beaufort | 6.95 | 6.95 | 1.28 | .89 | 1.44 | .21 |

Table 8. Areal energy resource assessments by the U.S. Geological Survey during 1988

[Project chief shown in parentheses]

| Studies supported by AMRAP |
|---|
| Interior Basins Project: |
| (1) Oil and gas potential of the interior basins (L.B. Magoon) |
| (2) Geologic framework and petroleum potential of the Nenana basin (R.G. Stanley) |
| (3) Petroleum geochemistry of the Seldovia quadrangle (L.B. Magoon) |
| (4) Petroleum geology of the Alaska Peninsula (L.B. Magoon) |
| Other current studies in Alaska by the USGS |
| (1) Ellesmerian petroleum system, North Slope of Alaska (K.J. Bird) |
| (2) North Slope of Alaska basin study (K.J. Bird) |
| (3) North Slope of Alaska gas-hydrate evaluation study (T.S. Collett) |

"The oil and gas resource of Alaska can be allocated to three categories: produced, discovered, and undiscovered (table 9; Mast and Dolton, 1988). As of December 31, 1987, 6.1 billion barrels of oil (bbo) and 3.8 trillion cubic feet of gas (tcfg) have been produced. In addition, a significant amount of gas has been reinjected back into the reservoir to maintain pressure. Except for safety reasons, gas is seldom flared. Gas produced on the North Slope is consumed locally to run the facilities; the rest is reinjected into the Prudhoe Bay oil field. Cook Inlet gas is consumed locally, liquified and shipped

Table 9. Ultimate oil and gas resources for onshore and State of Alaska offshore waters

[inf + ind, inferred plus indicated; bbo, billions of barrels of oil; tcf, trillion cubic feet of gas. From Mast and Dolton, 1988. Cumulative production to Dec. 3, 1987; measured reserves, for Jan. 1, 1988, from Energy Information Agency 1987 annual report; inferred + indicated reserves, for Jan. 1, 1988, from D.H. Root, written commun., 1988]

| | Produced cumulative production | Discovered | | Undiscovered recoverable resources |
|-----------|--------------------------------|-------------------|--------------------|------------------------------------|
| | | Measured reserves | Inf + ind reserves | |
| Oil (bbo) | 6.1 | 6.9 | 6.4 | 13.2 |
| Gas (tcf) | 3.8 | 32.7 | 3.0 | 57.9 |

overseas, or reinjected into other reservoirs. Reinjected gas is not included in the cumulative production.

"Discovered hydrocarbons include measured reserves and inferred plus indicated reserves. Measured reserves are the known volume of petroleum remaining in a field to be produced; inferred plus indicated reserves are the expected volume of hydrocarbons from field extensions, infill drilling, or enhanced recovery techniques.

"Undiscovered recoverable resources is petroleum not yet found, but, based on geologic information, expected to exist; regardless of economics, it is technically and physically recoverable. For the undiscovered recoverable resources, two probability fractiles, F95 and F5, and the mean are shown for both oil and gas (table 10). The F95, for example, indicates a 95 percent chance that at least 1.50 bbo is yet to be discovered under the

Table 10. Estimates of undiscovered recoverable resources for onshore and State of Alaska offshore waters as of December 3, 1986

[F95 and F5, probability fractiles at 95- and 5-percent chance, respectively. From Mast and Dolton, 1988]

| Area | Oil (billion barrels) | | | Gas (trillion cubic ft.) | | |
|------------------------------|--------------------------|-------------|-------------|-----------------------------|--------------|-------------|
| | F95 | F5 | Mean | F95 | F5 | Mean |
| North Slope | | | | | | |
| Arctic Coastal Plain | 1.50 | 14.80 | 6.00 | 4.66 | 58.24 | 22.11 |
| Northern foothills | .67 | 5.12 | 2.24 | 4.03 | 24.31 | 11.49 |
| Southern foothills | .58 | 13.18 | 4.35 | 2.85 | 61.56 | 20.49 |
| Central Alaska | | | | | | |
| Yukon-Kandik | .00 | .49 | .11 | .00 | .49 | .11 |
| Alaska Interior ¹ | .00 | .00 | .00 | .45 | 2.85 | 1.33 |
| Bristol basin | .00 | .00 | .00 | .11 | 0.67 | .32 |
| Hope basin | - | - | - | - | - | - |
| Cook Inlet | 0.09 | .64 | .29 | .35 | 3.91 | 1.53 |
| Gulf of Alaska | .03 | .58 | .19 | .03 | 2.00 | .56 |
| Kodiak | - | - | - | - | - | - |
| Southeast Alaska | - | - | - | - | - | - |
| Total² | 3.6 | 31.3 | 13.2 | 15.6 | 138.6 | 57.9 |

¹Includes Alaska Peninsula, Bethel basin, Copper River basin, Holitna basin, Kobuk basin, Minchumina basin, Ruby-Rampart basin, Susitna basin, Tanana basin.

²Fractile values (F95, F5) are not additive.

Arctic Coastal plain. If the numbers in table 9 are assumed to be correct, then Alaska could ultimately produce 32.6 bbo and 97.4 tcfg. Based on mean values for all of Alaska, 95 percent (12.6 bbo) of the undiscovered oil and 93 percent (54.1 tcfg) of the undiscovered gas will be found on the North Slope. Areas of oil potential for the rest of Alaska, in descending order, are Cook Inlet, Gulf of Alaska, and the Yukon-Kandik basin. Gas potential is highest for Cook Inlet, followed by the entire Alaska interior, Gulf of Alaska, and Bristol Basin.

“Unconventional sources of hydrocarbons have been left out of all estimates. The West Sak and Ugnu sands above the Kuparuk River oil field on the North Slope contain billions of barrels of heavy oil (API oil gravity from 10–20°) (Werner, 1987). On the North Slope, the volume of methane included in gas hydrate is estimated to be 8–10 tcfg (Collett and others, 1988).”

North Slope

The operational phase of the Federal petroleum exploration program in the National Petroleum Reserve in Alaska (NPRA) was completed in 1982. A nontechnical report (Gryc, 1985) describes this program. In late 1988, 39 technical papers by USGS scientists were published as U.S. Geological Survey Professional Paper 1399 (Gryc, 1988). Topics include stratigraphy, sedimentation,

seismic stratigraphy, petrography, paleontology, biostratigraphy, petroleum source-rock geochemistry, structural geology, direct hydrocarbon detection by aeromagnetic and helium methods, assessment results, and exploration history. Most data from the 1974–82 exploration program, as well as numerous pertinent contractor reports, are available to the public through the National Geophysical and Solar-Terrestrial Data Center, Boulder, CO 80303. Their catalog itemizes information about 38 wells, 14,770 line-miles of reflection seismic surveys, 52,000 gravity measurements, and numerous reports about geology, geophysics, the environment, construction, and logistics.

The North Slope basin is covered in considerable depth in an article by Moore and others in the Decade of North American Geology volume on Economic Geology of the United States being published by the Geological Society of America.

Gas Hydrates

The North Slope natural gas-hydrate evaluation project, funded by the Department of Energy (fig. 9), continued to be very active through 1988. Study of the physical properties controlling in situ natural gas-hydrate stability dominated the research efforts; the findings of the initial phase of this project are summarized in the

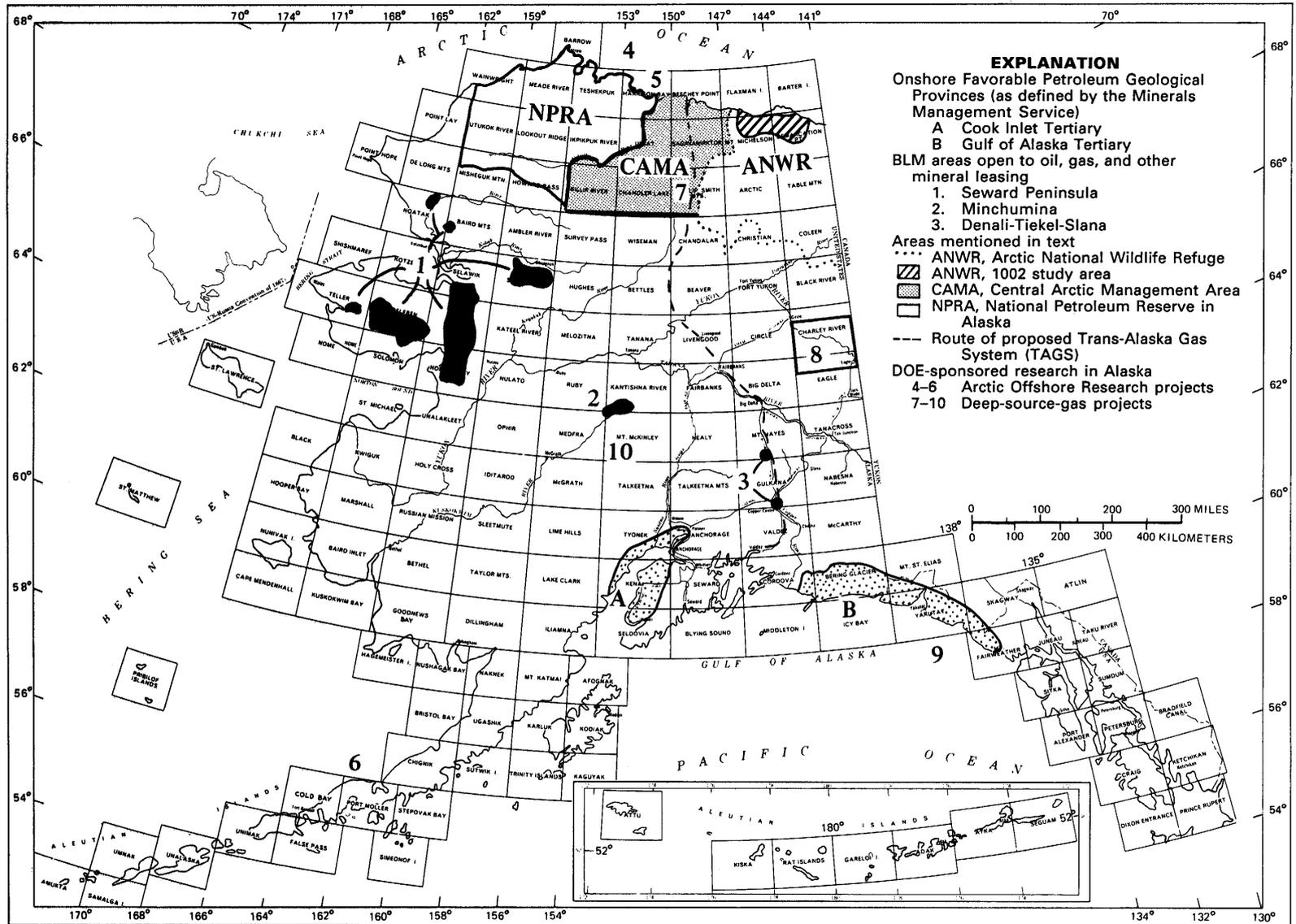


Figure 9. Onshore Favorable Petroleum Geological Provinces (land units referred to in text) and areas of research funded by Department of Energy during 1988.

report by Collett and others (1988). Topics of talks and publications during 1988 include: a North Slope gas-hydrate resource estimate (Collett, 1988b); freezing-point depression at the base of ice-bearing permafrost (Collett and Bird, 1988); geologic interrelations relative to gas hydrate (Collett, Bird, Kvenvolden, and Magoon, 1988); and internal characteristics of ice-bearing permafrost (Collett, 1988). Geologic and geochemical samples collected from an ARCO Alaska production well in the Kuparuk River field are being studied to determine compositions of natural gases in the near surface sediments (0–1,000 m) of the North Slope, and to characterize the potential gas-hydrate reservoirs. Newly acquired temperature profiles totaling 31,332 feet from ten wells in the Kuparuk, Milne Point, and Prudhoe Bay oil fields were incorporated with previous measurements by Lachenbruch and others (1988).

Interior Basins of Alaska

During 1988 USGS scientists continued work on the geology and petroleum potential of the interior basins of Alaska (those south of the North Slope as shown on fig. 5). A 4-week helicopter-assisted field program focused on the detailed facies architecture of Tertiary fluvial deposits in the Nenana basin, and reconnaissance studies of Mesozoic and Tertiary sedimentary rocks in the Manley, Rampart, and Tanana areas.

The petroleum source potential of Tertiary and Mesozoic coals and mudrocks is currently being evaluated using Rock-Eval pyrolysis, vitrinite reflectance, and visual kerogen. Preliminary results, summarized by Stanley (1988), show an abundance of gas-prone kerogen and a wide range of thermal maturity related to burial depth and nearness to igneous intrusions.

Bureau of Land Management

The BLM provided the Fish and Wildlife Service with oil and gas assessments for the Alaska Maritime, Innoko, Izenbeck, Kanuti, Koyukuk, and Tetlin National Wildlife Refuges. This completes the petroleum assessments needed for the FWS's Comprehensive Conservation Plans. The final ANILCA 1001 Central Arctic Management Area (CAMA) Report on the utility corridor was completed and has been submitted for congressional action. In addition, resource assessments for the Central Yukon, Fort Greely and Fort Wainwright, South Central, and Cook Inlet planning areas are in progress. Five resource evaluations were completed in 1988 for various types of Federal land disposals under the Federal Land Management and Policy Act (FLMPA).

The annual report of the Branch of Pipeline Monitoring is available through the BLM Public Affairs Office located in the Federal Building in Anchorage. This

Branch, part of the Division of Mineral Resources, assures that the terms and conditions of Alyeska Pipeline Service Company's pipeline rights-of-way are met. The BLM's involvement with the Northwest Alaska Pipeline Company's proposed Alaska Natural Gas Transport System (ANGTS) remains at a low level. During 1988, the BLM published the final EIS and issued a conditional grant of right-of-way to the Yukon Pacific Corporation for its proposed Trans-Alaska Gas System (TAGS) (fig. 9). If constructed, this system would deliver natural gas from Alaska's North Slope to tidewater in Valdez, where it would then be liquified and exported to Pacific-rim countries.

In establishing and implementing an oil and gas leasing program as required by Section 1008 of ANILCA, the BLM has made land available for noncompetitive oil and gas leasing in three areas south of latitude 68° N. (fig. 9). Both the Minchumina and the Denali-Tielke-Slana areas were opened in 1982, and the Seward Peninsula in 1983. As of September 30, 1988, the BLM had approximately 254 leases issued on 52,856 acres in the Minchumina area; 4,550 leases on 676,919 acres in the Denali-Tielke-Slana area; and 1,919 leases on 1,068,986 acres on the Seward Peninsula. A total of 2,880 acres was leased in these areas during 1988. Favorable Petroleum Geological Provinces (FPGP, fig. 9) were identified by the Secretary of the Interior under the authority of Section 1008 of ANILCA; however, no competitive oil and gas lease sales were held as a result of a FPGP determination. The three FPGP areas were Cape Lisburne, Cook Inlet, and the Gulf of Alaska. The Federal Onshore Oil and Gas Leasing Reform Act of 1987 amended Section 1008 of ANILCA to eliminate FPGP's. Except for NPRA, all BLM-administered oil and gas reserves in Alaska are now handled under the leasing system established by the Reform Act of 1987.

The national preliminary injunction (PI) imposed during the lawsuit of the *National Wildlife Federation v Burford et al.*, in 1985, suspended all oil and gas leasing on the Seward Peninsula. The PI order was appealed in 1986. In December 1987, the PI order was upheld in a 2–1 decision by an appeals panel of three judges. The PI was vacated on November 4, 1988. Leasing has now resumed based upon status as it existed at the time the PI was imposed.

Fish and Wildlife Service

The primary efforts of the FWS in Alaska are to protect and conserve fish and wildlife, and their habitats, and to administer 16 national wildlife refuges (fig. 4). The FWS also cooperates with other Federal and State agencies in similar efforts on behalf of wildlife throughout Alaska. Any oil- or gas-related activities in refuges are subject to FWS restrictions and protective stipulations.

Kenai National Wildlife Refuge

The Kenai National Wildlife Refuge is the only refuge in Alaska from which oil and gas have been produced. During 1988, 29 wells continued production in the Swanson River oil field (loc. K, fig. 5), with a production of about 5,800 bbl/d. A workover rig continued to correct downhole problems of some wells in the field. Other wells were shut-in because of poor oil/gas or water ratios, and additional wells have been evaluated for plugging and abandonment. Field production to date represents a recovery of about 46 percent of the estimated barrels of original oil in place. Maximum production of nearly 40,000 million cubic feet per day (mcfpd) from 3 gas wells and just under 400 bbl/d from 2 oil wells is being produced in the Beaver Creek field (loc. A, fig. 5).

The cleanup of polychlorinated-biphenyl(PCB)-contaminated materials within the Swanson River field continues. Although all contaminated road soils have been excavated and stockpiled, final cleanup adjacent to the compressor plant facility and certain associated pipeways will be completed during the 1989 summer season. A portable Circulating Bed Combustor Unit (fig. 10), designed to destroy PCB's in contaminated material through a fluidized-bed incineration process, was erected near the stockpile area. Demonstration test results audited by the U.S. Environmental Protection Agency, the State of Alaska, and the FWS indicated that the removal of PCB's met the regulatory requirements of

99.9999-percent destruction. The Circulating Bed Combustor Unit will continue to process the stockpiled contaminated materials during the next two years.

Activities under Section 1008 of ANILCA

Section 1008 of ANILCA provides for oil and gas studies on refuges in Alaska to provide information for use in future land-management decisions. In 1988, special-use permits were issued for surface geologic work in the Alaska Maritime, Alaska Peninsula, Becharof, and Yukon Flats National Wildlife Refuges. Exxon, Inc. had a permit for seismic exploration within the Yukon Flats National Wildlife Refuge (fig. 4) for 1988. Special-use permits include numerous stipulations for ensuring that permitted activities are environmentally sound and compatible with refuge purposes, and are designed for the specific locale and activities of the proposal. Bonds of at least \$10,000 for surface geology studies, and \$100,000 for seismic studies, must be posted before any company can undertake such work in Alaska refuges. Copies of data resulting from such exploration must be submitted to the FWS; they remain confidential in storage with the BLM.

Section 1008 of ANILCA also calls for establishing a program for oil and gas leasing on Federal lands south of latitude 68° N., pursuant to the Mineral Leasing Act of 1920 as amended. All leasing, exploration, and production would be subject to permits and stipulations designed to protect fish, wildlife, and subsistence activi-



Figure 10. Tours conducted for agency representatives and other groups have been frequent at the Circulating Bed Combustor Unit used for PCB cleanup on Kenai Peninsula. Photograph by R. Richey.

ties. This program does not apply to those refuge lands where the Secretary of the Interior determines, after consideration of the national interest, that oil and gas exploration or development would be incompatible with the purposes of the refuge. Section 304(g) of ANILCA cites a comprehensive conservation planning process as the means for identifying parts of refuges where leasing or related activities may be compatible.

Final plans were issued in 1988 for the Yukon Delta, Alaska Maritime, and Arctic National Wildlife Refuges. Supplemental environmental impact statements for the wilderness reviews were completed for Kenai, Becharof, and Alaska Peninsula National Wildlife Refuges. These plans complete the comprehensive conservation planning process mandated by ANILCA.

Mineral Activity Impact Assessment

FWS resource-related activity includes making recommendations for mitigating adverse impacts on fish and wildlife and their habitats. To this end, the FWS reviews U.S. Army Corps of Engineers permit applications under Section 404 of the Clean Water Act of 1977; these applications may involve public or private lands. This review includes making recommendations for minimizing habitat losses in all proposals for new or modified roads, pads, well sitings, and operations.

Department of Energy

Arctic Activities

The Arctic and Offshore Research subprogram of the DOE's Advanced Process Technology program was established to enhance petroleum-energy development by examining critical natural forces (such as sea-ice and subsea-permafrost formation) and their effects, to develop technologies for utilizing Alaskan natural gas, and to establish a data base for Arctic parameters. Much of the subprogram's efforts are directed at offshore development (Morgantown Energy Technology Center, 1988); onshore objectives involve enhanced oil recovery, Alaska natural gas utilizations, and study of heavy oil, oil shale, and tar sands.

In 1988, the DOE continued developing the Arctic energy-related technology data base (AORIS), presenting and demonstrating the AORIS at international conferences (Shoemaker and Chiang, 1988), coordinating interagency research, and studying the applicability of recovery techniques to Arctic petroleum occurrences.

AORIS is a computerized (PC and VAX versions) information service designed to assist the technological and planning community in the development of Arctic oil and gas resources. It has three principal components: a directory that lists 85 data bases containing Arctic

energy-related information and how to access them; a bibliographic/management information system (B/MIS) containing approximately 9,000 references and abstracts on energy-related research; and a scientific and engineering information system containing approximately 1,100 quantitative data sets, in both tabular and graphical formats, on sea-ice characteristics from the B/MIS citations (Shoemaker and Chiang, 1988). AORIS also contains much unpublished information on the Arctic. When the AORIS is completed in September 1989, it will be transferred to the public sector via the National Energy Software Center. The public may purchase the AORIS (with appropriate use and data entry documentation) for their own computer system, and use as is, add to, update, or otherwise modify it for specific tasks; they may also make it available to others, if required.

Sea-Floor-Soils Research

To improve Arctic petroleum-development technology, the DOE sponsored sea-ice and sea-floor-soils research through several institutions and agencies. At the University of Alaska, research was on ice-island generation from the Canadian Islands ice shelves and their drift paths into the Alaskan Beaufort Sea. Several ice islands that have calved off the Canadian Ellesmere Island ice shelves during the past few years are being electronically tracked in hopes of developing a drift-simulation model. Most of these buoy-equipped ice islands are currently located off Ellef Ringnes Island about 630 miles west of Greenland, and are slowly proceeding southwest toward Alaska. Preliminary simulation of ice-island drift trajectories indicate that ice islands in the Arctic Ocean have a 10-year recurrence area along the Alaskan Beaufort Sea coast. This simulation study indicates that engineering designs in the Alaskan Beaufort Sea offshore areas need to include interactions with ice islands.

An assessment conducted by the Polar Research Board (PRB) of the National Research Council identifies and evaluates the research needed during the remainder of this century to provide a better understanding of the solid-earth geophysical and geological character of the Arctic, with an emphasis on the Arctic Ocean Basin and its perimeter. The PRB will identify the principal research questions in Arctic solid-earth sciences, recommend priorities to guide the direction of future research in this field, and indicate the facilities and support required for conducting meaningful research.

Research was conducted by Sandia National Laboratories, in cooperation with the Minerals Management Service, on measuring acceleration and velocity responses of the sea-floor soils to strong earthquakes. In 1986, a redesigned Seafloor Earthquake Measurement System (SEMS II) unit, deployed near Shell's Ellen-Elly platforms about 10 miles west of Long Beach, California,

in 250 feet of water, monitored two southern California earthquakes. The preliminary analysis of the data collected by SEMS II indicates that there is a significant difference between the vertical and horizontal accelerations at the seabed site of SEMS II, with the horizontal accelerations being almost an order of magnitude larger than the vertical acceleration; at land-based sites, the horizontal and vertical accelerations were similar. Further analysis and research may reveal other significant differences. Progress toward developing reliable soil-loading models from earthquake data will depend on collecting additional data from both seabed sites and nearby offshore platforms for earthquakes large enough to cause significant motion of the platforms. The SEMS II unit was retrieved in December 1987 to correct a data collection triggering problem. It has been redesigned and refurbished to be redeployed near the Shell platforms. Upon completion of quality assurance testing, Sandia will redeploy the unit (SEMS III) about May 1989. A second deployment of a SEMS III is planned for the summer of 1989, approximately 5 miles offshore from Point Arguello, California, in about 250 feet of water.

Petroleum Research

A primary petroleum target is the gas-hydrate reservoir, which contains gas in a solid, icelike form. Occurrences of such hydrates have been identified on Alaska's North Slope, and the technology for characterizing and developing this resource is under study as part of the DOE's Environmental and Advanced Research subprogram. Using both inhouse and contractors' facilities, subprogram efforts have recently been concentrating on laboratory testing of natural and synthetic hydrates to define the pressure and temperature conditions necessary for their formation and dissociation, as well as the geophysical and mechanical properties of the hydrates and their reservoirs (Morgantown Energy Technology Center, 1987b). Arctic research studies to determine the in-place conditions of gas-hydrate deposits have been initiated by the DOE in cooperation with the USGS and with ARCO Alaska, BP Exploration, Exxon, and CONOCO. As part of the research on gas hydrates, geological basin reports have been developed for a number of offshore areas. The series has been titled "Geological Evolution and Analysis of Confirmed or Suspected Gas Hydrate Localities." Volume 12 is Basin Analysis, Formation, and Stability of Gas Hydrates in the Beaufort Sea (Krason and Finley, 1989). This series of studies is being conducted by Geopexplorer International, Inc.

The DOE's research on deep-source gas is focused on evaluating the potential for recovering gas from depths greater than 30,000 feet, based on the hypothesis that natural gas would be generated in sediments carried

to these depths by tectonic processes. Primary reservoir targets are former and active subduction zones where suitable sediments have been encapsulated. Recent study areas include the Yukon Flats near Fairbanks, the Alaskan Range of south-central Alaska, and the eastern Aleutian Trench (fig. 9), where cooperative stratigraphic, structural, and magnetotelluric studies have taken place (Morgantown Energy Technology Center, 1987a).

Arctic National Wildlife Refuge

With the enactment of ANILCA in 1980, the Arctic National Wildlife Range in northeastern Alaska was enlarged to 18.6 million acres and renamed the Arctic National Wildlife Refuge (ANWR). Approximately 8 million acres of the ANWR was designated wilderness, to be managed under terms of the Wilderness Act (78 Stat. 892). Subsequently, other land additions have increased the size of the refuge to about 19.5 million acres. Section 1002 of ANILCA pertains to an approximately 1.5-million-acre strip of the coastal plain of ANWR, now known as the 1002 area (fig. 9). Section 1002 requires the Secretary of the Interior to: (1) conduct a comprehensive, continuing baseline study of the fish and wildlife resources of the 1002 area, (2) develop guidelines to initiate and monitor an oil and gas exploration program, and (3) prepare a report to Congress describing the fish, wildlife, and hydrocarbon resources; the potential impacts and development scenario for petroleum exploration and production; and recommendations regarding possible exploration, development, and production for oil and gas should those activities be allowed in the 1002 area.

The FWS was designated as principal coordinator for the Section 1002 resource assessment, and that agency, the BLM, and the USGS prepared an interagency memorandum of understanding in 1983 for the research and writing of the 1002 report for Congress. The specific agency roles and research are described in the "1987 Annual Report on Alaska's Mineral Resources" (Bohn, 1987, p. 20-24) and in the report to the Congress (Clough and others, 1987). During 1987, Alaska Federal agency activity regarding the 1002 area focused on responding to political and public inquiry regarding the final 1002 report findings.

Fish and Wildlife Service

In early 1988, the U.S. Fish and Wildlife Service continued to respond to numerous congressional inquiries concerning the potential for oil and gas leasing and development on the coastal plain of the ANWR. Both the House Merchant Marine and Fisheries Committee on May 3, 1988, and Senate Energy and Natural Resources Committee on March 24, 1988, reported bills which

would authorize an oil and gas leasing program on the coastal plain. These bills included numerous protective stipulations for the fish and wildlife resources of the area. Neither bill received floor action.

Recognizing that a variety of regulatory and planning processes would immediately be initiated if legislation is passed which opens the coastal plain to oil and gas activities, the FWS continues to pursue a biological study program of the area. The goal of this study program is directed at achieving a better understanding of: the area's natural dynamics; altered ecosystem dynamics that might result from oil and gas activities; associated adverse impacts; and means by which to avoid, minimize, or rectify those adverse impacts.

A "1002 Work Group" comprised of BLM and FWS representatives was formed in early 1988 to address management issues and processes necessary to pursue an orderly oil and gas program on the 1002 area in the event of congressional action.

In August of 1988, the Department of the Interior published a draft legislative environmental impact statement (EIS) on the acquisition of selected inholdings in national wildlife refuges in Alaska. Under the preferred alternative, six exchange participants involving 18 Native corporations would acquire limited oil and gas interests underlying approximately 166,000 acres in the ANWR coastal plain in exchange for approximately 896,000 acres of inholdings in seven refuges in Alaska.

The eight public hearings held on the proposal were in Washington, D.C., and in Anchorage, Fairbanks, Kodiak, Galena, Hooper Bay, Arctic Village, and Kaktovik, Alaska, between September 26 and October 5, 1988. Nearly 200 letters and postcards were received on the document. Availability of the final legislative EIS incorporating the public comments was announced on December 16, 1988. The Record of Decision recommending that Congress adopt the proposed exchanges was signed by the Secretary of the Interior on January 19, 1989. It is expected that Congress will consider this recommendation and supporting documents as they continue deliberations on the larger question of opening the ANWR to oil and gas development.

Coal and Peat Resources

Alaska's coal producers are ready and waiting for a coal boom, with the expectancy of mining coal by the mid-1990's (Anchorage Times, April 3, 1988). Although the coal boom has yet to materialize, there has been record coal production in Alaska for two years in succession. Usibelli Coal Mine, Inc., the only active coal mine in Alaska, had a production record for 1988 of 1.55 million tons (Green and Bundtzen, 1989), up 40,000 tons from the 1987 record of 1.51 million tons. Of that amount, 726,833 tons were used to fuel six power plants within

Alaska, 810,862 tons were shipped to Korea for power generation, and 13,467 tons were shipped to Japan for testing.

During 1988, as in the past several years, industry activity was focused on three Alaskan coal fields: Healy, Matanuska Valley, and Beluga (fig. 11). A cogeneration plant is in the planning stages for the coal at Healy (Fairbanks Daily News-Miner, Feb. 9, 1988). There, the Usibelli Coal Mine anticipates building, by 1992 or 1993, a mine mouth plant that would generate 100-150 megawatts of power for the railbelt region, with excess heat being utilized to dry coal for export (Anchorage Times, Nov. 16, 1988). The coal mined at Healy is low-ranked and wet, containing as much as 30 percent water. When subjected to drying temperatures above 450 °F, the coal is permanently altered and raised to bituminous rank; it will not readsorb water. A dry, higher rank coal could increase exports of Healy coal by at least 50 percent, with shipments to Japan being highly possible (Alaska Journal of Commerce and Pacific Rim Reporter, Oct. 31, 1988).

The Wishbone Hill coal project, near Palmer in the Matanuska Valley, is moving forward (Alaska Journal of Commerce and Pacific Rim Reporter, March 25, 1988). Idemitsu Kosan, a Japanese petroleum company, has initiated the permitting process. Current plans call for a truck and shovel open-pit mine which could produce up to 1 million short tons per year. The coal will be trucked to a railyard near Palmer, loaded into railcars, then transported to Seward for loading onto ships bound for Japan. The coal is high-quality bituminous coal, with low moisture and sulfur contents.

The Alaska Department of Natural Resources has given final approval to proceed with plans for mining coal at the Beluga site on the west side of Cook Inlet (Anchorage Times June 29, 1988). The permit allows Diamond Alaska Coal Company to mine up to 12 million short tons per year. Currently the market is oversupplied with coal, and prices are down. Until there is more demand, little mining is expected to take place at Beluga.

Peat mined in Alaska is used primarily in agriculture and greenhouses as a soil conditioner; minor amounts are burned locally in villages for heat. Peat production increased in 1988 to 55,000 cubic yards, up 9,000 cubic yards from 1987 (Green and Bundtzen, 1989). Alaska has one of the world's largest peat resources, estimated to be five times the energy potential of Prudhoe Bay.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

Coal of Late Cretaceous to Tertiary age in the eastern part of the Northern Alaska coal field (fig. 11)

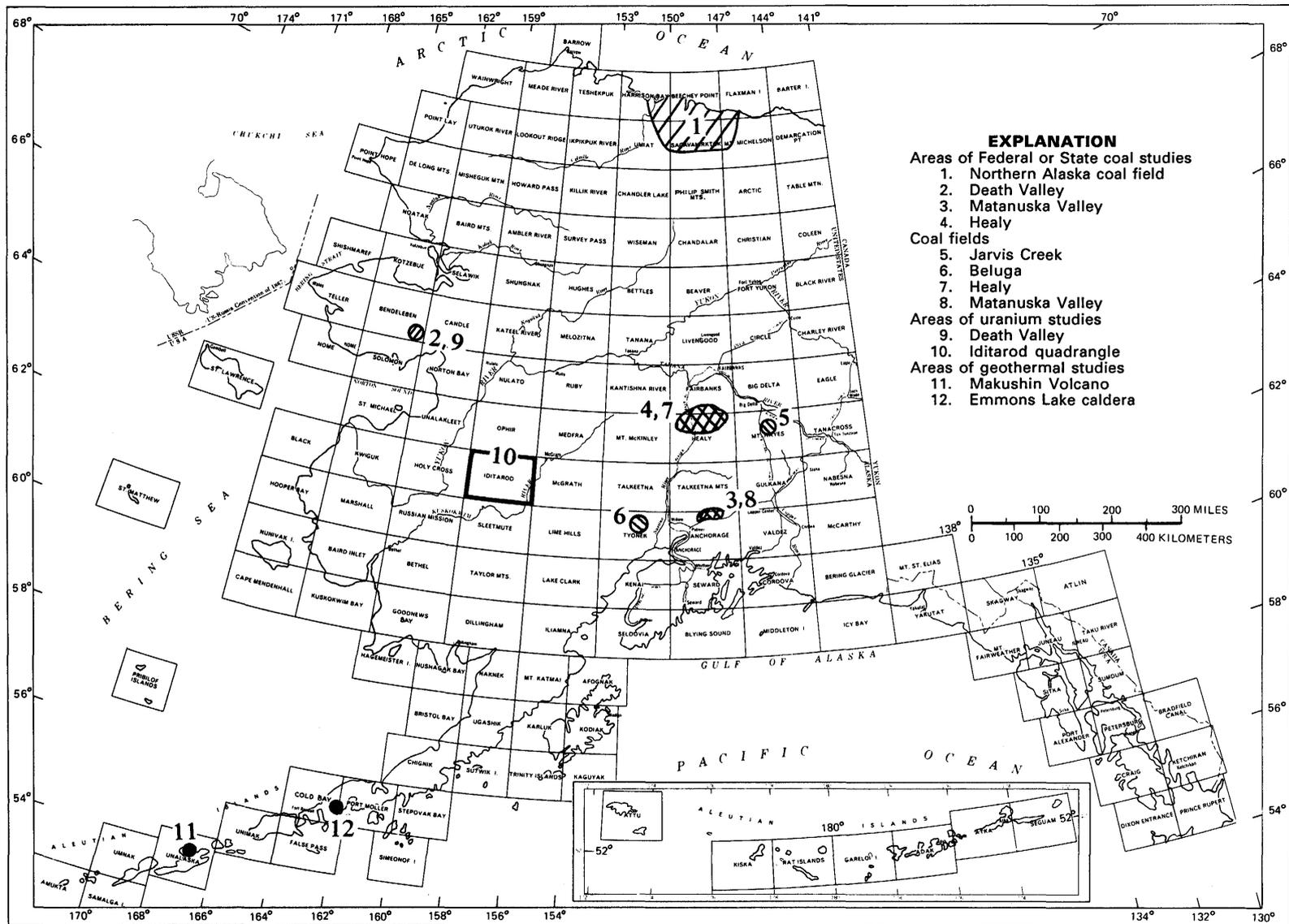


Figure 11. Areas of potential coal and peat, uranium, and geothermal resources mentioned in text. 1:250,000-scale quadrangles are outlined and labeled.

has been sampled by USGS personnel. This study, which will be utilized in resource analyses, includes investigations of depositional, structural, and diagenetic processes. Analysis of nine coal samples from the Sagwon Bluffs along the Sagavanirktok River, 12 channel samples from exposures along Juniper Creek and Shavovik River, and 32 channel samples of 5 beds from exposures along the Kavik and Ivishak Rivers, show that these Tertiary coals have a mean sulfur content of 0.58 percent, a mean ash content of 7.6 percent, and a mode apparent rank of subbituminous C. Coalbed correlation, both surface and subsurface, indicates that the size of the resource area is larger than 6,000 square miles. A 50-mile east-west cross section near the Arctic coast shows that the coal-bearing interval ranges in thickness from about 720 to 1,340 feet, and is informally divided into an upper and lower coal zone. The upper zone ranges in thickness from 50 to 350 feet, and contains up to 7 coal beds. The lower zone is thicker, 380 to 840 feet, and contains up to 12 coalbeds. The coal zones are separated by an interval of 130 to 320 feet, consisting mainly of sandstone. Net coal thicknesses for individual coalbeds range from 2 to 22 feet for the upper zone, and 2 to 14 feet for the lower zone. Half of the coalbeds are 5 feet or greater in thickness (Roberts, 1989).

USGS personnel continue to investigate the major-, minor-, and trace-element distribution in the Usibelli coal mine near Healy (fig. 11). Previous work by Affolter and Stricker (1987) at the Usibelli coal mine indicated that many trace elements vary vertically and horizontally within the three coalbeds presently mined at Healy.

Investigations are also continuing at the thickest known coalbed in Alaska, a 185-foot-thick bed located in the Death Valley area on the Seward Peninsula (fig. 11). The lower part of this Eocene-age coalbed is enriched in tungsten and uranium, and the bed is capped by a basalt flow. The apparent rank ranges from semianthracite near the top of the bed to subbituminous A near the base (Stricker and Affolter, 1988).

Bureau of Land Management

The BLM continued its management of a lease in the Jarvis Creek coal field south of Delta Junction (fig. 11). Coal from this field is a potential feed stock for gas production, which would be used to generate electrical power for the U.S. Army base at Fort Greeley. Interest in additional coal leasing on Federal land is low at this time.

U.S. Bureau of Mines

The USBM Twin Cities Research Center in Minnesota granted funds to the University of Alaska (Fairbanks) Palmer Research Center for feasibility testing of the use of a mycorrhizal fungus in stimulating revegeta-

tion on abandoned coal mine lands. Woody plants, such as alder and poplar, were treated with the fungus and transplanted to a site near Sutton, where their growth will be monitored. The USBM also funds, through the Mineral Institute program, a number of faculty and graduate student miniprojects in coal mining research at the University of Alaska (Fairbanks).

Fish and Wildlife Service

The Fish and Wildlife Service commented on the draft EIS for the Diamond Chuitna Coal Project in the Beluga coal field (fig. 11) and recommended that additional data were needed to support the preferred alternative. In responding to the U.S. Army Corps of Engineers permit application, stipulations were recommended to mitigate potential fish and wildlife habitat losses.

Uranium Resources

The uranium industry in the United States continues to be depressed due to low prices and severe competition from other countries, especially Canada. For the years 1985 through 1988, the U.S. Department of Energy declared the uranium industry nonviable. This finding requires that the Administration take action, such as import restrictions, to protect the domestic uranium industry. The new free-trade law with Canada may rescind this responsibility with regard to that country. In 1987, U.S. production was 12.5 million pounds of U_3O_8 , 1.3 million pounds below the 1986 level (Chenowith, 1988). The spot price for uranium continued to hover around \$17.00 per pound U_3O_8 . According to Chenowith (1988), expenditures for uranium exploration in the conterminous United States have dropped from about \$22 million in 1986 to about \$18 million in 1987. No uranium exploration in Alaska, where costs of exploration and development are high, is known to have taken place during 1988.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

The moderate amount spent by the U.S. Geological Survey on uranium research continues to decline. No mandated uranium research is being carried out in Alaska by the U.S. Geological Survey. Preparation of uranium reports based on previously collected data are being prepared. A circular based on National Uranium Resource Evaluation (NURE) data, including uranium from stream and lake sediments in the Iditarod quadrangle (fig. 11) was published by Gray and others (1988). A

Table 11. Mining production in Alaska, 1985–1988

[Values calculated from 1988 annual price averages of gold, silver, and platinum; other values directly supplied by mine operators. Data from Green and Bundtzen, 1989. NR, no report; W, information held by mine operators]

| | Volume | | | | Value (x \$1,000) | | | |
|-----------------------------------|-----------|-----------|-----------|-----------|-------------------|----------------|----------------|----------------|
| | 1985 | 1986 | 1987 | 1988 | 1985 | 1986 | 1987 | 1988 |
| Gold (troy oz) | 190,000 | 160,000 | 229,700 | 265,500 | 61,175 | 60,800 | 104,516 | 112,837 |
| Silver (troy oz) | 28,500 | 24,000 | 54,300 | 47,790 | 171 | 134 | 391 | 282 |
| Tin (lb., metal) | 300,000 | 340,000 | 288,000 | 300,000 | 650 | 890 | 460 | 950 |
| Tungsten (tons) | — | 120 | 160 | 240 | — | 23 | 11 | 14 |
| Antimony (lb) | 65,000 | 45,000 | NR | NR | 98 | 68 | NR | NR |
| Mercury (lb) | 2,094 | 912 | NR | W | 10 | 3 | NR | W |
| Platinum (oz) | — | W | W | 25 | — | W | W | 14 |
| Sand and gravel (million tons) | 28.2 | 20.9 | 16.7 | 17.2 | 112,063 | 75,761 | 42,660 | 48,750 |
| Building stone (million tons) | 2.5 | 4.2 | 1.8 | 3.6 | 12,150 | 20,320 | 11,620 | 24,650 |
| Jade, soapstone (tons) | W | 2.0 | 3.6 | W | W | 12 | 78 | W |
| Coal (tons) | 1,370,000 | 1,492,707 | 1,508,927 | 1,551,162 | 39,730 | 40,100 | 42,355 | 44,300 |
| Peat (yd ³) | 85,000 | 50,000 | 46,000 | 55,000 | 553 | 350 | 299 | 375 |
| Total | | | | | 226,600 | 198,461 | 202,390 | 232,172 |

report on lacustrine beds closely related to the Death Valley uranium deposit (fig. 11) on the Seward Peninsula was also published (Dickinson, 1988a).

Geothermal Resources

Hot springs occur throughout Alaska and historically have been used on a small, highly localized scale for recreation, space heating, and agriculture. However, with widespread young volcanic activity on the Aleutian Islands, the Alaska Peninsula, the Wrangell Mountains, and elsewhere in the State, the potential exists for geothermal energy production to serve population centers. In 1988, the ADGGS published a report of findings on the geothermal resources of an area of Akutan Island.

Makushin Volcano (fig. 11) has long been considered a potential source of power for the neighboring communities of Dutch Harbor and Unalaska, centers of a growing fishing industry. In past years, the Department of Energy (DOE) and the Alaska Power Authority (APA) have funded geologic mapping and drilling of a test well, as well as design, feasibility, environmental studies, and market analysis to investigate the practicality of developing a geothermal production facility at Makushin. Test well results showed the Makushin geothermal resource is capable of generating enough electricity to meet the power needs of Dutch Harbor and Unalaska for decades, but oil prices would need to return to 1985 levels before geothermal development costs could compete favorably with existing diesel generation

capabilities; therefore, in November 1988, the APA awarded a contract to plug the test well. Battle Mountain Gold Company has recently reached an agreement with the Aleut Native Corporation to continue investigating geothermal resource potential at Makushin.

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

The USGS is conducting a mapping project at Emmons Lake caldera near Cold Bay (fig. 11) in order to establish the geologic history of the volcano, in terms of both chemical evolution and areal distribution of its eruptive products. This study will provide the basis for an evaluation of the potential for geothermal resource development in this region.

NONFUEL-MINERAL RESOURCES

Metallic Minerals

INDUSTRY ACTIVITY

Alaska's mineral industry expanded dramatically in 1988 with significant increases in exploration and development expenditures, and in the value of mineral production. Exploration expenditures nearly tripled from

\$15.7 million in 1987 to \$44.5 million in 1988 (Green and Bundtzen, 1989). Major construction occurred at both the Greens Creek and Red Dog mines during the year, and development expenditures more than doubled from \$100.3 million in 1987 to \$269.7 million in 1988. The total value of metals production increased 8 percent in 1988 to \$114.1 million (table 11), led by a 16-percent increase in gold production (from 229,700 ounces in 1987 to 265,500 ounces in 1988).

The total value of Alaska's mineral industry in 1988, measured by the sum of exploration and development expenditures plus the value of mineral production, increased over 72 percent from \$318.4 million in 1987 to \$546.4 million in 1988. The number of people employed in the various segments of the mining industry in 1988 is estimated to have increased 49 percent to 4,904 in 1988, up from 3,299 in 1987.

Gold production again led all other mineral commodities and accounted for 49 percent of total dollar value (Green and Bundtzen, 1989). An estimated 265,500 ounces (oz) of gold were produced and valued at \$112.8 million. This represents an increase of 16 percent by quantity and 8 percent by value over 1987 levels. Gold, coal, building stone, and sand and gravel accounted for 99 percent of the total value of Alaska mineral production in 1988 (table 11). Tin, silver, tungsten, jade, platinum, soapstone, and peat accounted for the remaining 1 percent.

The increase in 1988 gold production reflected increased production from several of the largest placer operations and from two interior hard rock lode mines (Green and Bundtzen, 1989). The Valdez Creek Mining Company placer operation east of Cantwell produced 52,961 oz of gold and was Alaska's largest gold producer in 1988. Approximately 200 small gold placer operations produced at levels similar to 1987. Citigold Alaska, Inc. and Tricon Mining, Inc. produced 21,500 oz of gold-silver bullion from lode deposits on Ester Dome near Fairbanks.

Exploration activities in Alaska increased significantly in 1988, with expenditures totaling \$44.5 million, an increase of 184 percent over 1987 (Green and Bundtzen, 1989). Reported exploration employment increased 147 percent to a total of 2,780 person-months, from 1,126 person-months in 1987. As in previous years, the primary focus of exploration programs was precious metals. Over 90 percent of all expenditures were for precious metal exploration, with expenditures for coal and base metal exploration representing 6 percent and 3 percent, respectively.

According to Charles Utermohle, a research analyst with the Fairbanks North Star Borough's Community Research Center, 16,132 new mining claims were filed statewide in the third quarter of 1988, representing nearly nine times the number of new claims filed in the

same period of 1987 (Fairbanks Daily News-Miner, November 10, 1988).

The Alaska Department of Environmental Conservation adopted new mixing-zone water-quality regulations in 1988 that may help placer miners and other industrial water users comply with the State's turbidity standards (Green and Bundtzen, 1989). Guidelines are being developed to allow the new regulations to be tested in 1989 and implemented in the 1990 season. The U.S. Environmental Protection Agency issued effluent-limitation guidelines for placer mining; these will go into effect in 1989 and will require 100-percent recycling of mine process waters for the placer mining industry.

In Federal actions, the U.S. Bureau of Land Management (BLM) completed draft environmental impact statements (EIS) on the cumulative effects of placer mining on four interior Alaska river drainages (Green and Bundtzen, 1989). In late 1988, the first of four final EIS's to be issued identified a preferred alternative that proposed to allow placer mining to continue under management policies adopted in 1986. As part of the Federal court order that mandated preparation of the EIS's, an injunction was granted against the operation of placer mines disturbing more than five acres. Records of Decision for the four studies are expected in early 1989; however, the lifting of the injunction will be at the discretion of the Federal courts. In a similar action, in April 1989 the NPS released for public review court-ordered draft EIS's evaluating the cumulative impacts of placer and lode mining in Denali, Yukon-Charley, and Wrangell-St. Elias National Parks and Preserves.

In a major decision affecting Alaska mining, the U.S. Supreme Court has let stand a ruling by the Alaska Supreme Court that a section of State law pertaining to rent and royalties does not comply with the Alaska Statehood Act (Fairbanks Daily News-Miner, June 3, 1988). State law had permitted the extraction of mineral resources without payment of rents or royalties to the State of Alaska. New legislation is currently being drafted.

In 1988, final court decisions were issued for several lawsuits initiated by environmental groups in 1985 (Anchorage Daily News, March 27, 1988). These decisions reinforced legal and regulatory requirements for the completion of environmental assessments prior to the approval of mining operations on lands administered by the NPS and BLM. The placer and lode mines that are the focus of the lawsuits occur either in national parks or on designated national wild and scenic rivers administered by the BLM (Anchorage Daily News, January 30, 1988).

The 10th Annual Alaskan Conference on Placer Mining was held in March in Fairbanks (Fairbanks Daily News-Miner, March 25 and 26, 1988). Major topics discussed at the meeting included economics, techniques,

and regulations for placer gold mining with emphasis on small-scale mining.

A three-day conference was held in October at the annual meeting of the Alaska Miners Association in Anchorage (Anchorage Daily News, October 23, 1988). Major topics discussed were development of new lode and placer deposits, water-quality regulatory problems for placer mining, and current regulations and policies of State and Federal regulatory agencies (Alaska Journal of Commerce and Pacific Rim Reporter, October 24, 1988).

New major mining operations will improve the performance of industry in Alaska according to the Alaska Commerce Commission. Alaska ranks 47th among the States for mineral production (Alaska Journal of Commerce and Pacific Rim Reporter, January 25, 1988).

Precious Metals

Exploration and mining feasibility studies continued at a number of known lode gold mines, prospects, and new deposits in 1988 (fig. 12).

On Prince of Wales Island in southeastern Alaska, the Chichagof and the Hirst-Chichagof mines are being developed by Golden Sitka Resources (Alaska Journal of Commerce and Pacific Rim Reporter, April 4, 1988). Before closure in the early 1940's, the Chichagof and Hirst-Chichagof mines produced 791,000 oz of gold and 39,000 oz of silver (Nokleberg and others, 1987).

The Greens Creek deposit (fig. 13) on Admiralty Island was discovered in the early 1970's on the edge of the Admiralty National Monument (Bradner and Bradner, 1988). Development was under way in 1988, and operations at the mine began in early 1989. Forecasts project annual production of approximately 6.37 million oz of silver, 36,000 oz gold, 25,000 tons zinc, and 9,000 tons lead (Anchorage Daily News, January 24, 1988). It is estimated that the Greens Creek mine will be the Nation's largest silver producer. The major partners in developing the mine are Greens Creek Mining Co. and British Petroleum. Operation of the mine should have a large favorable economic impact on nearby Juneau (Anchorage Times, August 1, 1988).

Major exploration programs are under way in the Alaska-Juneau (A-J) gold mine near Juneau (Anchorage Daily News, October 23, 1988). The A-J mine has been explored and developed since 1985 by Echo Bay Mines and Watts, Griffis, and McQuat, Inc. The mine is owned by the City and Borough of Juneau and Alaska Electric Light and Power Co. The A-J mine is estimated to contain 250,000 oz of recoverable gold in about 100 million tons of ore (Alaska Journal of Commerce and Pacific Rim Reporter, July 11, 1988, November 8, 1988). The A-J mine produced 3,470,000 oz gold and 1,900,000

oz silver until closure in the early 1940's (Nokleberg and others, 1987). In early 1988 in a successful suit by the Taku Mining Company, the Alaska Supreme Court ruled that tailings from the A-J mine, dumped in Gastineau Channel from 1914 to 1944, have become public real estate eligible for staking by other companies (Anchorage Times, January 9, 1988).

Also north of Juneau, the Kensington gold mine (fig. 14) is being explored and evaluated by Echo Bay Mining (Anchorage Times, May 22, 1988). The Kensington mine produced 12,100 tons of ore grading 0.169 ounces per ton (oz/t) gold until closure in the early 1940's (Nokleberg and others, 1987). In the same area, the Jualin gold mine is being evaluated and explored by Curator America Company (Anchorage Times, May 22, 1988). An estimated 1,450,000 tons grading 0.507 oz/t has been delineated (Bradner and Bradner, 1988). In the early part of the century, the mine produced approximately 48,200 oz gold (Nokleberg and others, 1987).

Five sites in south-central Alaska are being pursued (fig. 12). West of Valdez, Hayes Resources continues to explore the Cliff gold mine (Bradner and Bradner, 1988; Bundtzen and others, 1988). Before the early 1940's, the mine produced about 51,700 oz gold (Nokleberg and others, 1987). On the Kenai Peninsula, Anna Philo is developing the Gulch Creek mine on an 80-acre gold placer site (Anchorage Times, March 8, 1988). Alaska Apollo Gold Mines Ltd. announced in early 1988 that the Shumagin mine on Unga Island contains 278,201 tons grading 0.524 oz/t gold and 2.47 oz/t silver (Anchorage Times, January 29, 1988). West of Anchorage, the Johnson River epithermal gold-zinc vein deposit, owned by Cook Inlet Region, Inc., is being explored by Hunt, Ware, and Proffett, Inc. (Bradner and Bradner, 1988). The Independence gold mine near Hatcher Pass was being mined by Alaska Hardrock Mining Co. (Bradner and Bradner, 1988). The mine produced 1,050 tons of ore in 1987.

Near Cantwell, development is continuing at the base and precious metals mine of Golden Zone (Alaska Journal of Commerce and Pacific Rim Reporter, January 11, 1988; Anchorage Daily News, October 23, 1988) by Golden Zone Developments Ltd. The mine is currently estimated to contain 208,500 oz gold (Anchorage Times, October 6, 1988; Bradner and Bradner, 1988). The mine produced about 1,580 oz gold and 8,617 oz silver until the early 1940's (Nokleberg and others, 1987).

The Valdez Creek mine (fig. 15) is the largest placer mine in Alaska and the only site where placer mining continues year-round (Fairbanks Daily News-Miner, November 10, 1988). The mine produced approximately 33,277 oz gold in 1987 (Bundtzen and others, 1988), and 52,961 oz gold in 1988 (Green and Bundtzen, 1989). In early 1988, the Valdez Creek Mining Company was cited for illegal disposal of waste oil and garbage by

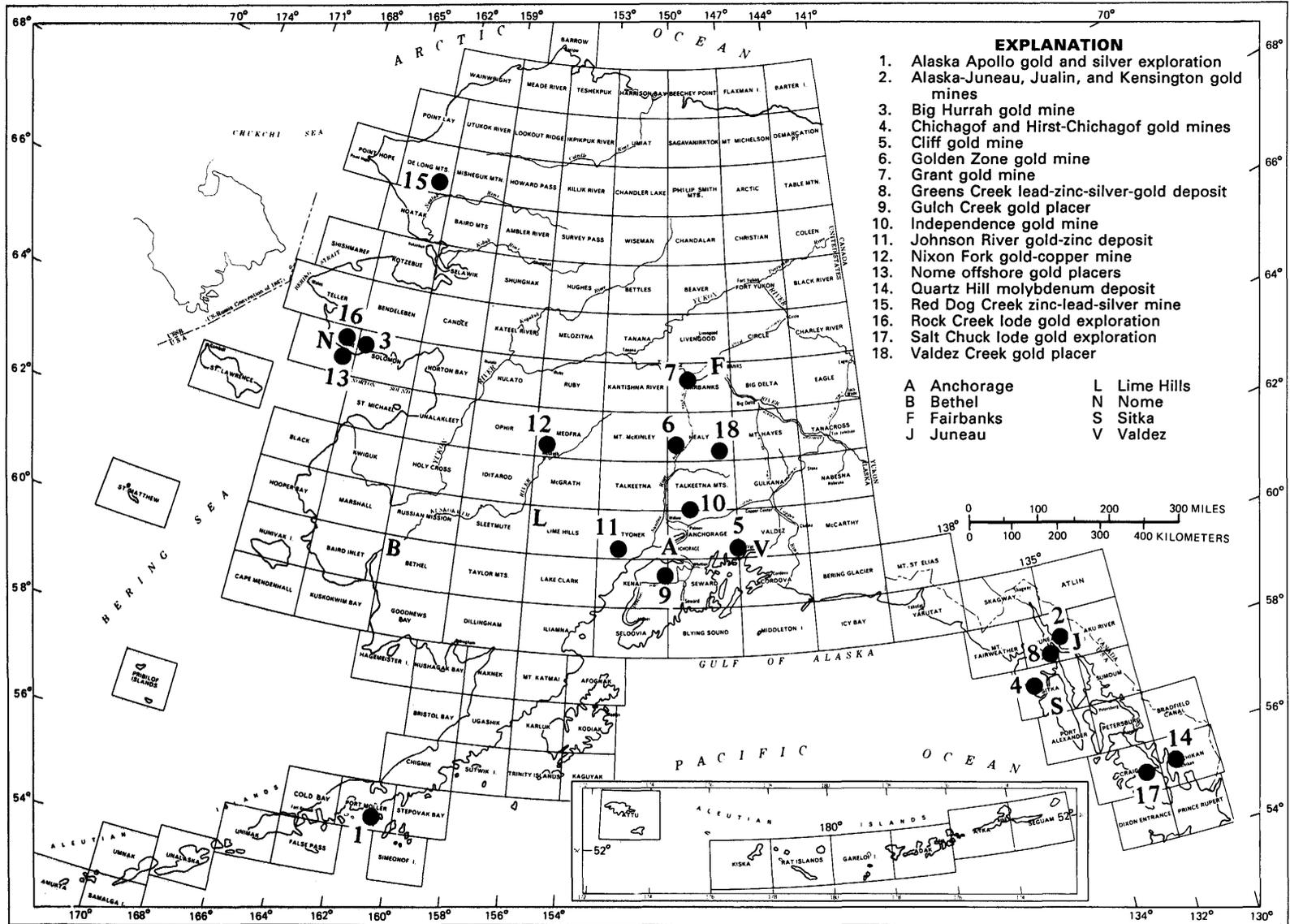


Figure 12. Areas of significant industry activity involving metallic minerals (excluding uranium) in 1988, and mine and deposit locations referred to in text. 1:250,000-scale quadrangles are outlined and labeled.

the Department of Environmental Conservation (Fairbanks Daily News-Miner, March 7, 1988). The company has agreed to a \$275,000 settlement (Anchorage Times, July 10, 1988).

New mining claims in the Fairbanks region in east-central Alaska increased 80 percent over 1987 (Fairbanks Daily News-Miner, April 29, 1988). Over 3,000 claims were filed from July through October (Fairbanks Daily News-Miner, November 10, 1988). Most of the claims are for placer and lode gold deposits. The relatively new technique of heap-leaching enables recovery of lode gold in much lower concentrations than previously possible, and has in part sparked new exploration for lode gold deposits.

Silverado Mines Ltd. is operating the Grant mine at Ester Dome near Fairbanks (Fairbanks Daily News-Miner, January 7, 1988). Upon reopening in late 1987, the mine produced gold valued at \$118,000 in December (Alaska Journal of Commerce and Pacific Rim Reporter, February 1, 1988). The area's largest trommel, used for size separations of gold ore, was installed in 1988 at the Grant mine (Fairbanks Daily News-Miner, June 14, 1988). Local miners expressed some concern over the possible development of a downhill ski resort west of

Ester Dome that might hamper further subsurface mining in the area (Fairbanks Daily News-Miner, March 12, 1988).

Also in the Fairbanks region, the Ryan Lode gold mine was operated in 1988 by Citigold Alaska Co. (Bradner and Bradner, 1988). The mine produced 6,100 oz of gold-silver bullion in 1987 (Bundtzen and others, 1988). Polar Mining, Inc. started development of a 40-year-old placer gold mine on a 1,291 acre plot on Murphy Dome (Fairbanks Daily News-Miner, May 14, 1988).

Battle Mountain Mining Co. is exploring the Nixon Fork mine, a gold-copper skarn near Medfra in west-central Alaska (Bradner and Bradner, 1988). The Nixon Fork mine has produced about 40,000 to 60,130 oz gold (Nokleberg and others, 1987).

On the Seward Peninsula east of Nome (fig. 12), development is continuing at the Big Hurrah mine (Anchorage Daily News, October 23, 1988). The mine is being developed by Golden Zone Developments Ltd., Thor Gold Corporation, and Stratford American Resource Corp., and currently is estimated to contain 500,000 tons grading 0.35 oz/t gold (Anchorage Times, October 6, 1988; Bradner and Bradner, 1988). This mine



Figure 13. The 920 portal of Greens Creek mine, Admiralty Island, southeast Alaska. Photograph by D. Brew.

produced about 5,000 oz gold in the early part of the century (Nokleberg and others, 1987). Placer Dome US has announced plans to continue exploration in 1989 on various lode gold occurrences at Snow Gulch and Anvil Creek north of Nome, and at Rock Creek (Alaska Journal of Commerce and Pacific Rim Reporter, November 14, 1988).

BHP Utah International abandoned their exploration efforts on the 14,000-acre coastal plain lode gold project near Nome (Alaska Journal of Commerce and Pacific Rim Reporter, October 24, 1988). Since 1898, about 4 million oz of placer gold have been produced from coastal plain gravels, which are estimated to still contain about one million oz of gold. Since 1986, Alaska Gold Co. has been producing about 20,000 oz gold per year with two dredges operating on 17,000 acres of claims near Nome (Anchorage Times, July 3, 1988).

Offshore from Nome, the world's largest offshore gold dredge, the *Bima*, continues to extract gold from

sea-floor gravels (The Alaska Journal of Commerce and Pacific Rim Reporter, October 24, 1988). The dredge produced 36,700 oz gold in 1987 and 35,500 oz gold in 1988 (Anchorage Daily News, December 24, 1988). The owners of the *Bima*, Western Gold Exploration and Mining Co., have mineral rights to 15 miles of sea bottom west of Nome, from the coast out to the Alaska 3-mile limit (Fairbanks Daily News-Miner, March 26, 1988). During the winter of 1987–1988, the company drilled the sea floor from pack ice to determine gold values for the 1988 dredging season.

In early 1988, the Minerals Management Service asked for lease nominations for 350,000 acres of sea floor beyond the State's 3-mile coastal domain south of Nome. A coordination team is being established by the State of Alaska and the MMS to study the potential for mining in Federal waters west of Nome in Norton Sound (Anchorage Times, February 9, 1988). Seventy-four percent of the Federal Outer Continental Shelf (OCS) lands, the area extending from the 3-mile State offshore boundary, to the national 200-mile boundary, lies off the Alaska coastline.

Strategic and Critical Minerals

Exploration and mining feasibility studies continued at a number of known mines, prospects, and newly discovered deposits in 1988.

On Prince of Wales Island in southeastern Alaska, the Salt Chuck mine is being explored by America Platinum, Inc. (Bradner and Bradner, 1988). The Salt Chuck mine produced 331,000 tons of ore grading 0.95 percent copper, 0.035 oz/t gold, 0.169 oz/t silver, and 0.064 oz/t platinum-group metals (Nokleberg and others, 1988).

North of Sitka (fig. 12), the Mirror Harbor deposit is being explored for nickel, cobalt, and platinum by Galactic Resources (Bradner and Bradner, 1988). The largest deposit at Mirror Harbor is estimated to contain about 8,050 tons grading 1.57 percent nickel, 0.88 percent copper, and 0.05 percent cobalt (Nokleberg and others, 1987).

In the western Brooks Range, the Red Dog zinc-lead deposit (fig. 16) is scheduled for production in early 1990, and will be the Western World's largest base-metals mine (Anchorage Daily News, October 23, 1988; Bradner and Bradner, 1988). The Red Dog deposit is estimated to contain 85 million tons of ore grading 17 percent zinc, 5 percent lead, and 2.4 oz/t of silver (Nokleberg and others, 1987), and is estimated to be operable for at least 50 years (Anchorage Times, October 31, 1988). The ore will be extracted by open-pit mining. More than two million tons of ore will be processed annually, producing 580,000 tons of zinc concentrate, 120,000 tons of lead concentrate, and 50,000



Figure 14. Gold-bearing quartz vein in Kensington mine, Juneau mining district, southeast Alaska. Photograph by E. Redman.

tons of middling product (Alaska Journal of Commerce and Pacific Rim Reporter, July 18, 1988).

The Red Dog deposit is being developed jointly by Cominco, Alaska, a subsidiary of Cominco Ltd. of Canada, and NANA Regional Corporation (Anchorage Times, October 31, 1988). A 52-mile-long haul road has been constructed from the mine to a shallow water port northwest of Kotzebue. A contract for the mill facility was awarded in 1988 to VECO, Inc. and NANA Development Corporation (Anchorage News, October 18, 1988). The warehouse, maintenance building, and accommodations complex are being completed (Anchorage Daily News, December 3, 1988).

Other Metals

Exploration studies and related activities for other metals occurred at various sites within Alaska in 1988.

Near Ketchikan, the USFS issued a final EIS for mine development at the Quartz Hill molybdenum deposit (fig. 12), and the Environmental Protection Agency (EPA) has drafted a water-discharge permit for the mine (Anchorage Times, November 12, 1988). Quartz Hill is a world-class deposit that was discovered and developed by U.S. Borax (Fairbanks Daily News-

Miner, November 22, 1988). The deposit is estimated to contain 1,800 million tons grading 0.136 percent molybdenum (Nokleberg and others, 1987).

On the Seward Peninsula, the Lost River Mining Company continued placer tin mining. In 1987, this mine produced 280,000 pounds of tin and remains one of the country's largest primary tin producers (Bundtzen and others, 1988).

ACTIVITY BY FEDERAL AGENCIES

U.S. Geological Survey

Studies of nonfuel minerals in Alaska are an important part of the USGS programs in Alaska. The Alaska Mineral Resource Assessment Program (AMRAP) continues as a major USGS program of geologic mapping, mineral resource assessment, and specialized geologic study of Alaska lands. Because of budgetary restraints, AMRAP activities in 1988 were at a lower level than in previous years. The Trans-Alaskan Crustal Transect (TACT) program continued as a multidisciplinary geologic and geophysical study of a cross section of Alaskan geology parallel to the Trans-Alaska



Figure 15. Blasting activity in pit of Valdez Creek placer gold mine, south-central Alaska. Photograph by S. Teller.

Pipeline System. In 1988, the TACT program successfully completed geologic mapping and companion geophysical studies from the Gulf of Alaska to the southern flank of the Brooks Range. The geologic mapping and mineral resource assessment studies of the White Mountains National Recreation Area were completed in 1988. Also in 1988, a statewide synthesis of the metallogeny of lode mineral and placer deposits of Alaska was completed by a team of geologists from the USGS and ADGGS with contributions from geologists in the USBM, private industry, and universities. Locations of 1988 studies are included on figures 17 and 18.

Alaska Mineral Resource Assessment Program

AMRAP studies are conducted at four progressively more detailed levels to produce comprehensive assessments of the mineral and energy resources of Alaska. Level I studies are statewide in scale, and published maps are generally at a scale of 1:2,500,000. In 1988, work continued on updating the mineral data base for the entire State. USGS Open-File Report 88-73 reported on the metallogeny and mineral deposits of Alaska (Nokleberg and others, 1988). This publication

was prepared by a team of eight geologists from the USGS and ADGGS, with contributions from additional geologists in industry, academia, and other Federal and State agencies.

Level II studies address large parts of the State, and resultant maps are generally published at a scale of 1:1,000,000. Level II studies continue on the geology and mineral resource potential of the Alaska Peninsula and the eastern Alaska Range.

Level III studies continue to receive the major effort of AMRAP (fig. 18), consisting of multidisciplinary evaluations involving team studies of selected 3° quadrangles. Geologic, geochemical, and geophysical data are gathered to produce an inventory of areas defined to have mineral resource potential. Studies are in progress in 26 quadrangles. Field research is complete, and reports are in preparation, for the Baird Mountains, Chandler Lake, Iditarod, Killik River, Livengood, Mount Katmai, Naknek, Port Moller, Simeonof Islands, and Stepovak Bay quadrangles. Fieldwork continues in the Bethel and Lime Hills quadrangles, each in its second year of field investigations, and also in the Juneau, Seldovia, and Taku River quadrangles. Pre-assessment evaluations of possible future studies are being added to



Figure 16. Red Dog deposit (foreground) in western Brooks Range, northwest Alaska, will be largest base-metals mine in Western Hemisphere when production begins in 1990. Photograph by J. Schmidt.

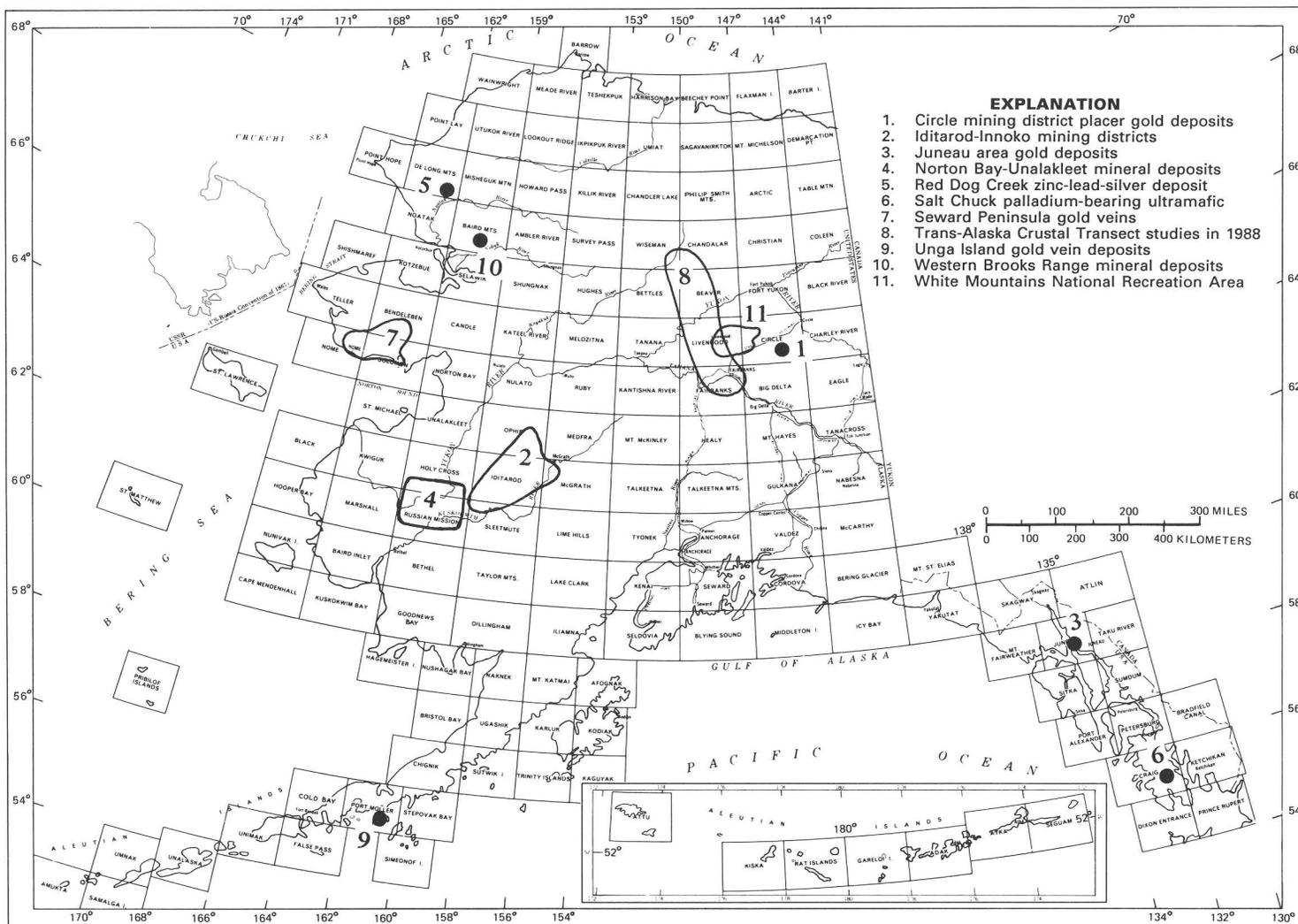


Figure 17. Locations of U.S. Geological Survey level IV metallic-mineral studies in 1988. 1:250,000-scale quadrangles are outlined and labeled.

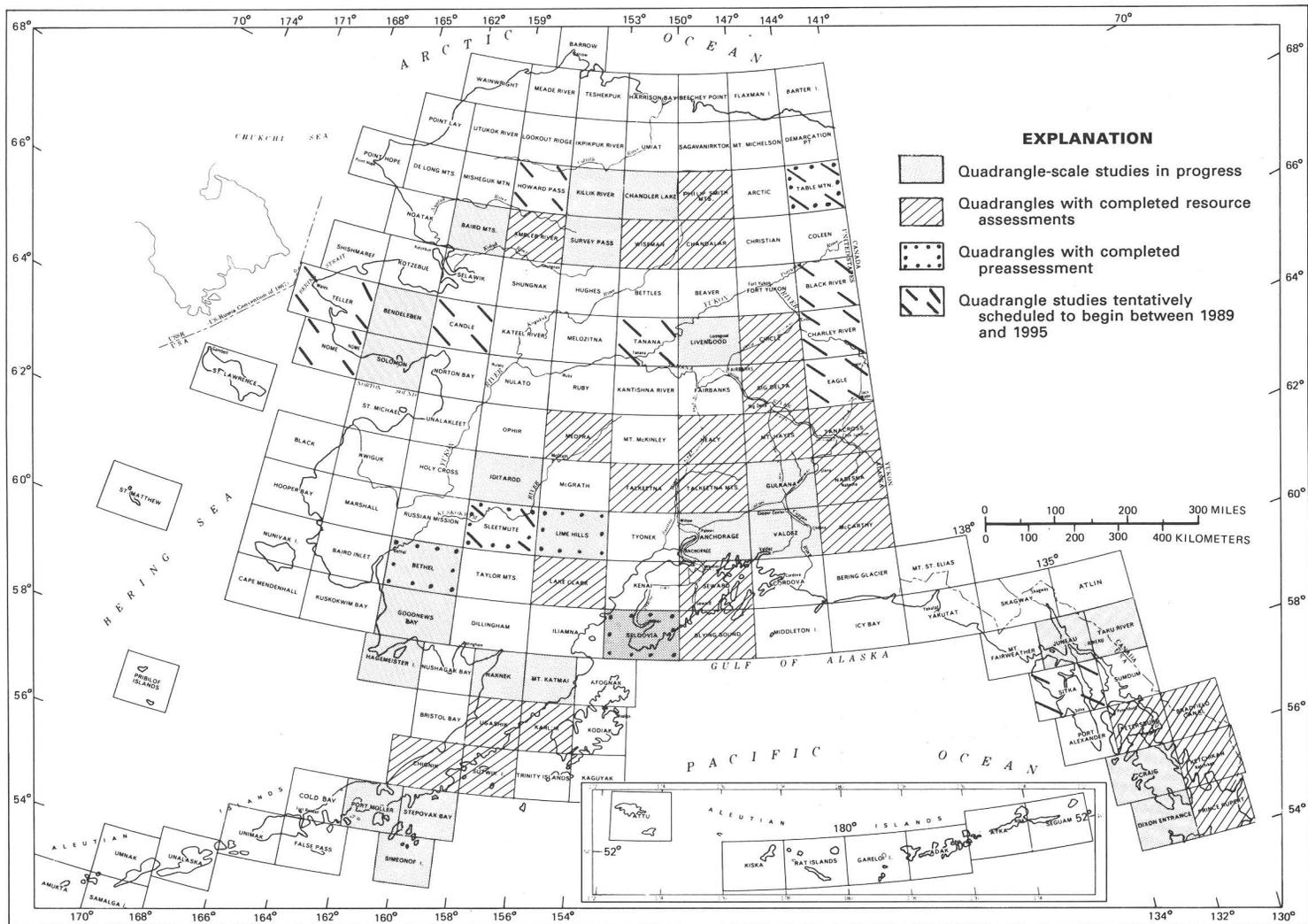


Figure 18. Status of level III Alaska Mineral Resource Assessment Program quadrangle studies as of January 1989. 1:250,000-scale quadrangles are outlined and labeled.

the AMRAP program. Pre-assessments have been completed for the Bethel, Iditarod, Lime Hills, Seldovia, and Table Mountain quadrangles, and are in progress for the Sitka and Sleetmute quadrangles. Level III AMRAP projects publish an assessment of the mineral resources of the quadrangle examined. To date, resource assessments have been published for 25 quadrangles (fig. 18). Publications since initiation of the AMRAP program now number approximately 540 documents.

Level IV studies consist of detailed mapping (at a scale of 1:63,360 or larger) of mining districts, specific mineral deposits, and related research. Current level IV activities are studies of gold vein deposits in the Unga Island (Apollo mine) area on the Alaska Peninsula, and metamorphic and structural studies of the Brooks Range and central Alaska. The locations of level IV studies are shown in figure 17, and the project titles listed in table 12.

Some of the reports published in 1988 as a result of AMRAP and related USGS programs include: geologic map of the Ketchikan and Prince Rupert quadrangles (Berg, Elliot, and Koch, 1988); mineral resource assessment of the Wiseman quadrangle (Bliss and others, 1988); studies of nonplacer mineral occurrences and rock geochemistry in the Solomon, Bendeleben, and southern part of the Kotzebue quadrangles (Gamble, 1988; Gamble and others, 1988); geologic map of the Chandler Lake quadrangle (Kelley, 1988); rock geochemistry of the Anchorage quadrangle (Madden and others, 1988); mineral occurrences and rock geochemistry of the Baird Mountains quadrangle (Schmidt and Allegro, 1988; Zayatz and others, 1988); geology and mineral resources of the White Mountains Recreation Area (Weber and others, 1988); and mineral occurrences in the Port Moller and Stepovak Bay quadrangles (Wilson, White, and DuBois, 1988). Exploration geochemistry of stream sediments and heavy mineral concentrates was published for the Iditarod quadrangle (Bennett, Gray, and Taylor, 1988; Gray, Arbogast, and Hudson, 1988; Gray, Smith, and Goldfarb, 1988); the Ugashik, Bristol Bay, and western Karluk quadrangles (Church and others, 1988; Frisken and others, 1988; Frisken, Church, and Willson, 1988); the Goodnews Bay, Hagemeister Island, and Nushagak Bay quadrangles (Cieutat, Goldfarb, and Speckman, 1988); the Naknek, Afognak, and Iliamna quadrangles (Erlich and others, 1988); and the Solomon and Bendeleben quadrangles (King and others, 1988). These papers are listed in appendix 1.

Numerous short papers on geology and mineral resources of Alaska were published in U.S. Geological Survey Bulletin 1903 entitled "Geologic studies in Alaska by the U.S. Geological Survey, 1988" (Dover and Galloway, 1989). A recent bibliography and index of articles in U.S. Geological Survey circulars devoted to research in Alaska from 1975 to 1986 (Reed and Marks, 1987) includes references to many papers on mineral resources.

Table 12. Level IV studies of the USGS Alaska Mineral Resource Assessment Program and related studies active in 1988

[Project chiefs listed in parentheses. Projects marked by an asterisk are of statewide scope]

| |
|---|
| Areal mineral-resource assessments |
| *Tin commodity studies (B.L. Reed) |
| *Placer gold deposit studies (W.E. Yeend) |
| *Subjective probability estimations of Alaskan mineral resources (W.D. Menzie) |
| Mineral deposits, western Brooks Range (J.M. Schmidt) |
| Metallogenesis, eastern Alaska Range (W.J. Nokleberg) |
| Geology and mineral resources, Norton Bay-Unalakleet area (W.W. Patton, Jr.) |
| Tin and tungsten deposits, Circle district (B.L. Reed and W.D. Menzie) |
| Areal energy-resource assessments |
| Petroleum potential of the Yukon-Kandik basin (H.E. Cook) |
| Geologic framework and petroleum potential of the Nenana basin (R.G. Stanley) |
| Coal studies in the Nenana basin (C. Wahrhaftig) |
| Genesis of trace elements of the Nenana basin coal fields (G.D. Stricker) |
| Coal resources of northern Alaska (G.D. Stricker) |
| Exploration geophysical studies |
| Geophysics of the Yukon-Koyukuk basin and its borderlands (J.W. Cady) |
| Mining geophysics of central Alaska (D.L. Campbell) |
| Biostratigraphic studies |
| Brooks Range and Arctic Slope studies (L.N. Marincovich) |
| *Paleozoic and Mesozoic radiolarians (C.D. Blome and B.L. Murchey) |
| *Brachiopod and conodont paleogeography (J.T. Dutro, Jr., and A.G. Harris) |
| Framework or process studies |
| Yukon-Koyukuk crustal transect study (W.W. Patton, Jr.) |
| Structural analysis of interior metamorphic terranes (J.H. Dover) |
| Mafic and ultramafic rocks of Alaska (R.A. Loney) |
| Upper Mesozoic stratigraphy of the Alaska Peninsula (R.L. Dettnerman) |
| *Paleomagnetism of accreted terranes (C.S. Gromme) |
| *Metamorphic-facies map of Alaska (C. Dusel-Bacon) |
| Northwestern Alaska crustal study (A.B. Till) |
| Central Alaska metamorphic studies (J. Dover) |
| Gold mineralization of the Apollo and Shumagin mines (W. White) |
| Radiometric ages and chemistry of the shallow Tertiary igneous rocks of the Mt. Katmai quadrangle (J.R. Riehle and M.A. Lanphere) |
| Exploration geochemical studies |
| Alaska placer gold deposits (J.C. Antweiler) |
| Southern Alaska lode gold deposits (J.R. Goldfarb) |
| Isotopic and radiometric studies |
| *K-Ar studies and radiometric age file (N. Shew) |
| *Lead and oxygen isotope studies (S.E. Church) |
| *Uranium-lead and rubidium-strontium isotope studies (J.N. Aleinikoff) |

A bibliography of U.S. Geological Survey geologic and water-supply reports and maps for Alaska was recently published by the U.S. Geological Survey (1986).

Trans-Alaska Crustal Transect Program

The Trans-Alaska Crustal Transect (TACT) program continued for a fifth year. This program is a major integrated multidisciplinary investigation designed to study the geology, tectonics, and deep crustal structure of Alaska along a corridor parallel to the Trans-Alaska Pipeline System. Major results of the 1988 TACT program were: (1) completion of marine seismic reflection surveys in the Prince William Sound southwest of Valdez and south of Seward; (2) extension of 1:63,360-scale geologic mapping and specialized geologic studies to the southern flank of the Brooks Range, resulting in a completed geologic strip map that covers the southern four-fifths of the State along the transect; (3) completion of magnetotelluric surveys from the Gulf of Alaska to the Yukon River; and (4) presentations and publications on the geology, tectonics, and geophysics of the study area (Aleinikoff and others, 1988; Fuis and others, 1988; Geist and others, 1988; Labson and others, 1988; Moore and Nokleberg, 1988; Nokleberg and others, 1988c; Pavlis and others, 1988; Stanley and others, 1988).

White Mountains National Recreation Area Project

A cooperative study between the USGS, ADGGS, and USBM to develop mineral information for parts of the White Mountains National Recreation Area, which began in 1986, was completed in 1988. This special study consisted of geologic, geophysical, and geochemical mapping and resource assessment of the area for BLM. The USGS assessed all or parts of 10 inch-to-the-mile (1:63,360) quadrangles within the Livengood and Circle 3° sheets. Geologic mapping, geophysical, exploration geochemical, and mineral resource assessment studies by the USGS are published in two reports by Sutley and others (1987a, b), and by Weber and others (1988). As part of a cooperative effort, the ADGGS completed a similar, but more detailed study, of a smaller area consisting of all or parts of five 15-minute Circle quadrangles in the adjoining Lime Peak and Mount Prindle areas (Smith and others, 1987). The ADGGS report identifies an area with significant potential for lode-tin and lode-gold deposits.

Cooperative Programs with the USSR Academy of Sciences

In 1987, joint studies were proposed during a visit of the Chief Geologist and Chief of the Branch of Alaskan Geology to the Soviet Far East Branch of the USSR Academy of Sciences. In 1988, as an outgrowth of

these discussions, two study proposals were exchanged during a visit of five USGS geologists to the meeting of the Pacific Science Association in Blagoveshchensk in the USSR Far East. One proposal is a comparative study of the metallogenesis of lode mineral deposits in the USSR Far East and Alaska. This proposal will result in defining the trends of bedrock geology and lode mineral deposits across the outer continental shelf area of western Alaska and into the relatively unknown areas of the USSR Far East. A second proposal is a joint study of the distribution and origin of ophiolites and associated rocks in Alaska and the USSR Far East. Ophiolites are generally interpreted as remnants of oceanic crust thrust onto continental margin areas and are often the host rock for platinum-group metals, chromium, nickel, and cobalt lode deposits. Both proposals consist of exchange scientific visits by teams of two or three geologists for working conferences and field trips. The goals of both projects are to publish geologic and mineral resource maps and interpretive scientific articles. Both projects will take several years for completion.

Private companies are also investigating economic ventures in the USSR Far East. In 1988, an official of Greatland Exploration visited the USSR Far East to discuss the feasibility of establishing smelters in the USSR for mining of the Lost River tin, tungsten, and fluorite mine on the Seward Peninsula (Alaska Journal of Commerce and Pacific Rim Reporter, October 24, 1988).

Precious Metals

USGS geologists are involved in several studies of precious-metal occurrences in Alaska. Present research (fig. 17, table 12) includes gold quartz veins north of Nome, gold mineralization of the Apollo and Shumagin mines on the Alaska Peninsula (fig. 19), lode gold deposits in southern Alaska, metallogenesis in the eastern Alaska Range, and mining geophysics of central Alaska. Reports published in 1988 include lode and placer deposits of the Wiseman quadrangle (Bliss and others, 1988); placer gold deposits and mines of the Circle and Tolovana mining districts (Cathrall and others, 1988); gold deposits of the Manley Hot Springs, Tofty, Eureka, and Rampart mining districts in the Tanana and Livengood quadrangles (McDanal and others, 1988); and placer gold of the Solomon, Bendeleben, and southern part of the Kotzebue quadrangles (Yeend, Kaufman, and Till, 1988). Most level III AMRAP studies also involve some aspect of precious-metal deposits.

Strategic and Critical Minerals

USGS geologists are involved in several studies of strategic and critical metal occurrences in Alaska. Cur-

rent research (fig. 17, table 12) includes mafic and ultramafic rocks with associated PGM-chromium-nickel-cobalt deposits, tin commodity studies, and tin and tungsten deposits in the Circle mining district.

Other Metals

Studies of other metals and related geologic studies (figs. 17, 18; table 12) are continuing on: geology and mineral resources of the Norton Bay area; geophysics of the Yukon-Koyukuk Basin; mining geophysics of central

Alaska; Yukon-Koyukuk geologic transect; metamorphic terranes in interior Alaska; stratigraphy of the Alaska Peninsula; metamorphic facies maps of Alaska; and a northwestern Alaska crustal study.

U.S. Bureau of Mines

The USBM's AFOC is responsible for conducting four programs under the Directorate of Information and Analysis and for coordinating work with other USBM field and research centers throughout the United States.

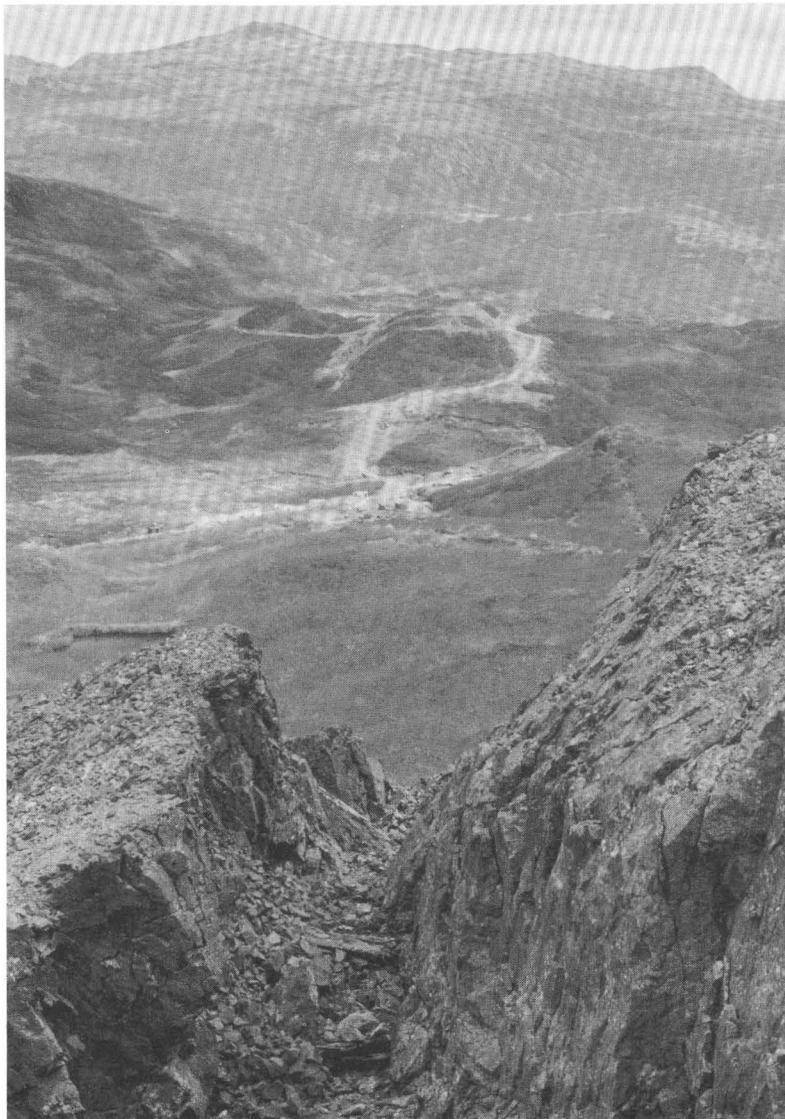


Figure 19. Looking northeast from Apollo mine stopes (foreground) to Apollo camp (center) and Sitka mine dumps (background), Unga Island, southwest Alaska. Photograph by W. White.

The USBM's Research Directorate is responsible for several ongoing projects in Alaska, through both the Mineral Institute program and the nine USBM research centers.

Minerals Availability Program

During 1988, a report by Sherman and Baggs was published on the feasibility of economic gold mining in the Juneau Gold Belt. A new study, to be published in 1989, was undertaken to examine the impact that environmental constraints have on lode and placer mining in Alaska. The Windy River chromite deposit was evaluated, and the Salmon River platinum and Greens Creek silver-zinc deposits were reevaluated, as part of an ongoing effort to maintain the Minerals Availability System (MAS) data base in support of the USBM's Mineral Supply Analysis appraisals. A report by Herzog (1988) listing all of the mineral-related references, other than those related to mineral fuels and construction materials, for the coast of Alaska was published. Statistics on the use, or proposed use and disposal of cyanide compounds, by the Alaskan mining industry were compiled for inclusion in the USBM's national data base of cyanide-related topics.

The Minerals Industry Location System (MILS) data base received considerable use during 1988. For the fiscal year, 76 reports and 44 maps were prepared in response to requests from the USBM, other Federal and State agencies, and the public. An Alaska Map E overlay and report of 272 potential placer and lode producers were created for distribution in response to numerous requests. Approximately 30,000 update transactions were transmitted to the USBM's MAS data base located in Denver.

Policy Analysis

Two reports describing lands open to exploration and locations of new mineral claims were published, one for western Alaska (Bottge, 1988) and another for south-western Alaska (Maas, 1988). This completes the USBM's survey of such lands in Alaska's six regions. A summary report for the State and a parallel report on leasable minerals were recessed in order to complete a project portraying mining claim activity at the section level. In 1987, claim activity was summarized and shown on the sixteen 1:250,000-scale quadrangles of southeastern Alaska. In 1988, the remaining 137 quadrangles were reviewed, and new overlays prepared for the 80 quadrangles having claim activity between 1980 and 1987. The overlays were released as USBM Open-File Report 20-73 (USBM 1973, revised), and complete sets were sent to the USBM offices in Anchorage, Fairbanks, and Juneau.

State Mineral Activities

The State Mineral Officer wrote the annual preliminary "Mineral Industry Survey of Alaska in 1988," summarizing significant nonfuel mineral activity. "The Mineral Industry of Alaska in 1987" detailing major nonfuel mineral exploration, development, production, and legislative action in the preceding year, became the Alaska chapter in the annual Minerals Yearbook, volume 2, published by the USBM. Legislative and executive actions of interest to the mineral industries were monitored and reported monthly. News items were prepared for the weekly "Mineral Alerts" and the bimonthly survey "Minerals and Materials" Mineral briefing profiles were prepared for Department of the Interior and USBM officials as required. Mineral news of interest to the USBM and its commodity specialists were forwarded weekly.

Minerals information and analysis is provided through a series of scheduled and unscheduled publications and reports, and other responses to inquiries from State and Federal agencies, industry, and the public. A priority activity is identifying and evaluating issues, problems, and trends to provide the USBM additional opportunities for constructive action in the minerals field. The State Mineral Officer represents the USBM on the interdisciplinary team assisting in the preparation of the EIS for the Quartz Hill molybdenum mine project.

Mineral Land Assessment

The USBM conducted mineral land assessment activities during 1988 in the Valdez Creek and Juneau mining districts (fig. 20, table 13).

Valdez Creek.—The USBM's work in the Valdez Creek mining district is part of a 4-year project begun in 1987. The study will: identify the type, amount, and distribution of mineral deposits; evaluate probable reserves using computerized statistical analysis; study ore beneficiation technologies; finalize economic feasibility studies; and address economic and legislative effects on mineral development. The program is a cooperative effort involving the USBM and ADGGS.

Site-specific studies in the Valdez Creek mining district include a study of platinum and gold in the Yacko and Peters Creek areas, a geophysical survey of the Golden Zone mine, an evaluation of the potential for the existence of a bulk minable gold deposit in the Valdez Creek area, and detailed geologic mapping of the Clearwater Mountains by the ADGGS. Studies also include collection of samples and engineering data from the Valdez Creek mine to ascertain the feasibility of using underground mining techniques to mine deep unfrozen gravels. By yearend, all 1988 sample analyses were completed and evaluated. A report summarizing 1988 field studies will be published in 1989.

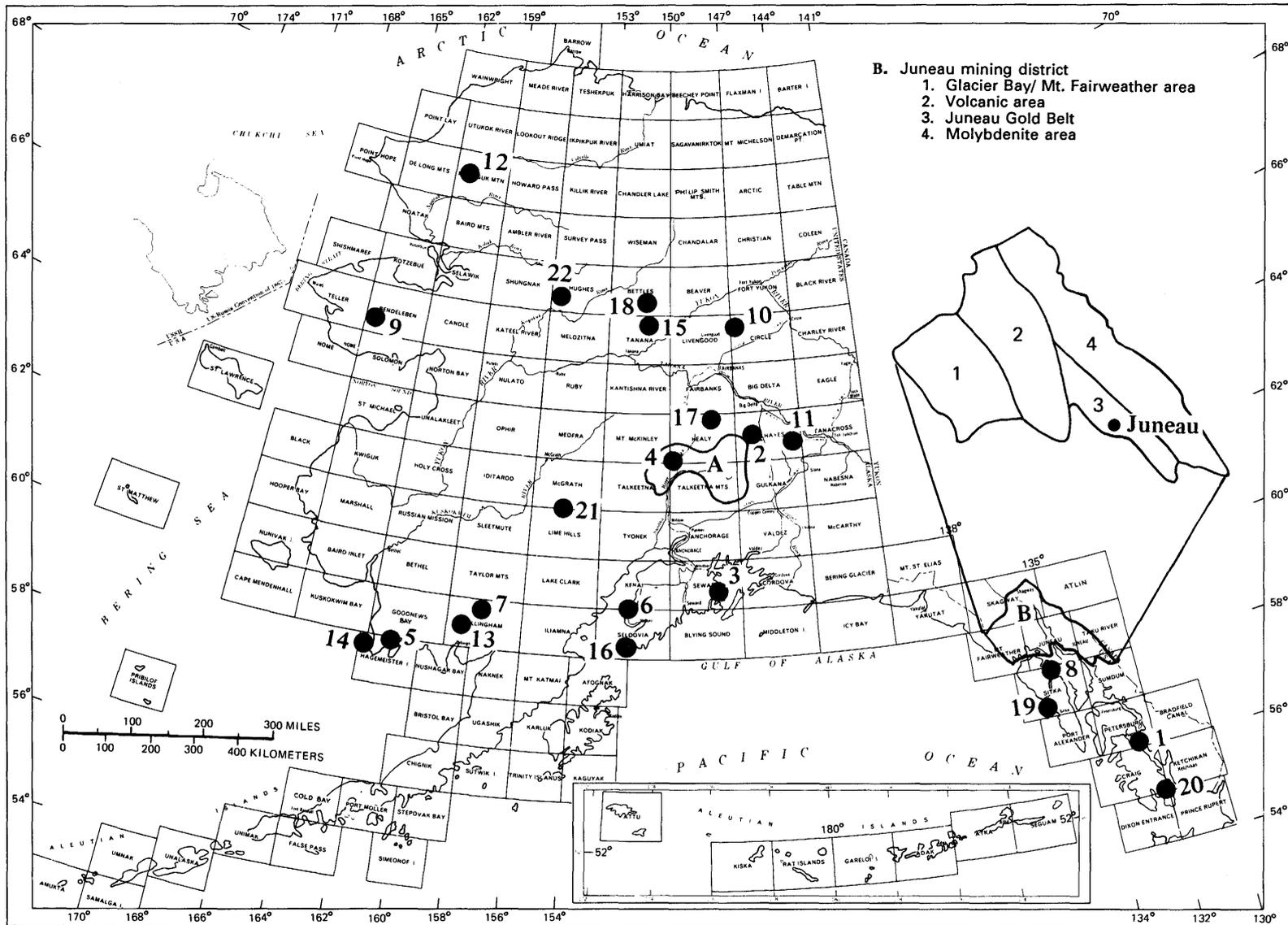


Figure 20. Locations of U.S. Bureau of Mines 1988 mining district studies (A, B) and 1988 studies of critical and strategic minerals (1–22) listed in table 13. 1:250,000-scale quadrangles are outlined and labeled.

Table 13. Areas of U.S. Bureau of Mines activity in mining districts and critical and strategic minerals in 1988

[See fig. 16 for locations. PGM, platinum-group metals; REE, rare-earth elements]

A. Mining districts

| Study area | Deposit of major interest |
|---------------------------------|---|
| A. Valdez Creek mining district | Placer and lode gold, massive sulfide, tin, chromite, PGM |
| B. Juneau mining district | Placer and lode gold, volcanogenic and sediment-hosted massive sulfide, molybdenum porphyry |

B. Critical and strategic minerals

| Area of critical and strategic mineral studies | Elements of interest |
|--|-----------------------------|
| 1. Blashke Islands | PGM |
| 2. Broxson Gulch | PGM, nickel, copper, cobalt |
| 3. Chenega Islands | Manganese |
| 4. Coal Creek | Tin |
| 5. Hagemeister Island | PGM |
| 6. Homer | Strontium, phosphate |
| 7. Kemuk Mountain | PGM |
| 8. Kook Lake | REF, niobium, uranium |
| 9. Kougarok | Tin, tantalum, niobium |
| 10. Lime Peak | Tin |
| 11. Miller Gulch | PGM, gold |
| 12. Misheguk Mountain | PGM, chromium |
| 13. Okstukuk Hills | PGM |
| 14. Platinum | PGM, gold, chromium |
| 15. Ray River | Tin, REE, tungsten, gold |
| 16. Red Mountain | Chromium |
| 17. Sithylemenkat | Tin, REE |
| 18. Sheep Mountain | Tin, zinc, lead, silver |
| 19. Southern Prince of Wales Island | REE, niobium |
| 20. Snipe Bay | Copper, nickel, cobalt, PGM |
| 21. Windy Fork | Ree, niobium |
| 22. Zane Hills | REE, uranium, gold |

Open-file report 43-88, "Valdez Creek mining district study, 1987 update" by Kurtak, Balen, and Fechner, summarizes 1987 field results and sample data, and a 1:63,360-scale geologic map of the Healy A-2 quadrangle, Alaska was published by the ADGGS, with USBM assistance. As a result of the 1988 sampling program, a new mineral occurrence in the Chulitna mineral belt was discovered, and a news release detailing the discovery was published in February 1989.

Juneau district.—In 1988, the USBM completed the fourth year of fieldwork in a 4-year study of the

mineral resources of the Juneau mining district. The program is a cooperative effort involving the USBM and ADGGS. ADGGS personnel make detailed geologic studies of selected areas, while USBM personnel conduct site-specific examinations. The Juneau mining district has been subdivided into four areas for evaluation (fig. 20): the Glacier Bay/Mount Fairweather area; the Volcanic area, which includes the West Lynn Canal, Haines, and Porcupine areas; the Juneau Gold belt; and the Molybdenite area, which borders Canada north and east of the Juneau Gold Belt.

Fieldwork in the Glacier Bay/Mount Fairweather area was completed in 1987. No work was performed in this area in 1988. In the West Lynn Canal area, the mineralized zones in the upper Sullivan River region that were discovered by USBM personnel in 1987 were the focus of claim-staking activity by private companies. Curator American enlarged their claim block at the Opus prospect west of Sullivan Island to over 500 claims; the Opus prospect appears to be a widespread occurrence of stratiform massive-sulfide mineralization. In the Haines area, additional work north of Haines indicates that gold-copper mineralization extends north from the Chilkat Peninsula. A one-day trip to the Mt. Seltat area on the Canadian border indicated that the Canadian Rainy Hollow skarn district extends into the extreme north end of the Juneau mining district. In the Juneau Gold Belt area, recent developments include the discovery of additional occurrences of telluride minerals in samples from the Kensington mine. Check samples from other mines in the Juneau Gold Belt are currently being analyzed. Fieldwork in the Molybdenite area was completed in 1987.

Accomplishments during fiscal year 1988 included publication of three open-file reports: "1985-1986 Mineral investigations in the southern Chilkat Range, southeast Alaska," by Clough and Hayden; "Gold-Copper mineralization of the Chilkat Peninsula and Islands," by Still; and "Mineral investigations in the Juneau mining district, Alaska (Eagle River area)" by Kurtak and Maas. An open-file report is in preparation concerning the Porcupine area entitled "Lode deposits, prospects, and occurrences of the Porcupine mining area, southeast Alaska," by Still, Gilbert, and Forbes. In addition, a paper entitled "Ore controls in the Alaska-Juneau gold mine" was presented at Bicentennial Gold '88, an international professional meeting. The final Juneau mining district report is due for publication in the spring of 1989.

Juneau mining district personnel also provided expertise on request to companies working on the Alaska-Juneau, Gold Fork, Treasury Hill, Jualin, Kensington, Dream-Opus, and Klukwan deposits. A group meeting to assess nine mineral deposit types in the Juneau mining district was held in September 1988 and was attended by personnel from the USBM, USGS,

ADGGS, and private industry. Assessment results were tabulated, base maps updated, and the results forwarded to participants for review.

Other.—A 1988 USBM summary of mineral development potential in the Tongass National Forest will be used by USFS personnel in their revision of the Tongass Land Management Plan (TLMP). Digitized maps show areas of high and identified mineral development potential. These areas will be integrated on the Forest Service Geographical Information System (GIS) in order that minerals may be readily compared with commodities of other land uses. Other products of the summary include a compilation of inferred reserves from known mineral deposits in southeast Alaska, as well as economic evaluations of the areas in which the reserves occur. Data presented on an overlay map were reviewed by USGS and mining industry representatives. The map and resource data were then revised to reflect reviewers' comments. USBM personnel have worked closely with the Tongass Interdisciplinary Development Team throughout this minerals assessment project.

A probabilistic assessment of the mineral resources of the Gravina/Big Island planning units of the Chugach National Forest was conducted in cooperation with the USGS. The data will be included in the management area analyses and used to identify the current and projected future locations and development of mining claims, locations of probable occurrences of minerals, and current and projected access needs. Draft reports were submitted to the Forest Service by the USBM and USGS.

The USBM assessed the potential supply of minerals from undiscovered deposits in the White Mountains National Recreation Area and in part of the Steese National Conservation Area north of the Steese Highway; BLM will use this assessment in its future land-use decisions. The assessment consisted of a quantitative mineral resource appraisal, an engineering cost analysis, the specifications and metal price scenarios, and a potential-supply-analysis computer model which integrated these components. The evaluation based on these procedures was a joint effort by the USBM, ADGGS, and USGS. A draft report was delivered to the BLM in 1988.

Critical and Strategic Minerals

As part of the studies mandated by ANILCA, the USBM is evaluating occurrences of strategic and critical minerals. Project work in 1988 was divided between studies of manganese, tin-tantalum-niobium-rare earth elements (REE), and chromium-cobalt-platinum group metals (PGM) (fig. 20, table 13).

On southern Prince of Wales Island, the USBM completed evaluations of the mineral development potential for REE and niobium, with associated zirco-

ni-um, uranium, tantalum, and other lithophile metals. The studies are concentrated on a 35-mile-long trend of sodic intrusions and associated mineral occurrences. In 1988, final checking and bulk sampling were conducted in the Stonerock and Dora Bay areas. Extractive hydro-metallurgical processing studies of southern Prince of Wales deposits are under way at the USBM's Salt Lake City Research Center. To date, USBM investigations have delineated more than 40 million tons of mineralized material in 11 deposits (Barker and Mardock, 1988; Barker and Warner, 1988). Most of this tonnage contains 0.5 percent or more REE and more than 0.1 percent niobium, in addition to numerous potential byproducts. Notably, there is an unusual concentration of the heavy yttrium subgroup amounting to nearly half the total contained REE.

The USBM conducted evaluations in the Zane Hills, where REE is associated with placer gold deposits, and at the Sithyemenkat placer tin-REE deposit. New REE-related projects were started in the Windy Fork-Kuskokwim River and Kook Lake-Chichagof Island areas. These projects will be continued in 1989.

Alaska contains geologic terranes favorable for tin deposits. The Bureau's tin program is intended to characterize several deposits from each terrane. During 1988, placer testing was continued along the Ray River. A deposit characterization study was initiated in conjunction with the University of Alaska on drill core from the Coal Creek deposit in the Chulitna area; the Coal Creek deposit represents an estimated 5-million-ton deposit. Final characterization studies were also completed at the Sheep Mountain tin-zinc-lead-silver stratabound sulfide deposit and Kougarak tin-tantalum deposit. The final report of the Bureau's 1985 investigation of tin deposits at Lime Peak in the White Mountains was released (Warner and others, 1988).

Attempts continued to identify potential Alaskan PGM resources. Lode sources of PGM in the Miller Gulch placer have been identified, but appear to be too low grade for resource consideration. Extensive, but very low grade PGM's have also been identified between Rainbow Mountain and Broxson Gulch. Efforts to further evaluate a PGM-chromium occurrence near Misheguk Mountain were attempted, but were unsuccessful due to adverse weather conditions and restricted entry. Several magnetic anomalies in southwest Alaska were examined for indications of ultramafic bedrock and PGM. The Blashke Islands were examined for possible residual placers, and this work will be continued in 1989. Final field activities were concluded in the area offshore from the Goodnews Bay ultramafic complex (fig. 3). A report summarizing this work and making recommendations for further exploration was published as Open-File Reports 11-88 and 53-88 (Zelenka, Barker, and Lamal, 1988).

Research Activities

Researchers at USBM centers in Albany, Oregon, and Salt Lake City, Utah, continued to characterize materials from Alaskan strategic mineral deposits and determine their amenability to beneficiation. Materials from the southern Prince of Wales REE-niobium deposits, Red Mountain chromite, and the Coal Creek tin deposit are presently being tested. Tests were also concluded on samples from the Kougarok tin deposit.

Researchers from the Spokane Research Center conducted physical property tests at the Valdez Creek placer mine as part of a program to develop technology for underground mining of deep placers.

Under the USBM Mineral Institute program, researchers at the University of Mississippi tested a new remote-controlled underwater sampling device offshore near Nome. If further work is successful, this tool could replace the cumbersome placer sampling drill that is presently being used and could significantly reduce the cost of offshore resource assessment work.

Bureau of Land Management

BLM continued study and preparation of four EIS's analyzing the cumulative and synergistic impacts of placer mining on four watersheds and on subsistence uses and resources in those watersheds in interior Alaska. The draft EIS's were released for public review and comment—Beaver Creek, April 15, 1988; Birch Creek, May 10, 1988; Fortymile River, June 8, 1988; and Minto Flats, July 8, 1988. The final EIS for each watershed was expected to be completed by March 1989.

In 1988, there were filings/recordings of a total of 33,266 Federal mining claims in Alaska. The total number of active mining operations on BLM-administered lands was 156 notices (five acres or less total surface disturbance) and 60 plans (greater than five acres of total surface disturbance). Six mineral patents for 25 gold claims were issued by BLM-Alaska in fiscal year 1988. A total of 399 acres was conveyed into private ownership.

During the 1988 mining season, a total of 20 operators filed for limited intervenor status in accordance with the terms of the injunctions issued in the *Sierra Club v Penfold* litigation affecting the Beaver Creek, Birch Creek, Fortymile River, and Minto Flats watersheds. Six operators were granted limited intervenor status. The remaining 14 operators were denied relief. All but one of the operators denied relief were petitioning for long-term camping permits within the Scenic Corridor of the Fortymile River Wild and Scenic River System. The court ruled that miners using suction dredges, operating on State-owned mining claims below the mean high water mark of the Fortymile River, could not camp on BLM lands immediately adjacent to the

river, which lies within the Scenic Corridor. Such camping, according to the court, would impinge upon the purpose for which the corridor was established, that is, a wilderness experience, and would thereby constitute a significant cumulative impact.

Fish and Wildlife Service

In keeping with its primary mission, efforts of the FWS relating to mineral activity emphasize fish, wildlife, and habitat protection. However, some mining claims were located before refuges were established. By the end of 1987, the number of active mining claims on refuge lands had been reduced to approximately 175 claims on 12 of the 16 refuges. Most of the placer mines were in the Togiak and Yukon Delta National Wildlife Refuges, and most of the lode mines were in the Alaska Peninsula and Innoko National Wildlife Refuges (fig. 4).

Contaminant sampling was conducted on and downstream from mines on: the Tuluksak River, Yukon Delta National Wildlife Refuge; the Iditarod, Mud, Little Mud, Dishna, and Innoko Rivers, and the Grouch, No Name, Hammer, Hather, and Madison Creeks, Innoko National Wildlife Refuge; on Braided Creek, Alaska Peninsula National Wildlife Refuge; streams in the Tetlin National Wildlife Refuge; streams in the Wiseman area; and in the 1002 area of the Arctic National Wildlife Refuge. These streams were sampled in order to establish baseline data and to determine if impacts were occurring. Analysis of the samples is not yet complete. The FWS also commented on the Greens Creek mine on Admiralty Island, the Quartz Hill mine near Ketchikan, and offshore gold dredging in Norton Sound.

Minerals Management Service

OCS Mining Program, Norton Sound Lease Sale

The MMS has proposed a competitive OCS mineral lease sale in Norton Sound south and southeast of Nome, Alaska (fig. 12). The sale focuses on gold-bearing placer deposits at or near the sea floor in water depths ranging from 60 to 100 feet. The proposed sale includes an area of 178,282 acres, which extends up to 10 miles seaward of State of Alaska coastal waters. Preliminary studies indicate that the sale area could yield up to 1,060,000 ounces of gold, although the most likely (mean) expected production is estimated at 530,000 ounces.

Industry responses to a Request for Comments and Nominations in March 1988 revealed that sufficient interest existed to justify proceeding with an offshore sale. For the past 3 years, West Gold has used the floating dredge *Bima* to conduct sea floor dredging on 21,750 acres of mineral claims in State of Alaska waters

landward of the proposed sale area. Mining of onshore beach placers near Nome has occurred intermittently since the first gold discoveries in 1899. Placer operations over the past 90 years have recovered over 5 million troy ounces of gold from the Seward Peninsula, with over 4.5 million troy ounces from the Nome mining district.

In the event that the sale is held in April 1990, detailed prospecting of the deposit could begin in the 1990 open-water season. It is estimated that production could begin as early as the fourth year following the sale. The timetable for the Norton lease sale would include the following key events: (1) final EIS published; (2) Secretarial Issue Document prepared, circulated, and implemented; (3) proposed leasing notice published; (4) proposed leasing notice comment period closes; (5) final leasing notice published; and (6) sale.

National Park Service

The NPS Alaska Regional Office, Minerals Management Division, is organized into two branches: Resource Assessment, and Mining and Minerals. Personnel review mining plans of operations and evaluate available natural, cultural, and physical engineering information on areas subject to mineral-related operations. They also conduct claim validity examinations, and develop and implement long-term reclamation programs. In addition to the Regional Office, the Denali and Wrangell-St. Elias National Parks and Preserves have professional minerals management staffs of environmental specialists and geologists or mining engineers who implement park-specific aspects of the minerals management program. Major accomplishments during 1988 were:

1. Processing and completeness reviews were made for five plans of operations for mining activities in four different park units; one plan was determined to be complete and received approval by the end of the calendar year.

2. Mineral examinations for claim validity determinations were made on 25 placer, and 8 lode, claims in two park units.

3. Field investigations were conducted for engineering and environmental analyses on proposed plans of operations and reclamation activities. Additionally, natural resource inventory and evaluations were performed on areas subject to mineral-related activity in two park units.

4. Photopaneling and surveying of 209 mining claims in four park units was completed.

5. Color infrared and black and white aerial photographs were taken of claim areas in Denali, Gates of the Arctic, and Wrangell-St. Elias National Parks and Preserves.

6. Cultural resource field crews conducted investigations of mining claims and access routes in three park units during 1988. A total of 14,000 acres was surveyed, and 61 cultural resource sites were recorded. Site types ranged from isolated historic equipment to large, complex mill sites.

7. The first phase of the Glen Creek Reclamation Project was accomplished along 2.3 miles of Glen Creek in Denali National Park and Preserve (fig. 21A, B). The purpose of this project is to restore a more natural appearance to the drainage and to assist in the revegetation of the site. Mine tailings were recontoured, available topsoil was redistributed, and 88 tons of debris and abandoned structures and equipment were removed from 27 acres of abandoned placer mining claims. Native plants from park sources will be planted over the reclaimed areas in 1989. Experimental revegetation studies will be conducted on these areas, providing current data for use in mining and reclamation plan reviews.

8. By adapting commercially available computer software, the NPS has developed three-dimensional models of the topography of the mining areas (including claims) in park units. This allows the automation of many site-specific engineering analyses for mining plans of operation and reclamation proposals. Examples include the generation of cross sections, cross-sectional areas, volumes, profiles, areal analyses, stream and roadway gradients, and stream sinuosity, all in both tabular and graphic form. An additional benefit is the automation of all required technical output of the analysis, including graphs, charts, and accurate map production at any scale.

Other.—On May 9, 1985, the Northern Alaska Environmental Center, et al., sued the Department of the Interior over noncompliance with NPS mining regulations in Alaska. The Federal district court issued a preliminary injunction on July 22, 1985, suspending approval of all existing operations in National Park System units in Alaska, and requiring NPS to prepare EIS's to assess the cumulative impact of mining on park resources in Wrangell-St. Elias National Park and Preserve and in Yukon-Charley Rivers National Preserve. For the other National Park System units in Alaska, mining plans could be submitted and approved by the NPS for operations if all regulatory requirements were met, including the completion of environmental assessments and a finding of no significant impact. The Government filed a motion for reconsideration, which was denied by the district court on December 4, 1985. In the court's memorandum and order, the preliminary injunction was amended to require a similar EIS for Denali National Park and Preserve. The court also retained the mechanism of approval for plans of operation within these three units prior to completion of the EIS's; plans could be approved upon petition to the court if no

cumulative impacts would occur, and if all other provision of law and regulation were met.

On December 9, 1987, in ruling on one issue of the original litigation, the district court decided that an on-site field inspection and validity examination are not essential preconditions for review and decision on a proposed plan of operations; the NPS has some latitude in determining the timing and need for validity examinations, but it may not approve operations if sufficient evidence exists to indicate invalidity.

In a final judgement and injunction on March 3, 1988, the district court: (1) restated the requirement to prepare the above-mentioned environmental impact statements; (2) enjoined the NPS from approving proposed plans of operation in the three parks until EIS's are completed; (3) voided mining permits and temporary approvals of plans of operation issued before July 24, 1985; (4) voided 36 CFR 9.10 (c) to the extent that it was contrary to existing law; (5) required that access to mining claims be permitted in accordance with 43 CFR 36 and by way of specific, stipulated routes; and (6) settled or dismissed the remaining issues in the case.

U.S. Forest Service

Greens Creek.—Greens Creek (figs. 12, 13), one of the largest mining developments in southeast Alaska, is

in Admiralty Island National Monument, administered by the Tongass National Forest. Development and production at the site is authorized by Section 503(f)(2)(A) of ANILCA. USFS completed an EIS for the project in January 1983. The Greens Creek Mining Company aggressively developed the mine, and production began in January 1989. Under the provisions of Section 503(e)(1) of ANILCA, USFS mineral examiners evaluated nine new mining claims to determine whether a valid mineral discovery had been made. The company was notified that the mining claims were valid in September of 1988, thus increasing the viable ore reserves of the mine.

In August 1987, the Sealaska Corporation proposed to exchange mineral lands owned by the Native corporation in the Cube Cove area of Admiralty Island National Monument for Federal mineral lands in the vicinity of the Greens Creek project. The USFS determined that the tracts to be exchanged were not of equal value and that the exchange proposal was not in the best public interest. The Sealaska Corporation appealed this determination; the appeal is presently under review.

Quartz Hill.—U.S. Borax and Chemical Corporation's Quartz Hill molybdenum deposit (fig. 12) is in Misty Fjords National Monument, on a 152,000-acre tract that is excluded from designation as wilderness. Section 503(f)(2)(A) of ANILCA provides for the eval-



A

Figure 21. Abandoned mining claim along Glen Creek in Denali National Park and Preserve. *A*, Pre-reclamation. Note mine tailings and abandoned equipment. *B*, After first phase of reclamation activities. Photographs by D. Schramm.

uation and development of the deposit. The USFS was the lead agency for the final mine development EIS (FEIS), which was released in October 1988. Two alternatives for marine tailings disposal were considered in the FEIS: disposal in the Boca de Quadra fiord, and disposal in the Wilson Arm/Smeaton Bay fiord. In his Record of Decision, the Regional Forester chose the Wilson Arm/Smeaton Bay fiord for the tailings disposal site, concluding that there was little difference between the two fiords in the environmental effects of tailings disposal. In Wilson Arm, however, the impact of mine development would be confined to a single drainage; greater community stability would ensue for Ketchikan and southeast Alaska; and mine shutdowns would be fewer and of shorter duration due to a reduction in mine operating costs. The Sierra Club Legal Defense Fund, on behalf of several environmental and commercial fishing organizations, appealed the Regional Forester's decision. The appeal is presently under review.

Other.—Abandoned gold mines in the Juneau Gold Belt (figs. 12, 22) are presenting opportunities for exploration and development. USFS evaluations are underway at the A-J mine in Juneau and also at the Kensington and Jualin properties in the Berners Bay area about 50 miles north of Juneau. These properties are a mix of patented and unpatented mining claims.

Since the summer of 1984, the USFS has been conducting mineral validity examinations on mining claims located in National Forest wilderness lands. These examinations are conducted for the purpose of establishing valid existing rights. If these rights are established, then the claimants can proceed with certain exploration and development activities. To date, five such examinations have been completed, four in the West Chichagof-Yakobi Wilderness and one in the Stikine-LeConte Wilderness.

The USBM prepared minerals inventory data for the revision of the Tongass Land Management Plan. A draft of the plan is scheduled for release in December 1989. Mineral resource data, including areas of mineral interest, claim staking and exploration activity, USGS publications, and field investigations, are being used to update the existing data base. This information will be used to determine areas of the Tongass where mineral exploration and development are most likely to occur and to assist in making the appropriate land allocation decisions and recommendations.

A similar inventory effort is being conducted by the USGS and USBM for planning in the Chugach National Forest. The USFS is currently preparing a series of management area analyses for selected geographic areas of the forest.



Figure 21. Continued.

Industrial Minerals

The use of building stone increased dramatically in Alaska in 1988; approximately 3.6 million tons worth \$24.6 million were produced, up 111 percent by value from 1987 levels (Green and Bundtzen, 1989). Infrastructure development at the Red Dog mine, at several mine sites in southeast Alaska, and at the Bradley Lake hydroelectric project were responsible for this increase.

Sand and gravel production rose 14 percent by value in 1988, resulting in 17.2 million tons with an estimated worth of \$48.8 million (Green and Bundtzen, 1989).

Glacial ice is being exported from Juneau to Japan by Dimond's Pure Alaskan Glacier Ice Co. (Fairbanks Daily News-Miner, June 23, 1988). The ice is collected from icebergs within Tracy Arm near Juneau, then broken, sacked, and shipped in freezer vans on container ships. The Alaska Department of Natural Resources has started to issue permits for this activity (Fairbanks Daily News-Miner, July 28, 1988).

ACTIVITY BY FEDERAL AGENCIES

U.S. Bureau of Mines

As part of the USBM Juneau mining district study, sand, gravel, and quarry rock resources were identified and classified in the city and borough of Juneau (R and M Engineers, 1988a, 1988b). The study indicated that there are abundant resources of material in the borough, but at the present rate of depletion and assuming an average population growth rate of ± 2 percent per annum, the most economical supplies of material close to Juneau will be severely depleted by the year 2000. A report summarizing the industrial minerals of the district will be published in 1989.

Bureau of Land Management

The disposal of salable mineral materials, that is, sand and gravel, continued to be a minor activity for BLM in Alaska. In 1988, the BLM issued three Free Use



Figure 22. Alaska-Juneau gold mine in southeast Alaska, closed since 1942, may be reopened in 1990's. Photograph by R. Griffin.

Permits and made four mineral material sales. Total production from these actions was 117,143 cubic yards of mineral material.

Fish and Wildlife Service

The Fish and Wildlife Service continued permitting and monitoring small ongoing sand and gravel operations in support of local transportation and industry in various areas in the State.

U.S. Forest Service

Annually, the USFS permits the removal of many thousands of tons of sand, gravel, and stone. Nearly 2.8 million tons of this material, in the form of quarried stone, is used for the construction of timber sale roads. Lesser amounts are used by State and local governments for the construction and maintenance of breakwaters, airports, and roads. For calendar year 1988, the USFS sold 105,876 tons of quarried stone for \$36,357, and 85,036 tons of sand and gravel for \$73,202.

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APPENDIX 1.—ALASKA MINERAL REPORTS RELEASED DURING 1988 AND EARLY 1989

The following selected references contain pertinent information about energy resources and other minerals in Alaska published during 1988 or early 1989. This is only a selection of germane reports from the publications of any agency. Reports by Federal or State agencies can generally be obtained from the agency offices in Alaska,

or are available in the Alaska Resources Library, Federal Building, 222 West Seventh Avenue, Anchorage, AK 99513-7599.

The USGS publishes a monthly listing of its own releases, "New Publications of the U.S. Geological Survey," available free on request from the U.S. Geological Survey, 582 National Center, Reston, VA 22092. These listings are compiled in an annual publication, "Publications of the U.S. Geological Survey, 198_," also free. Information about the prices and sources of listed reports is given in these two publications and is also available from the USGS Earth Science Information Centers.

The USBM's central distribution office is the Branch of Production and Distribution, 4800 Forbes Ave., Pittsburgh, PA 15213. Many USBM reports are available from the U.S. Government Printing Office in Washington, D.C., or from the National Technical Information Service in Springfield, Va. USBM reports listed here are available from the USBM library in Juneau; for further information, contact the Chief, Alaska Field Operations Center, 201 East Ninth Avenue, Anchorage, AK 99501.

Publications of the MMS may also be purchased from the National Technical Information Service (NTIS), Springfield, VA 22161. NTIS publishes listings of all available MMS publications. A limited number of complimentary reports are available at the MMS, Library/Public Information Room, 949 East 36th Avenue, Anchorage, AK 99508-4302; telephone inquiries at (907) 261-4439.

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APPENDIX 2.—ROLES OF FEDERAL AGENCIES IN MINERAL PROGRAMS

Department of the Interior

U.S. GEOLOGICAL SURVEY

The mission of the USGS is to develop and interpret the geologic, topographic, and hydrologic data necessary for prudent management of the Nation's minerals, land, and water. The USGS carries out its mission through research that produces geographic, cartographic, and remotely sensed information; geologic, geochemical, and geophysical maps and studies; energy, mineral, and water resource assessments; geohazards research, including toxic waste studies; and participation in multidisciplinary projects, maintaining data bases, and publishing reports and maps.

In Alaska, the USGS is active in assessing minerals, including metalliferous and energy resources. Field and laboratory researchers also gather information about domestic petroleum, coal, uranium, and geothermal resources. At the request of land-managing agencies, the

USGS provides mineral resource assessments for land planning, including wilderness studies. Within Alaska, the USGS maintains offices for its Geologic, National Mapping, and Water Resources Divisions. Within the Geologic Division, the Branch of Alaskan Geology is the primary USGS office studying mineral resources in Alaska; the Branch is headquartered in Anchorage, with a field office in Fairbanks. Other Alaskan branch geologists are stationed in Menlo Park, Calif. During the summer field season, many USGS scientists from other branches within the Geologic Division conduct mineral-related research in Alaska.

U.S. BUREAU OF MINES

The mission of the USBM is to help assure that the Nation's mineral supplies are adequate to maintain national security, economic growth, and employment. The USBM's Alaska Technology Transfer Office (ATTO), located in Anchorage, is responsible for working with other Federal agencies, the State, universities, and industry on technology issues and needs; conducting technology transfer briefings; and facilitating work with USBM research centers throughout the United States. The USBM's Alaska Field Operations Center (AFOC) has headquarters in Anchorage and offices in Juneau and Fairbanks. The AFOC carries out its mission through five programs:

1. *Minerals Availability Program*.—This program is part of a worldwide USBM program responsible for developing the Minerals Availability System (MAS) computer data base and the Mineral Industry Location System (MILS), a subset of MAS. MILS contains basic information about the identification and location of known mineral deposits. MAS is more extensive, containing information about reserve estimates, mineral extraction and beneficiation methodologies, environmental constraints to mining, and cost analyses for selected major mineral deposits. A computer and communication system allow the information to be stored, manipulated, and retrieved as computer-plotted map overlays and printouts of MAS/MILS data, enabling rapid and uniform development of cost data for MAS mineral-deposit evaluations. MAS and MILS mineral-deposit data are crossindexed to several other minerals-information data bases.

2. *Policy Analysis*.—This program emphasizes analyses of newly developed and existing mineral data to interpret their significance relative to local and national mineral needs. Assessment of technical, institutional, political, social, and economic factors that affect the supply of, and demand for, domestic and international minerals is the key to identifying mineral issues.

3. *State mineral activities.*—This program covers minerals-related activities in Alaska and assists in developing and releasing nonfuel-mineral-industry information. The section of State Mineral Activities in Alaska provides USBM direct communication with the Alaska Division of Geological and Geophysical Surveys, the Alaska Division of Mining, other minerals-oriented government agencies, industry, private firms, and individuals. The USBM's State Mineral Officer collects, analyzes, and reports mineral data and develops information regarding activities and trends in the mining industry. This program produces the annual USBM Mineral Yearbook chapters and Mineral Industry Surveys.

4. *Mineral land assessment.*—This is the USBM's major Alaskan program, conducted in cooperation with other Federal and State agencies. Mineral assessments are both area and commodity oriented. In support of the Secretary of the Interior's mandate to assess the mineral potential of public lands in Alaska, the AFOC initiated a program in 1985 to evaluate mineral resources of the mining districts in the State. The program seeks to identify the type, amount, and distribution of mineral deposits; related studies will determine economic feasibility. Legislative effects on mineral development will also be addressed. The USBM is completing the study of the Juneau mining district and is continuing the study of the Valdez Creek mining district.

A statewide program provides an inventory and specific technical evaluations of Alaska's critical and strategic mineral deposits on Federal lands that are closed to mineral entry, and on land open to entry, but not of current interest to industry. In addition to locating, mapping, and estimating the size and grade of deposits, the USBM obtains bulk samples for metallurgic research to determine recovery and extraction methods and costs. These studies are undertaken in cooperation with the USBM research centers in Albany, Oregon, and Salt Lake City, Utah. These investigations provide reserve estimates of marginal and submarginal deposits in Alaska and its coastal waters.

5. *Minerals Research.*—The USBM is attempting to provide solutions to mining, mineral recovery, and environmental problems in Alaska through a number of research efforts and technology transfer. Several research projects are currently being conducted in Alaska USBM research centers or at universities sponsored by the USBM through the Mineral Institute Program. USBM and university research centers cooperate with AFOC to solve mineral utilization problems.

BUREAU OF LAND MANAGEMENT

The BLM is responsible for multiple-use management of both the surface and subsurface of 23 million

acres of the National Petroleum Reserve in Alaska, plus an additional 76 million acres elsewhere in Alaska (see fig. 1). The second figure changes from day to day due to the ongoing program of land conveyance to State and Native organizations. In addition, the BLM administers mineral resources on approximately 100 million acres of other Federal lands, including acquired lands and private lands where the Federal Government has retained the mineral rights.

In December 1984, the BLM revised its policy statement on mineral resources to reflect its continuing commitment to encourage private enterprise to develop domestic minerals in a manner consistent with the need for these resources. Land-use planning decisions will reflect energy and mineral values addressed by mineral-resource assessments. Public lands are generally to remain open to environmentally sound mineral exploration and development.

FISH AND WILDLIFE SERVICE

The FWS provides Federal leadership to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of people. In Alaska, the FWS seeks to accomplish this mission through programs that implement provisions of the Endangered Species Act, Marine Mammal Protection Act, Fish and Wildlife Coordination Act, Rivers and Harbors Act, National Wildlife Refuge System Administration Act, Alaska National Interest Lands Conservation Act (ANILCA), various migratory-bird laws and treaties, and other statutes.

Under ANILCA, 16 refuges in Alaska were created or enlarged to conserve fish and wildlife populations and their habitats, as well as other values. Except for valid rights existing at the time of establishment, these refuges are closed to entry and location under mining laws. The refuges are open to entry under leasing laws; however, they are closed to mining of coal by the Federal Coal Leasing Amendments Act of 1975, and closed to geothermal resource leasing by the Geothermal Steam Act of 1970. Although many traditional activities have been deemed appropriate for these refuges, other uses, including oil and gas leasing, will be permitted only when such activities are compatible with the purposes for which the refuges were established.

MINERALS MANAGEMENT SERVICE

Created in 1982, the MMS has a twofold mission: (1) to collect and disburse revenues generated from mineral leases on Federal and Indian lands, and (2) to manage mineral resources on the Outer Continental Shelf (OCS). Revenues from the OCS are primarily derived from competitive leasing activities, as no mineral

development or production is presently occurring on the OCS. The MMS also has the authority to lease the OCS for ocean mining of hard minerals. The responsibility of MMS for onshore Alaskan minerals is limited to the collection of royalties, bonuses, and rents from Federal and certain Native lands.

In Alaska, the MMS is active in assessing the oil and gas potential of offshore basins through the analysis of geophysical data and relevant geologic information. This work is integrated into the National Resource Assessment and is a basis for evaluations of the potential monetary worth of individual OCS lease blocks, appraisals of the resource potential of entire basins, and formulation of geologic models for basin development. The MMS also conducts specialized studies of Deep Stratigraphic Test (DST) wells and exploratory wells drilled on OCS lands. All of this work is carried out at the MMS Regional Office maintained in Anchorage, Alaska. The results of these studies are published through the MMS OCS Report series or in appropriate outside journals. The MMS also sponsors resource-oriented geologic studies through the Program for Studies Related to Continental Margins, which funds research by State agencies and affiliated academic institutions.

NATIONAL PARK SERVICE

In 1916 Congress established the NPS and stated that the fundamental purpose of the Nation's parks, monuments, and other reservations was "...to conserve the scenery and natural and historical objects and the wildlife therein and to provide for enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations" (39 Stat. 535). NPS management policies are based on the concept of conservation and preservation while providing for appropriate enjoyment of natural and cultural resources within the park system. Congress enacted the "Mining in the Parks Act" in 1976, declaring that a continued application of the mining laws of the United States to park units conflicts with the purposes for which they were established and all mining operations in park units "...should be conducted so as to prevent or minimize damage to the environment and the other resource values" (90 Stat. 1342). The NPS manages mining activities through regulations found at Title 36, Part 9, Subpart A, of the Code of Federal Regulations. These regulations apply to mining-related activities on patented or valid unpatented claims located under the Mining Law of 1872. Proposed plans of operations for these claims must conform to the regulations.

Under the broad authorities granted the Secretary of the Interior by Congress (39 Stat. 535) for regulation of activities to protect park resources, NPS has promul-

gated regulations at Title 36, part 9, Subpart B, of the Code of Federal Regulations which control all activities in any unit of the National Park System in the exercise of rights to nonfederally owned oil and gas. A regulation (36 CFR 13.15 (d) (2)) which rendered 36 CFR 9B inapplicable to Alaska has been deleted in the action which established Interior's new access regulations for Conservation System Units. Thus, the Service's non-Federal oil and gas regulations now apply in National Park System units in Alaska. Plans of operation are now required of operators who, within park units, must access their nonfederally owned oil and gas on, across, or through federally owned or controlled lands or waters.

Department of Agriculture

U.S. FOREST SERVICE

The mission of the USFS is to provide a continuing flow of natural resource goods, including mineral and energy resources, to help meet national needs and to contribute to meeting such needs worldwide. The responsibility of the USFS is to encourage and support environmentally sound mineral enterprises on Federal lands under its administration. In managing the use of these resources, the USFS's objective is to minimize unnecessary adverse environmental impacts to surface and cultural features and values which might result from lawful exploration and development operations. This objective is accomplished through the application of reasonable conditions that do not interfere with well-planned mineral operations. The USFS also provides research information and technology to help with post-mining reclamation. In implementing this policy, the Chief of the Forest Service has directed that:

1. A key objective of the minerals program is to encourage and facilitate the orderly exploration, development, and production of mineral resources.
2. Minerals, like range, recreation, timber, water, wildlife, and wilderness, are one of the multiple uses the USFS manages.
3. USFS managers must develop a good understanding of the mineral industry, its practices, and the mineral laws and regulations.
4. Managers must develop a strong working relationship with the mineral industry.
5. Visibility and interaction with the mineral industry must be increased by attendance and participation of line officers and appropriate staff at industry and professional association activities and meetings.
6. Directories, organization charts, and receptionists direct the mineral industry to personnel who have minerals administration responsibilities.

DEPARTMENT OF ENERGY

The Federal Government's mission is to reduce the Nation's vulnerability to disruptions of energy supplies and to mitigate any adverse impacts on the Nation, should a shortage occur. With regard to Alaska, the energy sources currently being addressed by the DOE are fossil fuels (petroleum and coal) and geothermal.

The strategy for responding to petroleum-supply interruptions is to rely on the free market, supplemented as necessary and appropriate with other measures, such as the Strategic Petroleum Reserve. The DOE's Fossil Energy Research and Development Programs are aimed at careful consideration of the alternatives available and the relative chances for success in fostering an adequate supply of energy at a reasonable cost through long-term, high-risk research and development. Alternatives for increasing domestic petroleum supplies include (1) the DOE's Unconventional Gas Recovery Program, which

emphasizes the development of advanced technologies for the extraction of natural gas from resources that are classified as unconventional because of unique geologic settings and production mechanisms which are not now well understood; and (2) DOE programs for developing tertiary oil recovery, tar sand, and heavy-oil deposits of the United States.

The purpose of the DOE's Geothermal Energy Program is to develop the technology needed by industry for the use of geothermal resources. DOE research is aimed toward improving methods used to locate, extract, and convert geothermal heat to usable forms of energy. Through DOE funding in Alaska, Federal and State agencies have researched and published several studies of specific geothermal systems.

A further purpose of DOE programs is to generate data essential to the private sector's decision making process, leading to the development of commercial projects.