

1995 Annual Report on Alaska's Mineral Resources

U.S. GEOLOGICAL SURVEY CIRCULAR 1127



Prepared in cooperation with the Bureau of Land Management, the Minerals Management Service, the National Park Service, the U.S. Bureau of Mines, the U.S. Fish and Wildlife Service, the 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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**1995 Annual Report on
Alaska's Mineral Resources**



Frontispiece. Retort site at Red Devil mercury mine in Sleetmute quadrangle of southwestern Alaska. Operating intermittently from 1933 to 1971, the mine produced over 36,000 flasks of mercury. Here and at other sites in the region, the USGS, USBM, and State of Alaska are investigating the potential hazards of environmental mercury from both natural occurrences and manmade contamination. Photograph by J. Gray, USGS.

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JILL L. SCHNEIDER, *Editor*

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A summary of mineral resource activities in Alaska during 1994

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U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, *Secretary*

U.S. GEOLOGICAL SURVEY

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To convert from	to	divide by
cubic meter	cubic foot (gas)	0.02831685
cubic meter	cubic yard	0.7645549
degree Celsius	degree Fahrenheit	$t^{\circ}\text{F} = 32 + (1.8 \times t^{\circ}\text{C})$
gram	troy ounce	31.10348
kilocalories per kilogram	Btu per pound	² 0.556
liter	gallon	3.785
meter	foot	0.3048
kilogram	pound	0.4535924
kilogram	troy ounce	0.03110348
kilometer	mile	1.609347
metric ton	ton (short)	0.9071847
square kilometer	acre	0.004046873
square kilometer	square mile	2.589998

¹ American Society for Testing and Materials (1980)

² Handbook of Chemistry and Physics (Weast, 1974, p. F-284)

ACRONYMS AND ABBREVIATIONS

3-D	three-dimensional
ACE	U.S. Army Corps of Engineers
ADEC	Alaska Department of Environmental Conservation
ADGGS	Alaska Division of Geological and Geophysical Surveys
ADNR	Alaska Department of Natural Resources
AESP	Alaska Environmental Studies Program
AIDEA	Alaska Industrial Development and Export Authority
A-J	Alaska-Juneau
AMHL	Alaska Mental Health Lands
AMRAP	Alaska Mineral Resource Assessment Program
ANILCA	Alaska National Interest Lands Conservation Act
ARCO-Ak	ARCO Alaska
ARDF	Alaskan Resource Data File
ASRC	Arctic Slope Regional Corporation
bbl/d	barrels per day (of oil)
BLM	Bureau of Land Management
BPX-Ak	BP Exploration-Alaska
CFR	Code of Federal Regulations
CIRI	Cook Inlet Region Incorporated
COST	continental offshore stratigraphic test
DOE	U.S. Department of Energy
DOI	U.S. Department of the Interior
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FS	U.S. Department of Agriculture, Forest Service
FWS	U.S. Fish and Wildlife Service
GIS	Geographic Information System
GVEA	Golden Valley Electric Association
I&E	Inspection and Enforcement
JPO	Joint Pipeline Office
LNG	liquefied natural gas
LOA	Letter of Authorization
MAS	Minerals Availability System
MILS	Minerals Industry Location System
MMS	Minerals Management Service
MRDS	Mineral Resources Data System
NP&P	National Park and Preserve
NPRA	National Petroleum Reserve—Alaska
NPS	National Park Service
NWR	National Wildlife Refuge
OCS	Outer Continental Shelf
PGM	platinum-group metal
SAMRAP	State of Alaska Mineral Resource Assessment project
TACT	Trans-Alaska Crustal Transect
TAPS	Trans-Alaska Pipeline System
USBM	U.S. Bureau of Mines
USGS	U.S. Geological Survey

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1995 Annual Report on Alaska's Mineral Resources

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SUMMARY

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

This circular is the fourteenth in the series of annual mineral reports mandated by the ANILCA. The report provides information about current Alaskan mineral projects and events during 1994; the emphasis is on Federal activity. The report addresses both onshore and off-shore areas of Alaska.

The U.S. Geological Survey (USGS), U.S. Bureau of Mines (USBM), and Minerals Management Service (MMS) are the principal Federal agencies that publish information about energy and mineral resources in Alaska. Their reports and data form the basis for decisions by other Federal agencies regarding land use, access, environmental impacts, and mining claim evaluation. The time required for sample analysis, data synthesis, and publication is lengthy; as a result, scientific reports are generally issued a year or more after initial sample and data collection. Other sources of information for this report include additional Federal and State publications, trade and professional journals, 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

Alaskan oil production in 1994 totaled 594.9 million barrels of oil and natural gas liquids, down 1.6 percent from 1993. This decrease is consistent with the general

decline in Alaskan oil activity from a peak production of 738 million barrels in 1988. Alaska provided 25 percent of total United States oil production in 1994. Dry natural gas production in 1994 was 5.1 billion cubic meters, 5.6 percent below 1993. North Slope oil prices during the year averaged \$14.77 per barrel (West Coast), a 7.5-percent decline from the previous year; prices ranged to a high of \$16.70 in September, up from a low of \$10.38 in January. The 10-billionth barrel of oil was transported by the Trans-Alaska Pipeline System (TAPS) in February 1994.

The Alaska Oil and Gas Conservation Commission issued 161 drilling permits in 1994, a 23-percent decrease from 208 permits in 1993. Seven exploratory oil wells were active, and two oil discoveries in northern Alaska and one confirmation in Cook Inlet were announced. Geophysical permits were issued for 6,000 line-kilometers of seismic exploration in the Beaufort Shelf area, Gulf of Alaska, and Lower Cook Inlet. There were 1,696 producing oil wells, 105 gas wells, and 673 injection wells. The Niakuk pool in the Prudhoe Bay oil field was brought into production, and blowdown began at the Swanson River oil field; the Sterling gas field was reactivated. The one State lease sale held during 1994 received high bonus bids totaling \$1.65 million for 552 square kilometers in the Cook Inlet region.

The State of Alaska received \$5.2 million in minerals revenues collected in 1994 by the MMS from Federal public lands located within its borders. The MMS did not hold any Federal lease sales in 1994, but lease sales are proposed for 1996 and 1997 in the Beaufort Sea, Lower Cook Inlet, and Gulf of Alaska/Yakutat planning areas of the Alaskan Outer Continental Shelf (OCS). At year's end, the oil industry held 95 leases in the Beaufort Sea, Chukchi Sea, Navarin Basin, and North Aleutian Basin OCS planning areas. No exploratory wells were drilled on OCS lands in 1994. Geophysical data were collected by industry along 267 line-kilometers of seismic surveys in the Beaufort Shelf area and along 45,000 kilometers of airborne magnetic surveys over the Gulf of Alaska and Lower Cook Inlet. The MMS Alaska Environmental Studies Strategic Plan for 1996-1997 was published. The National Park Service (NPS) provided comments to the MMS regarding a proposed oil and gas lease sale in the Chukchi Sea.

The USGS completed its assessment of undiscovered oil and gas resources on Alaska's onshore and State

offshore lands in late 1994; the results will be incorporated into a national assessment. The USGS is also conducting several research projects concerning onshore oil and gas resources in Alaska. On the North Slope, a second transect of the Brooks Range foothills was in progress, and scientists were investigating the Sagavanirktok Formation, a current industry target for oil, gas, and coal. The seismic signature of gas hydrates was analyzed and used to assess gas-hydrate accumulations on the Alaskan continental shelf. A study was conducted to quantify the amount of gas released into the atmosphere from decomposing hydrates. Near Fort Yukon in interior Alaska, a 390-meter-deep borehole was drilled for the Global Change and Climate History Program; analysis of the sediment cores will provide information on the oil and gas potential of the Yukon Flats Basin. A synthesis volume on Alaskan geology included descriptions of Alaska's petroleum systems and comprehensive summaries of Alaskan sedimentary basins.

The Division of Minerals of the Bureau of Land Management (BLM) completed oil and gas appraisals for land exchanges in southwestern Alaska and on the Kenai Peninsula. The Division of Minerals also provided geologic and economic evaluations of 15 oil and gas properties for the Internal Revenue Service to determine their net present worth. BLM research on the North Slope has defined a new hydrocarbon exploration target; other possible targets are being analyzed.

The BLM continues its Alaska Inspection and Enforcement program for leasehold oil and gas operations on producing Federal leases in the Cook Inlet Basin. The Division of Minerals processed applications for both drilling permits on the Kenai National Wildlife Refuge (Kenai NWR) and seismic exploration permits for the Kenai NWR and the National Petroleum Reserve—Alaska (NPR).

The Joint Pipeline Office (JPO), which monitors the Trans-Alaska Pipeline System, is a cooperative effort between the BLM and 10 other Federal and State agencies. Applications are being reviewed for a liquefied-natural-gas facility near Valdez and a pipeline connecting the Badami oil discovery near Mikkelsen Bay to TAPS Pump Station 1. The JPO recently received an award for reinventing government.

Mineral-related activities of the U.S. Fish and Wildlife Service (FWS) during 1994 included environmental monitoring, permit review and comment, and contaminant analysis both on and off refuges. On refuges, the FWS maintained oversight for remedial cleanup programs in the Beaver Creek and Swanson River oil fields of the Kenai NWR and issued six special-use permits for exploration and development activities on six other refuges; off refuges, the FWS reviewed 29 permit applications for oil and gas activities. Reviews and comments were provided for three Federal OCS and five proposed State oil and gas lease sales. Contaminant research on

the North Slope will provide baseline information to evaluate the impact of local and long-range airborne pollution on Arctic ecosystems. Two FWS rulings concerning the incidental take of marine mammals during specified activities are currently in effect in Alaska.

The FWS also pursued its continuing wildlife and related studies in the ANILCA 1002 area, a 6,070-square-kilometer strip on the coastal plain of the Arctic NWR; five applications were filed with the State of Alaska for water rights on the Tamayariak River. The knowledge and information gained from these studies will be used to avoid, minimize, or rectify adverse impacts from surface developments, should they occur in the 1002 area.

COAL AND PEAT

Alaskan coal production dropped 4.8 percent in 1994 to 1.37 million metric tons, valued at \$36.75 million; peat production rose 22 percent, totaling 67,204 cubic meters worth \$439,500. Coal and peat combined represented 7 percent of total mining production value in 1994. The Healy Clean Coal Project, designed to demonstrate a new, clean-burning coal technology, is proceeding after several legal challenges were settled in April and June 1994; the construction contract for the plant was awarded in December 1994. Usibelli Coal Mine Incorporated is pursuing a test of a coal-slurry fuel that has been developed to replace heavy fuel oil in industrial boilers. The Arctic Slope Regional Corporation began development work on its Kuchiak Research underground test mine. The Alaska Mental Health Lards issue was settled in December 1994, allowing the possible development of coal resources on trust lands in south-central Alaska. Idemitsu Alaska suspended development of its Wishbone Hill coal project in the Matanuska Valley and is seeking a buyer for its claims.

USGS geologists measured 107 stratigraphic sections in the coal-bearing Tyonek, Sterling, and Beluga Formations of the Kenai Group on the western Kenai Peninsula. Rock core from 25 bore holes in the Beluga coal field were described. The USGS and State of Alaska drilled a 379-meter-deep coal-bed-methane test well near Wasilla in mid-spring 1994; preliminary results from 18 coal seams show coal-bed methane values between 1.25 and 7.66 cubic centimeters of methane per gram of coal. Analysis of core from the Global Change and Climate History Program's 390-meter-deep test hole near Fort Yukon will be used to assess the coal potential of the Yukon Flats Basin.

The Alaska Division of Geological and Geophysical Surveys (ADGGS) and the USGS evaluated the coal resources of the Colville Mining District for the USBM; coals of the Nanushuk Group were estimated at 300 billion metric tons, greater than 75 percent of which is

high-rank bituminous quality occurring between 0 and 150 meters from the surface. The USBM is conducting research at the Kuchiak Research coal mine in northwestern Alaska on mining methods, treatment of ore and mine wastes, protection of water resources, and post-mining reclamation in the arctic environment.

The U.S. Department of Energy signed a Record of Decision in March 1994 and will provide \$117.3 million in Federal funding for construction and operation of the Healy Clean Coal Project.

URANIUM

No private companies performed uranium exploration or development work in Alaska. Uranium-thorium prospects at Bokan Mountain in southeastern Alaska also hold potential for niobium and rare-earth-element production.

The USGS completed studies on the uranium resources of Cook Inlet. The USGS ended its uranium/radon research program on September 30, 1994, and future uranium research will be carried out under the priorities of a new energy program.

GEOTHERMAL RESOURCES

The greatest potential for geothermal energy production in Alaska exists at the Makushin Valley and Geyser Bight geothermal areas in the Aleutian Islands. State leaseholders near Mount Spurr, west of Anchorage, have proposed a geothermally heated greenhouse operation. The ADGGS published an inventory of potential geothermal resources in the Aleutian Arc. No Federal geothermal research was funded in 1994.

NONFUEL-MINERAL RESOURCES

METALLIC MINERALS

The value of Alaska's metallic mineral production rose 18 percent in 1994 to \$404 million, due mainly to increased production at the Red Dog Mine in northwestern Alaska; metallic minerals represented 79 percent of total mining production value. The four main metallic minerals produced in Alaska were zinc (\$296 million), gold (\$72 million), lead (\$26 million), and silver (\$10 million). Exploration and development expenditures, totaling \$76 million in 1994, were up 31 percent from 1993. The mining industry employed 3,152 people in Alaska in 1994. There were 12,280 Federal and 25,050 State registered mining claims in Alaska at year's end.

Alaska's mineral industry remains focused on lode gold deposits. The Fort Knox Mine received both Fed-

eral and State final permit approvals in 1994. Golden Summit, True North, and Ryan Lode are three additional Fairbanks-area gold properties under development. Other lode deposits include Illinois Creek and Nixon Fork in western Alaska, Johnson River in south-central Alaska, and the Kensington, Jualin, and Alaska-Juneau (A-J) mines in southeastern Alaska. Both the Kensington and A-J mines have received large-mine permits from the Juneau Planning Commission but need additional State and Federal permits before production can begin. The Valdez Creek Mine, North America's largest gold placer operation, will close in 1995 when known reserves are exhausted.

The USGS continues its geologic mapping and assessment of undiscovered mineral resources in Alaska under the Alaska Mineral Resource Assessment Program (AMRAP). In 1994, compilation of the Alaskan Resource Data File continued, and a statewide terrane map was published. Several papers of regional scope were published on the mineral deposits of southeastern Alaska. AMRAP field studies and mineral assessments are in progress for twenty-three 1:250,000-scale quadrangles. In 1994, mineral-resource maps of the Anchorage quadrangle; geologic maps of the Iditarod and Mt. Katmai quadrangles; and geochemical studies of the Medfra, Mt. Katmai, Craig, and Dixon Entrance quadrangles were published. Specialized AMRAP studies were conducted at a detailed scale on 24 projects around the State. The USGS released additional reports on geologic mapping, metallic mineral resource studies, and the environmental hazards associated with certain mineral deposits. A synthesis volume on the geology of Alaska was released.

USGS researchers also performed site-specific studies on gold and other precious-metal deposits in the Fortymile Mining District in interior Alaska and in the Kenai and Chugach Mountains of south-central Alaska. Studies of mafic and ultramafic rocks include research on their associated strategic and critical mineral deposits of platinum, chromium, nickel, and cobalt. Mercury, as both a naturally occurring and a manmade environmental hazard, is being investigated in southwestern Alaska. Cooperative USGS programs with Russian scientific agencies, the State of Alaska, and the Canadian Geological Survey continued research on the metallogensis, tectonic history, and ophiolites of the Russian Far East, mainland Alaska, and western Canada.

Fieldwork and data interpretation continued for the USGS Trans-Alaska Crustal Transect, a multidisciplinary study of the Earth's crust along a corridor from the Gulf of Alaska to the Arctic Ocean. The USGS also worked with the USBM in two collaborative studies requested by other Federal agencies: an evaluation of the mineral potential of the Colville Mining District in southern NPRA for the BLM, and an estimation of the mineral endowment of an area in the Chugach National Forest

for the U.S. Department of Agriculture, Forest Service (FS).

In 1994, the USBM studied submarine tailings disposal, compiled commodity-specific data sets that will allow the rapid analysis of mineral-related issues and policies, and developed a spatial data set for mineral terranes and known mineral deposits in Alaska. Minerals information from the Colville Mining District and the Fortymile River/Black River BLM planning units was added to the Minerals Availability System data base. Ongoing USBM studies include the impacts of the permitting process on mine development and of ecosystem-management concepts on mining and mineral development. The USBM completed its studies in the Colville and Ketchikan mining districts and its investigation of titanium resources along beaches of the eastern Gulf of Alaska. Mineral resources were inventoried in two BLM planning units and two FS ranger districts, and hazards associated with inactive and abandoned mine sites were evaluated for the FS, BLM, and NPS. Additional research projects are evaluating arctic mining methods and the mitigation of mining's environmental impacts in northern climates.

Only 538 new Federal mining claims were accepted for recording by the BLM during fiscal 1994; 5,519 claims were concurrently closed. Work began on a geologic road guide for the Taylor Highway and Fortymile Wild and Scenic River area.

The NPS reviewed seven, and approved two, Plans of Operations for mining and mining access in four National Park units; 39 mineral validity examinations were also conducted. Transfer to the NPS of four mining properties in Denali National Park and Preserve (Denali NP&P) is being negotiated. Personnel in the Cultural Resources Mining Inventory and Monitoring Program documented 10 new historic mining sites in 4 parks. Cartographic surveys were conducted on 31 claims in 3 parks. Under the Mineral Land Restoration program, 29 former mining sites in 5 parks were cleaned, and much of the waste was delivered to metal and waste-fuel recycling companies. The placer reclamation project in the Kantishna area of Denali NP&P continued to restore stream channels and revegetate flood plains. The NPS conducted one survey and three assessments of hazardous waste sites in two park units. Permits for four AMRAP projects in parks were issued to the USGS and USBM.

In 1994, 127 mining claims were active in 6 national wildlife refuges in Alaska. The FWS reviewed 67 U.S. Army Corps of Engineers permit applications for mining activities off refuges.

The FS received 41 Notices of Intent and 74 Plans of Operations for mineral activities in Alaska's national forests in 1994. Three patent examination reports and a validity report for claims in the Tongass National Forest were in various stages of preparation, and inventories of physical and environmental hazards on abandoned and

inactive mining claims were completed on the Chugach National Forest by FS and USBM personnel.

INDUSTRIAL MINERALS

Production of sand, gravel, and building stone was valued at \$67.6 million; 12.6 million metric tons of sand and gravel and 3.1 million metric tons of building stone were quarried. Jade and soapstone production was valued at \$20,000. Industrial minerals represented 13 percent of total mining production value in 1994.

The USBM completed work on the industrial mineral resources of the Colville and Ketchikan mining districts. Bedded barite and sedimentary phosphate deposits have been identified in the Colville Mining District, and the Ketchikan Mining District contains significant limestone resources.

In fiscal 1994, the BLM conducted 38 sand and gravel sales and issued 57 Free-Use Permits. The FWS made no gravel sales on Alaska refuges, but the Koyukuk and Nowitna NWR's jointly issued a special-use permit to the BLM to study the Batza Tena obsidian source, an archaeological site dating back at least 12,000 years. The FS sold 893,000 cubic meters of sand, gravel, and quarried stone for use in the construction of timber-sale roads, breakwaters, and airports.

INTRODUCTION

Section 1011 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980, as amended, requires that "On or before October 1, 1982, and annually thereafter, the President shall transmit to the Congress all pertinent public information relating to minerals in Alaska gathered by the United States Geological Surveys, United States Bureau of Mines, and any other Federal agency." The U.S. Geological Survey (USGS) subsequently was delegated as the lead agency in responding to this requirement. This circular is the fourteenth in its series, synthesizing information made public in 1994. The report focuses on energy resources (oil, gas, coal, peat, uranium, and geothermal) and nonfuel-mineral resources (metallic and industrial minerals).

The USGS and the U.S. Bureau of Mines (USBM) are the principal Federal agencies that generate information about onshore mineral resources in Alaska; the Minerals Management Service (MMS) is the prime agency reporting on resource activities in Alaska's coastal waters. Their data, analyses, and reports are used by other agencies for resolving questions 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; oral

presentations by representatives of Federal and State agencies and industry at symposia, conferences, and other public forums; conference proceedings volumes; and press releases. Data from the State's annual summaries on Alaska's oil and mineral industries are cited in parts of this circular. Papers cited in the text and other recently published reports pertinent to Alaska's mineral resources are listed in the "Selected References" section of this circular.

The next section describes 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 the appendix. The distribution of lands under Federal management is shown in figure 1.

MINERAL PROGRAMS

U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

Section 1010 of ANILCA establishes the Alaska Mineral Resource Assessment Program (AMRAP) and directs the Secretary of the Interior to assess "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." To assist in meeting the mandate of AMRAP, the USGS has undertaken systematic investigation of the State's mineral resources through four progressively more detailed levels of study. These studies are funded under the Mineral Resource Surveys program. Geologic studies at level I cover the entire State; level II studies are of regional scope. Studies at level III draw on many geologic disciplines to produce resource assessments at scales of 1:250,000 and 1:125,000. Level IV research focuses on detailed studies of specific mining districts, mineral deposits, or topics relating to the genesis of mineral deposits. In 1994, level III studies were under way in 23 quadrangles, and 24 level IV studies were in progress.

USGS AMRAP publications are a key source of information about Alaska's geology and mineral resources. AMRAP studies are essential for determining the distribution and potential of national mineral and energy endowments, formulating public policy affecting resource and land management, improving resource-assessment technology, and minimizing potential impacts from development. These studies, which develop the concepts, models, and techniques needed to identify new mineral deposits, are also vital to the minerals-exploration industry.

In 1994, the USGS performed its resource-assessment work in Alaska through two programs: (1) the Mineral Resource Surveys Program, which includes studies of undiscovered mineral resources on public lands, mineral-environmental investigations, and studies of mineral

deposit genesis and assessment techniques; and (2) the Oil and Gas Investigations Program, which focuses on studies of petroleum-forming processes and potential source regions in order to produce reliable estimates of undiscovered petroleum resources (fig. 2). In addition, the Trans-Alaska Crustal Transect (TACT) program is a multidisciplinary approach to study the Earth's crust along a corridor from the Pacific Ocean to the Arctic Ocean. The TACT program is coordinated with the Trans-Alaska Lithosphere Investigation, which involves 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.

Information for mineral deposits and occurrences in the United States and worldwide is available through computerized files of the USGS Mineral Resources Data System (MRDS). In Alaska, there are presently 4,156 records in 100 1:250,000-scale quadrangles throughout the State. Each MRDS record includes up to 200 pieces of information related to the identification, location, geology, deposit type, exploration and development, mine workings, commodity, production, reserves, resources, and references (Leonard and Huber, 1987). Geologic and deposit information from the Alaska MRDS files can be used to complement economically oriented data from the USBM's computerized Minerals Availability System (MAS), discussed in the next section. Further MRDS information can be obtained from Ray Arndt, MRDS Project Chief, U.S. Geological Survey, 920 National Center, Reston, VA 22092-0001.

U.S. BUREAU OF MINES

During 1994, the Alaska Field Operations Center and various research centers of the USBM were active in the programs listed below; see the appendix for further information on the scope and nature of these programs.

Minerals availability.—The two computerized components of the minerals availability program are the 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.—The policy analysis program compiles analyses of mineral data with respect to local and national needs. Technical, institutional, political, social, and economic criteria are used to identify mineral issues.

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

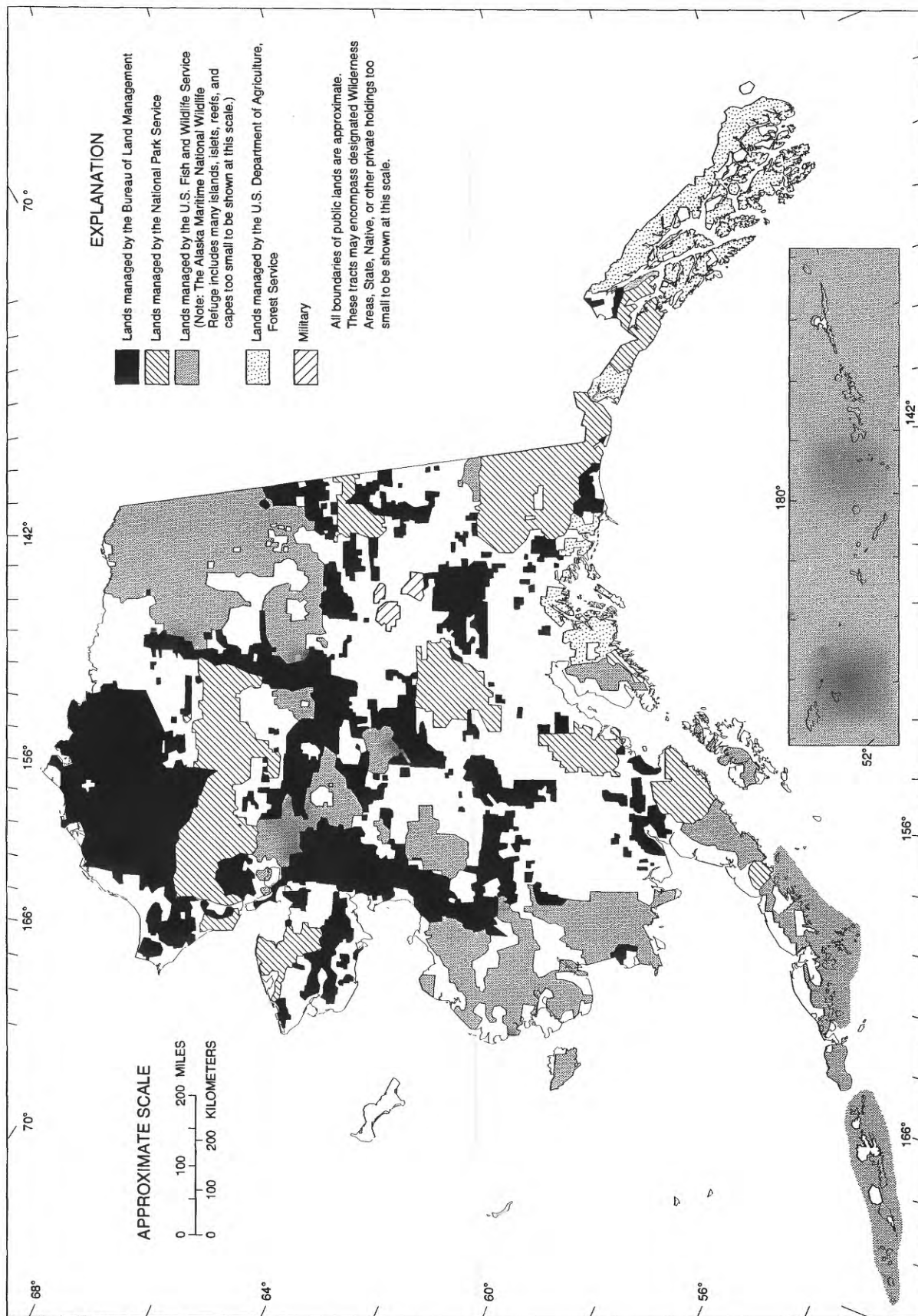


Figure 1. Federal land ownership in Alaska (Bureau of Land Management, 1990).

Mineral land assessment.—The USBM's major emphasis in Alaska has been the development of areal and commodity-oriented mineral assessments. Much of the work is focused on evaluations of mining districts, planning units of the Bureau of Land Management (BLM), and national forests. The evaluations include assessments of type, quantity, distribution, reserves, and beneficiation characteristics of specific mineral deposits. The program also includes the investigation and analysis of hazards associated with abandoned mine lands.

Minerals research.—Minerals research by the USBM includes the improvement of mining techniques for maximizing mineral extraction while minimizing the environmental impacts of mining (fig. 3). Much of the USBM's work involves speculative, long-range research designed to develop major technological improvements. Research in Alaska also considers the State's distinctive climate and geologic conditions. Minerals research is administered by the nine USBM research centers in the contiguous 48 States or by Washington headquarters, as in the case of cooperative programs with universities such as the Mineral Institutes. Partially funded by the USBM, the Mineral Institutes utilize university staff and facilities to conduct their work. Researchers from the

Mineral Industry Research Laboratory of the University of Alaska at Fairbanks Mineral Institute were active in Alaska in 1994. A primary goal of the USBM research mission is the communication of research results to industry, government, and the general public.

MINERALS MANAGEMENT SERVICE

The primary mission of the MMS in Alaska is the management of mineral resource exploration and development on Federal Outer Continental Shelf (OCS) lands. Management efforts are largely focused on leasing offshore areas for oil and gas exploration and development; the MMS also has the authority to lease OCS lands for mining of hard minerals.

Prior to an OCS lease offering, the MMS appraises the economic worth of leasable offshore lands and assesses environmental risks associated with development of resources on or beneath these lands. Following public review and comment, the MMS selectively makes these lands available through competitive OCS lease sales. The MMS regulates post-lease exploration, development, and production activities to ensure that operations are



Figure 2. USGS scientists use Global Positioning System satellite data to determine their ground location during field work for geologic studies investigating the petroleum potential of the North Slope's Colville Basin. Photograph by K. Franczyk, USGS.

conducted in a safe and environmentally acceptable manner. The MMS inspects operations to ensure compliance with applicable laws, regulations, and lease terms. Finally, the MMS is responsible for the collection and accounting of royalty and rental revenues generated by the leased properties. At present, no minerals are being developed or produced on the Alaska OCS.

The MMS does not oversee the onshore exploration and development of Federal mineral commodities in Alaska but is responsible for the collection of royalties, bonus payments, and lease rentals generated from onshore Federal and certain Native lands. Productive leases in the Beaver Creek and Swanson River oil and gas fields, as well as the Beluga, Cannery Loop, and Kenai gas fields provide the bulk of this kind of revenue. The State of Alaska received \$5.2 million as its 1994 share of minerals revenues collected from such properties. Specific data on production and revenues from these fields may be obtained from MMS Royalty Management, Lakewood, Colorado.

The MMS also conducts regional studies of the geologic history and petroleum potential of Alaska's offshore basins for the National Resource Assessment, an

MMS-USGS inventory of America's oil and gas resources. Results of these studies have been published as part of the MMS OCS Reports series.

OCS Reports and Maps are authored by the MMS professional staff. OCS Studies are generally contractually prepared environmental, socioeconomic, and technological studies. The "Selected References" section of this circular lists some of these titles. Copies of the reports may be obtained from the MMS regional Public Affairs Office in Anchorage.

BUREAU OF LAND MANAGEMENT

Principal BLM activities related to Alaska's onshore mineral and energy resources are (1) assessment of the mineral potential of BLM lands (fig. 1) and, through the planning process, identification of how the minerals can best be managed; (2) development of the terms and conditions, through the planning process and environmental review in accordance with the National Environmental Policy Act, for mineral exploration and development on BLM lands; (3) preparation of mineral-resource and eco-



Figure 3. To study the environmental effects of submarine tailings disposal, the USBM used depyritized mine tailings from the Greens Creek silver-lead-zinc mine in southeastern Alaska to perform aquarium simulations of underwater conditions. After documenting that no toxic metals were released from the tailings, the USBM was granted a permit to replicate the experiment in a real-life environment. Photograph by R. Lambeth, USBM.

conomic evaluations to determine mineral values for lease sales, land exchanges, and Federal land disposal; (4) issuance and management of Federal leases in coordination with the responsible surface-management agency; (5) administrative maintenance and adjudication of Federal mining claims, determination of claim validity, critical review of Federal mineral validity reports, and issuance of mineral patents; (6) regulation of mining activities on BLM land to protect the environment; (7) regulation, permit and agreement approval, inspection of oil and gas leasehold operations, and enforcement of on-shore orders for Federal leases producing oil and gas in the Cook Inlet Basin, in compliance with the BLM's National Inspection and Enforcement Strategy; (8) active participation in the State's Abandoned Well Site Closure Program for plugged and abandoned wells on Federal lands; and (9) protection of public mineral resources through an active program to identify, analyze, and study oil and gas drainage patterns.

The BLM is responsible for enforcing the environmental and technical stipulations of the Agreement and Grant of Right-of-Way for the Trans-Alaska Pipeline System (TAPS); the overall goal of this effort is to maintain a continuous supply of energy via pipeline integrity and to ensure public safety and environmental protection by minimizing environmental impacts. In addition, the BLM issues land-use authorizations and conducts mineral-materials sales to support the operations and maintenance of TAPS, as well as preconstruction activities for the planned natural-gas pipeline and other projects. The BLM has also provided assessments of mineral-potential studies for other land-managing agencies, such as the U.S. Fish and Wildlife Service (FWS) and National Park Service (NPS), and for input to congressional initiatives.

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. To assure proper surface and subsurface protections after a lease is issued, the BLM enforces the regulations of Title 43, Code of Federal Regulations, Section 3160 [43 CFR 3160] and the lease stipulations and permit conditions for exploration and development activities.

NATIONAL PARK SERVICE

The NPS manages over 206,390 square kilometers in Alaska in 15 administrative units and 13 wild river segments. Under its congressional mandate, the NPS manages all units of the National Park System so as "to conserve the scenery and natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future genera-

tions" [16 U.S.C. 1 et seq., NPS Organic Act]. This mandate requires that the NPS manage park ecosystems at the highest possible level of natural resources stewardship. To help the NPS meet that goal, Congress passed the Mining in the Parks Act [16 U.S.C. 1901 et seq.] in 1976, closing all park units to the location of new Federal mining claims under the 1872 Mining Law.

The NPS minerals management program deals with a variety of minerals issues, including mining claim management, navigability, access, hazardous waste, acquisition, reclamation, and non-Federal oil and gas and other non-Federal minerals. The goal of the NPS is to prevent adverse impacts to park resources from mineral activities occurring on valid claims or private lands within or adjacent to park boundaries owned by individuals, Native corporations, or the State.

The NPS carries out a variety of minerals-management functions through its offices at the national, regional, and park levels. The Alaska Regional Office, located in Anchorage, conducts a wide range of minerals management program activities in cooperation with park staffs through its Minerals Management Division. These activities include (1) the evaluation of proposed mining plans, including completeness determinations, engineering analysis, impact assessment, and bonding; (2) mineral examinations to determine claim validity; (3) compliance monitoring of approved operations; (4) aerial photography acquisition and topographic mapping; (5) hydrologic monitoring; (6) inventory and cleanup of debris and hazardous materials on abandoned and inactive mine lands (fig. 4); and (7) reclamation research and planning. In 1994, the Division also assumed responsibility for program activities associated with the cleanup of hazardous waste sites specified by the Comprehensive Environmental Response, Compensation, and Liability Act. In a cooperative role, the Regional Office's Lands Resource Division conducts mineral and land valuation appraisals, administers property relocations, and negotiates acquisitions and donations; the Cultural Resources Division surveys historical and prehistoric sites and provides cultural resources protection for both active and former mining properties.

Guidelines for NPS management and regulations of mineral-related activities are identified in the appendix.

U.S. FISH AND WILDLIFE SERVICE

In Alaska, the FWS manages 306,562 square kilometers of National Wildlife Refuge (NWR) lands and an additional 72,844 to 89,031 square kilometers of lands within the refuge boundaries that have been selected by the State or by Native corporations but have not yet been conveyed to them. The FWS is also responsible for research and monitoring of contaminants in fish and wildlife resources; for enforcement of Federal wildlife laws

on and off refuges; and for coordination and comment under the Fish and Wildlife Coordination Act, which provides for review and comment of Federal permitting and development activities in waters and wetlands. This last function includes the investigation, review, and comment on Federal permits and environmental impact statements.

Some mineral activities may be allowed under permit on national wildlife refuges provided that the activity is compatible with the purposes for which the refuge was established. Under Section 810 of the ANILCA, if an activity would significantly restrict subsistence use of Federal lands, the agency must give notice and hold hearings to determine (1) that the restriction is necessary, (2) that a minimum amount of land is affected, and (3) that reasonable steps are taken to minimize adverse impacts upon subsistence uses and resources. In 1994, seven special-use permits were issued for minerals activities on Alaska Refuges. The locations of the 16 national wildlife refuges in Alaska are shown in figure 5.

The FWS makes recommendations to other Federal agencies for mitigating adverse impacts to fish, wildlife, and habitats from federally constructed, funded, or per-

mitted projects. The FWS reviews U.S. Army Corps of Engineers permit applications under Section 404 of the Clean Water Act of 1977, as amended, and under Section 10 of the Rivers and Harbors Act of 1899, as amended. These permit requirements apply to both public and private lands and waters.

The FWS manages migratory birds, listed threatened and endangered species, and certain marine mammals. When an agency is considering permit applications for exploration or development activity, that agency must determine if listed species are present within the area of activity. When a listed species is present and it is determined that the proposed activity may adversely affect that species, the agency must consult with the FWS in accordance with the Endangered Species Act of 1973, as amended.

The FWS manages three marine mammals species in Alaska: polar bear, sea otter, and Pacific walrus. Section 101(a)(5) of the Marine Mammal Protection Act of 1972, as amended, authorizes the Secretary of the Interior to allow, via a permit, a U.S. citizen, when engaged in a specified activity in a specified region, the incidental, but not intentional, taking of small numbers of marine mammals.



Figure 4. NPS personnel prepare to remove fuel barrels and batteries from an abandoned mine site in Gates of the Arctic National Park and Preserve. Photograph from NPS files.

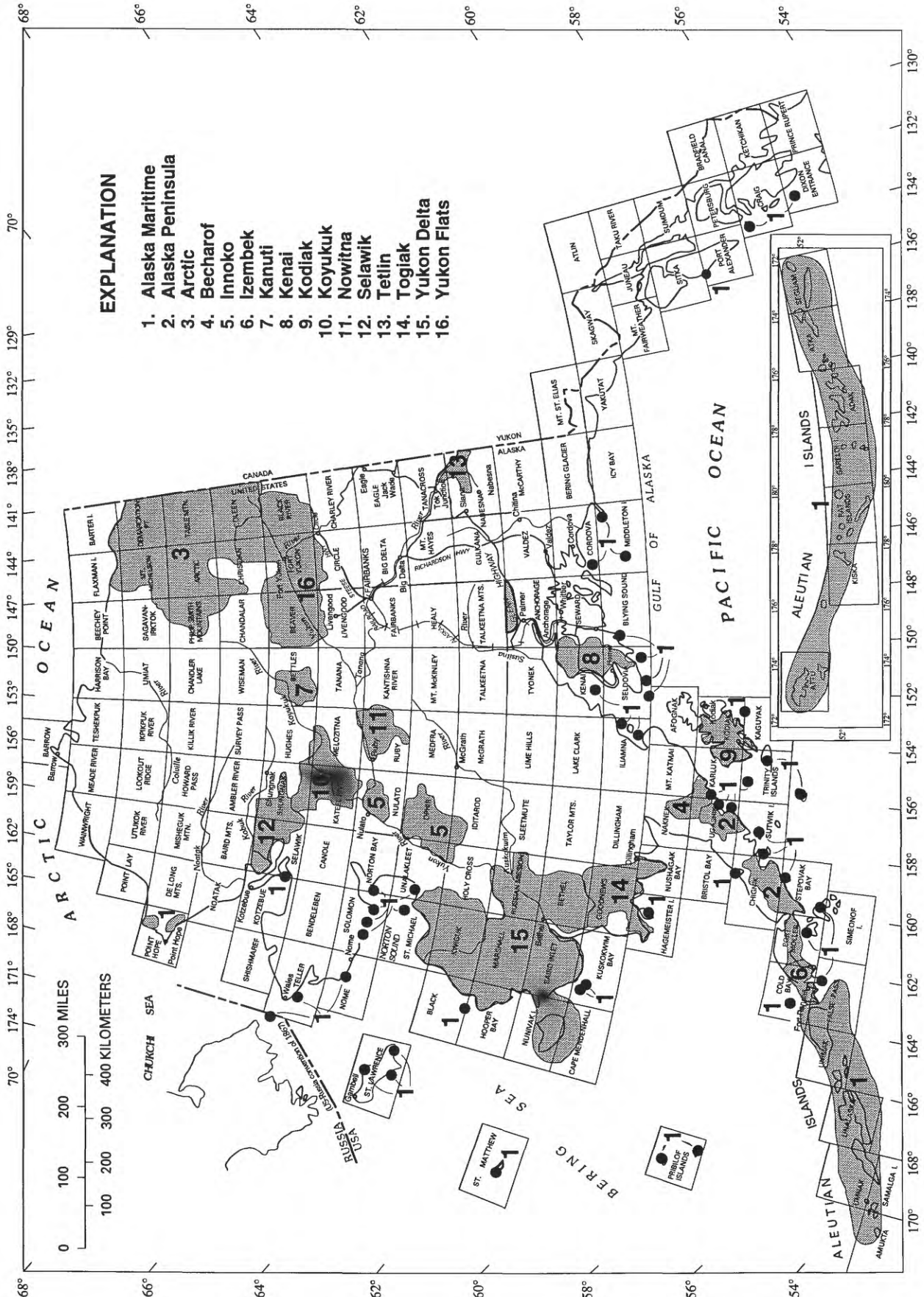


Figure 5. National wildlife refuges in Alaska. 1:250,000-scale quadrangles are outlined and labeled.

U.S. DEPARTMENT OF AGRICULTURE**FOREST SERVICE**

In Alaska, the U.S. Department of Agriculture, Forest Service (FS) administers 2 National Forests containing 93,000 square kilometers of land in 14 ranger districts (fig. 1, table 1). The Alaska regional office is in Juneau; offices for the Chugach National Forest are located in Anchorage, Girdwood, Seward, and Cordova; Tongass National Forest offices are in Yakutat, Juneau, Hoonah, Sitka, Petersburg, Wrangell, Thorne Bay, Craig, and Ketchikan.

The FS cooperates with U.S. Department of the Interior (DOI) agencies, particularly the BLM, in issuing mineral leases and assuring mitigation of surface impacts of lease activities. The FS also cooperates with State agencies and the private sector in development of energy and mineral resources on inholdings. One such inholding is the Bering River Coal Field, which is under consideration for possible development in a joint venture by Chugach Alaska Corporation and others.

Under a Memorandum of Understanding with the BLM, the FS jointly administers the general mining laws on National Forest System lands in Alaska. However, since March 1993, the FS no longer accepts additional patent application work from the BLM as a part of this Memorandum. Applications on which substantial work had already been completed will continue the patent process.

U.S. DEPARTMENT OF ENERGY

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

To develop a better understanding of petroleum resources and to provide fundamental information to accelerate utilization of these resources, the DOE emphasizes resource and technological investigations that continue to expand the body of essential and basic scientific knowledge concerning conventional and heavy petroleum, shale oil, tar sands, and gas hydrates.

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

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**U.S. DEPARTMENT OF THE INTERIOR**

Bureau of Land Management
Tom Allen, State Director
Federal Building
222 West Seventh Avenue, No. 13
Anchorage, AK 99513-7599

Minerals Management Service
Judith C. Gottlieb, Regional Director
Alaska OCS Region
University Plaza Building
949 East 36th Avenue
Anchorage, AK 99508-4302

National Park Service
Robert Barbee, Field Director
Alaska Field Office
2525 Gambell Street, Room 107
Anchorage, AK 99503-2892

U.S. Bureau of Mines
Donald W. Baggs, Chief
Alaska Field Operations Center
3301 C Street, Suite 525
Anchorage, AK 99503-3935

U.S. Fish and Wildlife Service
David B. Allen, Regional Director
1011 East Tudor Road
Anchorage, AK 99503-6199

U.S. Geological Survey
L. David Carter, Chief
Branch of Alaskan Geology
4200 University Drive
Anchorage, AK 99508-4667

U.S. DEPARTMENT OF AGRICULTURE

Forest Service
Phil Janik, Regional Forester
Alaska Region
P.O. Box 21628
Juneau, AK 99802

U.S. DEPARTMENT OF ENERGY

Hydrocarbon Resources
Harold Shoemaker
Morgantown Energy Technology Center
P.O. Box 880, 3610 Collins Ferry Road
Morgantown, WV 26507-0880

Table 1. Forest Service ranger districts in Alaska.

Chugach National Forest	
	Cordova Ranger District
	Glacier Ranger District
	Seward Ranger District
Tongass National Forest	
Chatham Area	
	Admiralty Island National Monument
	Hoonah Ranger District
	Juneau Ranger District
	Sitka Ranger District
	Yakutat Ranger District
Stikine Area	
	Petersburg Ranger District
	Wrangell Ranger District
Ketchikan Area	
	Craig Ranger District
	Ketchikan Ranger District
	Misty Fjords National Monument
	Thorne Bay Ranger District

ENERGY RESOURCES

OIL AND GAS RESOURCES

OVERVIEW OF PRODUCTION AND PRICES

Oil and gas remain the most valuable mineral-resource commodities produced in Alaska. Alaska's two oil-producing areas, the Arctic North Slope and Cook Inlet, provided a total of 568.9 million barrels (1 barrel = 159 liters) of oil, 25.9 million barrels of natural gas liquids, 5.14 billion cubic meters of dry natural gas, and 82.7 billion cubic meters of casinghead gas in 1994 (table 2); 74.5 billion cubic meters of gas and 991 million barrels of water were reinjected for enhanced oil recovery. Production was down 1.6 percent from 1993 oil levels, and dry gas production declined 5.6 percent. Daily oil production averaged 1.63 million barrels per day (bbl/d), about 30,000 bbl/d less than in 1993 and well below peak production of 1.98 million bbl/d in 1988. About 98 percent of Alaska's oil comes from North Slope fields, and 99 percent of dry natural gas production occurs in the Cook Inlet area. Alaska provides about 25 percent of domestic oil production.

Alaska North Slope crude oil prices were lowest at the beginning of the year, rose steadily to peak in August and September, and declined slightly until rising again in December (table 3). The average price of \$14.77 per barrel (West Coast) was 7.5 percent below the 1993 average price of \$15.97, continuing the general decline in prices from 1990 (fig. 6). The January low of \$10.38 (West Coast) was the lowest price for North Slope oil since the September 1986 price of \$9.00 per barrel. Alaska's treasury is especially vulnerable to crude oil prices because 85 percent of its current income is derived from royalties and taxes paid on State-owned oil and gas leases: each \$1 change in the price of crude oil translates to an approximate \$150-million gain or loss in State revenues.

EXPLORATION

PERMITS ISSUED

The Alaska Oil and Gas Conservation Commission issued 161 drilling permits in 1994, for 7 exploratory wells, 140 development wells, and 14 service wells. This was a 23-percent decrease from the 208 permits issued in 1993. For the North Slope, 6 exploratory, 125 development, and 14 service wells were scheduled; 1 exploratory and 15 development wells were planned for Cook Inlet.

DRILLING ACTIVITY

Only seven exploratory oil wells and one gas exploration well were active in 1994, 10 less than the year before. Six wells were completed on the North Slope and two in the Cook Inlet region (fig. 7; table 4). All wells were drilled on State onshore and offshore lands; no wells were drilled on Federal OCS lands. Although most wells were plugged and abandoned, complete information on the wells has not yet been released. A 1991 oil discovery in Cook Inlet was reconfirmed, and two oil discoveries were announced for the North Slope.

Cook Inlet.—Phillips Petroleum completed its Sunfish 3 confirmation well, which recovered oil at two levels. Originally discovered by ARCO Alaska (ARCO-Ak) in 1991, the 40-kilometer-long Sunfish prospect was first estimated to contain 750 million barrels of oil, but subsequent drilling and seismic results revealed that the reservoir was thinner and more discontinuous than originally thought (Alaska Journal of Commerce, September 19, 1994); current State estimates of the Sunfish discovery range from 77 million to 150 million barrels. As a result, ARCO-Ak has dropped all plans to develop the prospect, and Phillips is negotiating to acquire ARCO-Ak's share. Phillips already has a 40-percent interest in Sunfish and is the sole owner of the North Cook Inlet gas field, which overlies part of the Sunfish prospect.

The Alaska Department of Natural Resources (ADNR) drilled a 396-meter-deep exploratory well to test the coalbed methane potential of rocks in the Matanuska-Susitna Valley region. The well encountered 18 coal seams containing gas levels that exceed the minimum necessary for commercial production in the contiguous United States. Based on these results, the DOE has expressed interest in assisting the State's coalbed methane program by financing a pair of exploratory wells to further assess coalbed methane potential.

Cook Inlet Region Incorporated (CIRI), an Alaska Native corporation, has awarded large block leases to both ARCO-Ak and Union Texas Petroleum Alaska. ARCO-Ak has drilled 3 unsuccessful exploratory wells on CIRI lands since the early 1980's. Union Texas will

Table 2. 1994 Alaskan oil and gas production statistics.

[Data from Alaska Oil and Gas Conservation Commission Bulletin, February 1995; BBL, barrels; NGL, natural gas liquids; MCM, thousand cubic meters; DNG, dry natural gas; CHG, casinghead gas]

FIELD	BBL OIL	BBL NGL	MCM DNG	MCM CHG
NORTH SLOPE				
PRUDHOE BAY	363,103,508	23,881,845		71,077,549
KUPARUK RIVER	111,795,013			3,405,763
POINT MCINTYRE	37,545,347	547,816		1,098,540
ENDICOTT	34,284,551	1,484,750		3,315,047
MILNE POINT	6,677,340			114,388
WALAKPA			24,298	
SOUTH BARROW			7,383	
EAST BARROW			6,309	
	<u>553,405,759</u>	<u>25,914,411</u>	<u>37,990</u>	<u>79,011,287</u>
COOK INLET				
MCARTHUR RIVER	7,090,683		1,298,412	119,083
MIDDLE GROUND SHOAL	2,765,768		51,909	33,915
GRANITE POINT	2,209,404			58,806
SWANSON RIVER	1,672,193	23,310	54,331	3,468,830
WEST MCARTHUR RIVER	920,661			6,119
TRADING BAY	743,455			18,142
BEAVER CREEK	139,892		35,818	1,090
NORTH COOK INLET			1,491,996	
BELUGA RIVER			968,788	
KENAI		321	714,001	
IVAN RIVER			452,969	
STUMP LAKE			12,859	
LEWIS RIVER			6,908	
STERLING			6,355	
WEST FORK			5,821	
PRETTY CREEK			5,759	
	<u>15,542,056</u>	<u>23,631</u>	<u>5,105,926</u>	<u>3,705,985</u>
TOTALS	<u>568,947,815</u>	<u>25,938,042</u>	<u>5,143,916</u>	<u>82,717,272</u>

head a 3-year exploration program on more than 1,400 square kilometers on the Kenai Peninsula. The agreement allows Union Texas to acquire leases from CIRI on prospects identified during exploration and allows CIRI the option to participate in exploratory drilling and development programs. CIRI lands total 6,475 square kilometers.

North Slope.—Although low oil prices caused oil companies to scale back exploratory efforts in 1994, two new oil discoveries were announced. BP Exploration-Alaska (BPX-Ak) announced in early 1994 that its Cascade 1 well had intercepted an accumulation of oil. The well was drilled southeast of the Milne Point field in 1993 and flowed 1,720 bbl/d of oil from the Kuparuk reservoir. The field is estimated to contain 50 million barrels of oil, similar in size to the Niakuk field. The new field is close enough that the Milne Point infrastructure could be used to process the Cascade oil. BPX-Ak's Sourdough 2 well, located just west of the Arctic NWR and south of the Point Thomson field, was certified by the State as "capable of production." No additional information or test results have been released.

GEOPHYSICAL SURVEYS

The State of Alaska issued geophysical permits for seismic exploration covering 3,360 kilometers on Alaska's North Slope, 1,500 kilometers in the National Petroleum Reserve—Alaska (NPRA), and 327 kilometers in Cook Inlet. Most of the work entails traditional two-dimensional seismic work, but 1,290 kilometers on the North Slope will be explored using three-dimensional (3-D) seismic techniques. The MMS granted a permit for 415 kilometers of seismic surveys in the Beaufort Sea.

PRODUCTION

At the end of 1994, there were 1,696 producing oil wells, 105 gas wells, and 673 injection wells active in Alaska (Alaska Oil and Gas Conservation Commission Bulletin, February 1995). Of these, 127 development wells and 17 injection wells were drilled on the North Slope in 1994; 18 oil wells and 4 gas wells were drilled in the Cook Inlet region. Little information on these wells has been released to the public, but some data are

Table 3. Fluctuation in price of Alaska North Slope crude oil, 1994.

[Data compiled from Alaska Report; BP Exploration's Alaska North Slope contract crude oil price is based on the previous month's spot market price and represents 95 percent of production. WC, delivered to West Coast; GC, delivered to Gulf of Mexico]

Date	Price per barrel	
	WC	GC
(12/8/93)	(13.10)	(14.32)
1/5/94	10.38	12.28
2/2/94	11.65	13.31
3/2/94	12.59	13.68
4/6/94	12.88	13.70
5/4/94	14.90	15.54
6/8/94	16.41	16.82
7/6/94	16.45	16.88
8/3/94	16.54	17.47
9/7/94	16.70	16.88
10/5/94	16.12	15.99
11/9/94	16.00	15.90
12/7/94	16.65	16.81
(1/4/95)	(15.46)	(15.94)
1994 average price	\$ 14.77	\$ 15.44

NORTH SLOPE

North Slope oil fields produced 579.3 million barrels of oil and natural gas liquids in 1994, 97.4 percent of the State's total. The Prudhoe Bay and Kuparuk River fields contributed 86 percent of North Slope production.

Prudhoe Bay oil field.—The Prudhoe Bay field, producer of 65 percent of the State's oil and natural gas liquids, showed a 34-million-barrel decline in production, down 8 percent from 421 million barrels in 1993 to 387 million barrels in 1994. Oil yield at Prudhoe Bay is currently limited by the large amounts of casinghead gas and water that are by-products of oil production, because, as the field ages, proportionately more gas and water are produced along with the oil. These fluids are separated from the oil and reinjected into the field to enhance oil recovery, but the present equipment for this operation is already running at full capacity: the GHX-1 gas-handling facility is the largest in the world, reinjecting about 141.6 million cubic meters of gas into the reservoir through 22 wells each day. In order to keep oil production levels up, the GHX-2 facility, delivered in 1994, is expected to increase gas-handling capability to 212.4 million cubic meters per day, the equivalent of 55 percent of daily U.S. residential natural gas consumption. Operation of GHX-2 should increase production by 100,000 bbl/d of oil and, ultimately, add some 375 to 450 million barrels of recoverable oil to the Prudhoe Bay field. The original estimate for recovery from this 24-billion-barrel oil field was 9.4 billion barrels, but enhanced recovery techniques of water flooding, high-pressure fracturing, and gas reinjection have increased estimates for total recovery to about 12 billion barrels. In addition, a rapidly evolving technology known as coiled tubing may also extend the life of Prudhoe Bay and increase the amount of oil recovered by reducing drilling costs and allowing multiple horizontal or angled penetrations of a reservoir from a single vertical hole.

The Niakuk pool of the Prudhoe Bay field was discovered by BPX-Ak in 1985. Production began in April 1994 and totaled 3.4 million barrels of oil and natural gas liquids for the year. Production of the pool's estimated 54 million barrels of recoverable oil started at 15,000 bbl/d from 5 wells and is expected to peak in 1995 at 25,000 bbl/d from a total of 14 wells. Located entirely offshore in the eastern part of Prudhoe Bay, the field is being developed through extended-reach drilling from an onshore production facility at Heald Point, and the oil and gas is processed through the Lisburne

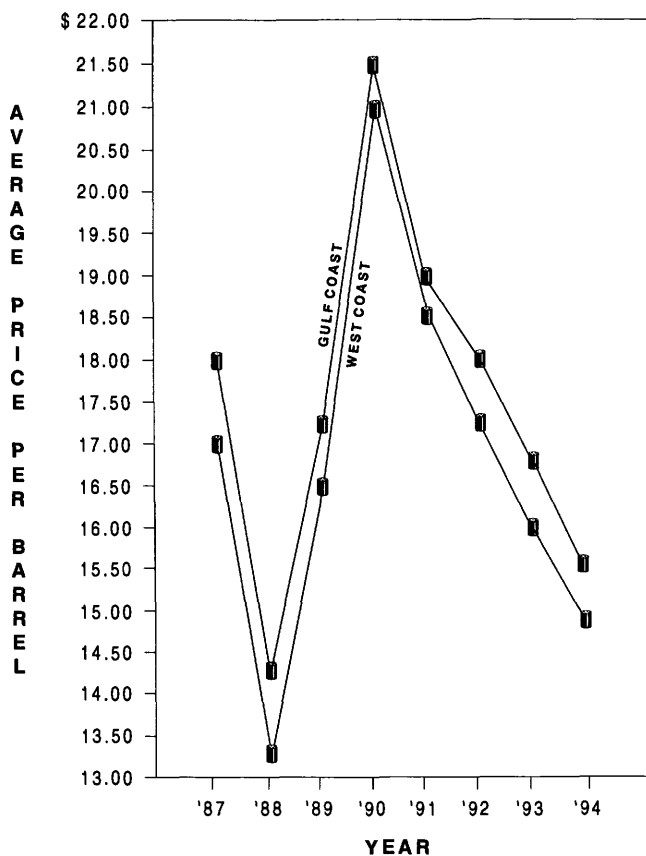
**Figure 6.** Fluctuation in annual average price of Alaska North Slope crude oil, 1987–1994. Averages calculated from data compiled from Alaska Report.



Figure 7. Locations of exploratory oil wells drilled in 1994, oil and gas fields, and possible petroleum-bearing sedimentary basins (outlined). Basins adapted from Kirschner (1988). 1:250,000-scale quadrangles are outlined and labeled.

Table 4. Alaska exploratory oil and gas wells drilled on State lands in 1994.¹

[Data from Alaska Oil and Gas Conservation Commission; see figure 7 for locations. Locations for onshore and State offshore wells given in section-township-range; SM, Seward Meridian (Cook Inlet); UM, Umiat Meridian (North Slope). ADNRR, Alaska Division of Natural Resources; Am-Hess, Amerada Hess; ARCO-Ak, ARCO Alaska; BPX-Ak, BP Exploration-Alaska, P&A, plugged and abandoned]

Well No.	Company	Well name	API No.	Location	Total depth (meters)	Date completed (1994)	Remarks
Cook Inlet							
1.	Phillips	Sunfish 3	50-883-20090-00	6-11N-09W,SM	4,482	4/02	Oil confirmation
2.	ADNR	Alaska 94 CBM 1	50-009-20008-00	31-18N-01W,SM	379	5/24	P&A
North Slope							
3.	BPX-Ak	Yukon Gold 1	50-089-22023-00	13-08N-23E,UM	3,901	1/29	P&A
4.	ARCO-Ak	Fiord 2	50-103-20201-00	14-12N-05E,UM	2,560	3/07	P&A
5.	Unocal	Amethyst-State 1	50-287-20013-00	12-02N-07E,UM	3,394	3/17	P&A
6.	Am-Hess	Northstar 3	50-029-22438-00	17-13N-13E,UM	3,048	3/28	P&A
7.	ARCO-AK	Bergschlund 1	50-103-20207-00	32-12N-05E,UM	2,286	4/14	P&A
8.	BPX-Ak	Sourdough 2	50-089-20025-00	31-09N-24E,UM	3,840	4/27	Oil discovery

¹ No exploratory wells drilled on Federal lands in 1994.

Production Center. Redesign of the original project from offshore production to onshore facilities reduced development costs from \$250 million to \$110 million.

The West Beach pool of the Prudhoe Bay field, located just north of Prudhoe's Ivishak and Lisburne pools, went into production in 1993 and produced 523,409 barrels of oil and natural gas liquids in 1994. The pool, jointly owned by ARCO-Ak and Exxon USA, is estimated to contain 12 million to 65 million barrels of oil and 283 million to 1,600 million cubic meters of gas in the Kuparuk reservoir.

ARCO-Ak discovered the North Prudhoe Bay pool of the Prudhoe Bay field in 1970. Although the North Prudhoe Bay-State 1 well intercepted oil and flowed 2,727 bbl/d from the Ivishak reservoir, the well was never completed. Following a 3-D seismic survey in 1990, the company directionally drilled the North Prudhoe Bay-State 3 well, which flowed 9,115 bbl/d of oil. ARCO-Ak now estimates that the pool could contain 12 million barrels of in-place oil and could produce up to 10,000 bbl/d. The accumulation is located in an area of intense faulting between the Prudhoe Bay and Point McIntyre oil fields.

Kuparuk River oil field.—The Kuparuk River field is the Nation's second largest oil field. Production peaked at 322,000 bbl/d in 1992 and declined to 306,288 bbl/d by 1994 but is still above original projections of 250,000 bbl/d. There are now 393 production wells in the field. ARCO-Ak suspended development drilling in the field in July 1994 as part of a cost-cutting operation driven by low oil prices. Cost controls are especially significant to the economics of the Kuparuk field due to high development and transportation costs.

Point McIntyre oil field.—The Point McIntyre field, discovered in 1988 beneath the waters of Prudhoe Bay, began producing oil in October 1993. Production rates

were better than expected, exceeding the 135,000-bbl/d capacity of the Lisburne Production Center within 2 months of startup. Initially expected to produce about 70,000 bbl/d, the field produced 104,365 bbl/d in 1994, with some individual wells flowing at rates of 15,000 bbl/d (Alaska Business Monthly, February 1994). Recoverable reserves are estimated at about 300 million barrels, making it one of the largest fields discovered in the United States since the 1978 discovery of the nearby Endicott field. The field is owned by ARCO-Ak, BPX-Ak, and Exxon, who together will spend about \$700 million to develop its resources. Taxes and royalties from this field are expected to provide about \$80 million per year to the State treasury.

Endicott oil field.—The Endicott oil field was discovered in 1978 and bears the distinction of being the first offshore Arctic oil field to be developed. In 1994, Endicott produced 35.8 million barrels of oil and natural gas liquids, a drop of 12 percent from the previous year. In September, most of the production wells on the main island were shut down for 5 days after gas began leaking from a development well and field personnel were evacuated. The field operated at about two-thirds capacity for a week, losing production of approximately 200,000 barrels of oil.

Milne Point oil field.—During 1994, the Milne Point field produced an average of 18,294 bbl/d of oil, a 1.2-percent decrease from 1993. Milne Point is distinguished among Alaskan oil fields by being the smallest stand-alone operation on the North Slope. BPX-Ak plans to invest \$120 million in order to boost oil production from 20,000 bbl/d to 50,000 bbl/d by 1997 and increase total recoverable reserves by more than 50 million barrels. The company has requested expansion of the Milne Point participating area from 57 square kilometers to 89 square kilometers in order to develop the 1992 North-

west Milne discovery and the 1993 Cascade discovery. BPX-Ak currently holds a 91-percent interest in the field, and Occidental Petroleum owns the remaining 9 percent.

Walakpa gas field.—The Walakpa gas field, 26 kilometers south of Barrow, was brought on line in 1992 to supply the village of Barrow in northwestern Alaska. During 1994, this field produced 24.3 million cubic meters of gas, 64 percent of the area's natural gas production and a 47-percent increase from 1993. The gas is transported to Barrow via pipeline. The field was discovered in 1979 during the Federal Government's exploration program in NPRA and turned over to the Arctic Slope Regional Corporation (ASRC) at the close of that program.

COOK INLET

The Cook Inlet region continues to be the main producer of dry natural gas, producing 99.3 percent of the State's total in 1994. Five fields produced 96 percent of the region's 5.1 billion cubic meters. Production of oil and natural gas liquids rose 12 percent in 1994 to 15.6 million barrels, an indication of new production from the West McArthur River field and increased efforts to maintain, revive, or stimulate more production from aging fields.

West McArthur River oil field.—Stewart Petroleum's West McArthur River oil field is Cook Inlet's newest field, producing 920,661 barrels of oil in 1994. The field was discovered in 1991 and confirmed by a second well in 1993. A third delineation well was started at the end of 1994. The oil, which was being trucked to Marathon Oil's Trading Bay facility, began flowing through a new 4.5-kilometer-long pipeline in July 1994; a parallel gas pipeline is expected to be completed in 1995. The oil line currently transports about 3,500 bbl/d. In addition to being the newest oil field in Cook Inlet, West McArthur River is also the first to be discovered by a small independent oil company. The company's most optimistic projections indicate the field could produce 100 million barrels of oil and 991 million cubic meters of gas over 15 years.

Granite Point and Middle Ground Shoal oil fields.—Unocal, Cook Inlet's major operator, designed and built a special modularized drilling rig to develop bypassed oil reserves in the Granite Point and Middle Ground Shoal fields. The development project may take as long as 10 years to complete and is expected to increase production by as much as 11,000 bbl/d of oil. Fifteen wells will be drilled during the first phase of the project.

Swanson River oil field.—Blowdown of Alaska's first major oil discovery, the Swanson River field, began at the end of 1993. Blowdown occurs in older oil fields when the operator begins to produce the field's gas,

rather than reinjecting it; this bleeds off the underground pressure that had kept the oil flowing. The Swanson River field contains an estimated 9.4 billion cubic meters of gas, most of which was originally piped from the Kenai gas field and injected into the Swanson field for enhanced oil recovery. This gas, which was continually produced and reinjected, has been recycled nearly eight times. The gas that is being produced now, currently 1.4 million to 1.98 million cubic meters per day, is transported 32 kilometers to Unocal's fertilizer plant at Nikiski; this plant is one of the largest in the country, accounting for 11 percent of the urea and 5 percent of the ammonia produced in the United States. The gas-producing blowdown phase is expected to last for 10 to 20 years, depending on market conditions.

Daily oil production in the Swanson River field is 4,500 bbl/d, down from a peak of 38,000 bbl/d in 1967. By January 1995, the field had produced a total of 220.2 million barrels of oil; another 10 million barrels are expected to be recovered, for an overall recovery efficiency of 52 percent. The field was discovered by Chevron and ARCO-Ak in 1957 and operated by them until purchased by Unocal in 1992. The Swanson River field is also noteworthy for its location within the Kenai FWR.

Sterling gas field.—The Sterling gas field was discovered in 1961 by Unocal and shut down in 1986 after producing about 57 million cubic meters of gas. The field was purchased by Danco Exploration and reactivated in 1994, producing 28,315 cubic meters per day. Reserves are estimated at 651.3 million cubic meters.

Liquefied natural gas.—Cook Inlet's liquefied natural gas (LNG) project celebrated its 25th anniversary in 1994. The project is a joint operation employing Marathon Oil's LNG tanker fleet and Phillips Petroleum's LNG production plant at Nikiski. In addition, the gas processed by the plant comes from Phillip's North Cook Inlet field (70%) and from Marathon's Kenai field (30%); Phillip's Tyonek platform produces 4.5 million cubic meters of gas per day for LNG processing. At the plant, gas is cleaned of impurities and cooled to minus 162°C, producing 99-percent-pure methane gas in liquid form. The plant currently produces an average of 54,000 barrels of LNG per day. About 900,000 metric tons of LNG from this plant is exported each year to two utility companies in Japan.

LEASING ACTIVITY

State of Alaska.—The State of Alaska held one lease sale during 1994. Cook Inlet Sale 78 was held during January, but court rulings delayed opening of the bids until late October. The sale offered 90 tracts covering 1,631 square kilometers in the lower Susitna River Valley, on the Kenai Peninsula, and in Cook Inlet. High bids totaled \$1.65 million for 34 tracts covering 552 square

kilometers in the Cook Inlet-Kenai Peninsula region. Union Texas acquired 17 tracts covering 277 square kilometers, ARCO-Ak acquired 10 tracts covering 178 square kilometers, and Marathon Oil acquired 3 tracts covering 40 kilometers; Stewart Petroleum and Zamarello/Craig also acquired two tracts each. The bids from Union Texas and Marathon Oil totaled 76 percent of the sale's total.

The State of Alaska tried to retrieve leases on Cook Inlet's Redoubt Shoal when a leasing document from Danco Exploration arrived late, missing a filing deadline for its leases acquired in January 1993. Danco filed suit, and, in October 1994, a Superior Court judge decided in Danco's favor and ordered the disputed leases to be restored to the company.

The Alaska Legislature passed three laws in 1994 affecting State oil and gas leasing. The first law restricts certain lawsuits that attempt to block oil and gas lease sales. A block-licensing law allows private industry to apply for 10-year exploration licenses and control blocks of 40 square kilometers to 2,000 square kilometers without competitive leasing; a timetable of work commitments are tied to performance bonds and the life of the license. The law applies only to exploration on currently nonproducing lands, such as the interior parts of Alaska and the foothills region of the Brooks Range. A third law would allow the State to subsidize much of a company's exploration costs in exchange for unlimited access to geologic information gathered from private lands, if the resultant data could shed light on the potential of nearby unexplored State land.

Federal government.—No Federal lease sales for oil and gas were held in 1994, but three sales are planned for 1996–1997. Plans for simultaneous American and Russian lease sales in the Chukchi Sea in 1997 have been dropped.

TRANSPORTATION

Trans-Alaska Oil Pipeline.—The 10-billionth barrel of oil was transported by the TAPS in February 1994. Average throughput was 1.6 million bbl/d in 1994, down from the peak of 2 million bbl/d in 1988. North Slope oil production is declining, and the future of the TAPS is not clear. Because less power is needed to move less oil along the pipeline's 1,280-kilometer route, cost-cutting measures to extend the economic viability of the TAPS include temporary idling and eventual shutdown of one or more pump stations. Pump Station 7, located north of Fairbanks, is scheduled for closure in March of 1995, and a mini-refinery at Pump Station 8 will be closed. The Alaska Department of Revenue estimates that about 6 billion barrels of recoverable oil remain in North Slope fields and that the pipeline will be required through the year 2017.

Proposed Natural Gas Pipeline.—Yukon Pacific Corporation has proposed construction of a \$14-billion, 1,280-kilometer-long natural gas pipeline to bring North Slope natural gas to a tidewater LNG plant at Anderson Bay near Valdez. In 1994, Yukon Pacific installed a meteorological tower at Anderson Bay for collecting baseline information on air quality at the site of the proposed plant. The company hopes to clear the final regulatory hurdle and get final approval in 1995 from the Federal Energy Regulatory Commission for the gas export certificate. Over the last 10 years, Yukon Pacific has obtained all major permits and approvals for the project, including State and Federal rights-of-way for the pipeline.

ACTIVITY BY FEDERAL AGENCIES

MINERALS MANAGEMENT SERVICE

LEASING AND EXPLORATION ACTIVITY

Since 1976, the DOI has held 17 oil and gas lease sales on the Alaska OCS (fig. 8, table 5), offering over 546,330 square kilometers. The DOI has leased 34,400 square kilometers (1,562 leases) and has received \$6.5 billion in high bonus bids (table 6). A total of 1,467 leases have been relinquished or have expired, leaving 95 leases still held by oil and gas companies as of December 31, 1994. No lease sales for oil and gas were held on the Alaska OCS in 1994.

Fourteen continental offshore stratigraphic test (COST) wells and 81 exploratory wells have been drilled on the Alaska OCS (table 5). In 1994, no exploratory wells were drilled in any of the Alaska OCS planning areas.

All of the exploratory wells drilled on the Alaska OCS have been permanently plugged and abandoned. However, nine leases have been classified as producible (table 7), although none are considered economically productive under current economic conditions. As defined by MMS regulations at 30 CFR 250.11, a producible lease is one from which oil, gas, or both can be produced in quantities sufficient to yield, after completion of the well, a return in excess of the cost of producing the hydrocarbons at the wellhead. All of the producible leases lie within the Beaufort Sea planning area; four of them have been relinquished. Other OCS leases might also be producible, but no operator has requested that such a determination be made.

Beaufort Sea planning area.—Lease sales were held in the Beaufort Sea planning area in 1979, 1982, 1984, 1988, and 1991. A total of 631 tracts have been leased; 62 remained active as of December 31, 1994. The Hammerhead, Kuvlum, North Star, and Sandpiper prospects are being evaluated for development; these 4 prospects cover a total of 22 leases. OCS Sale 144 is proposed for the Beaufort Sea planning area in early 1997.

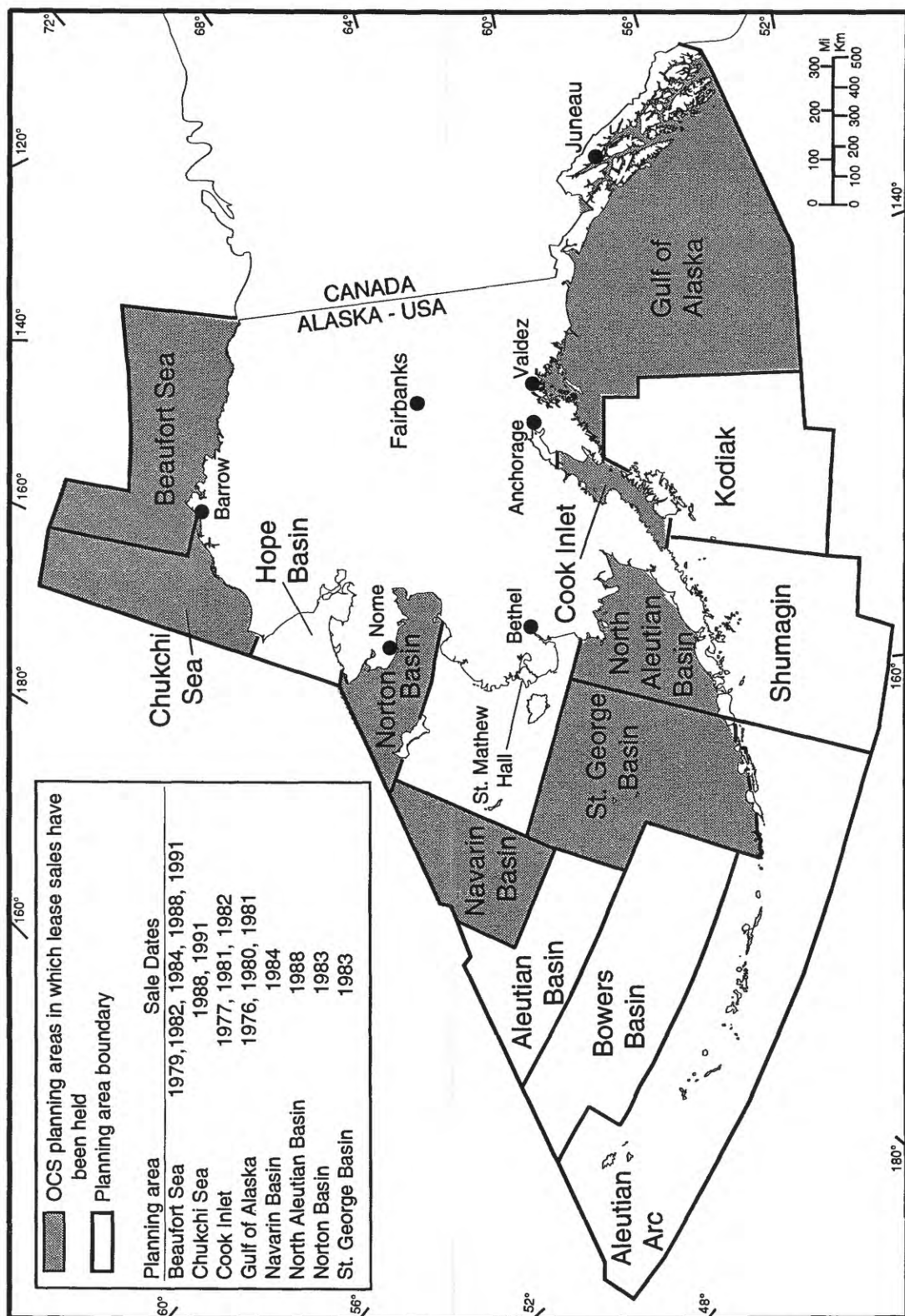


Figure 8. Alaska Outer Continental Shelf Region planning areas and lease sale history.

Table 5. Alaska Outer Continental Shelf leases and wells drilled, 1976–1994.

[COST, continental offshore stratigraphic test well]

Planning area (sale dates)	Number of tracts leased	Number of wells drilled ¹	Number of active leases
Beaufort Sea (1979,1982,1984,1988,1991)	631	28	62
Chukchi Sea (1988,1991)	378	4	8
Cook Inlet Basin ² (1977,1981,1982)	100	14 (1 COST)	0
Gulf of Alaska (1976,1980,1981)	112	13 (1 COST)	0
Kodiak (no sales held)	0	6 (6 COST)	0
Navarin Basin (1984)	163	9 (1 COST)	2
North Aleutian Basin ³ (1988)	23	1 (1 COST)	23
Norton Basin (1983)	59	8 (2 COST)	0
St. George Basin (1983)	96	12 (2 COST)	0

¹ Total includes both exploratory and COST wells.² Includes Lower Cook Inlet and Shelikof Straits.³ Leases under moratorium and concurrent suspension of operations at end of 1994.

Twenty-eight exploratory wells have been drilled in Federal waters in the Beaufort Sea planning area. The Kuvlum 1 well was announced as an oil discovery when drilled by ARCO-Ak in 1992, flowing 3,400 bbl/d with a gas-oil ratio of 17 cubic meters of natural gas per barrel. However, two 1993 delineation wells failed to define sufficient resources to make the prospect economically viable for ARCO. Transporting Kuvlum oil to the TAPS will require 123 kilometers of subsea and onshore pipelines.

Chukchi Sea planning area.—Lease sales in the Chukchi Sea planning area were held in 1988 and 1991. A total of 378 leases were awarded in the two sales; 8 remained active as of December 31, 1994. OCS Sale 148, originally proposed for June 1997, has been deferred to the next 5-year (1997-2002) schedule due to low industry interest.

Four exploratory wells were drilled in the Chukchi Sea planning area between 1989 and 1991. All have been permanently plugged and abandoned.

Cook Inlet planning area.—In the Cook Inlet planning area, a total of 100 leases were awarded in two lease sales held in 1977 and 1981. No successful sales have occurred since that time. In August 1982, OCS Sale RS-2 reoffered no-bid blocks from the 1981 sale, but no leases were awarded; OCS Sale 88, initially scheduled for December 1984, was postponed indefinitely due to lack of industry interest; and OCS Sale 114, originally scheduled for September 1990, was postponed pending

Table 6. Proceeds from lease sales on Alaska Outer Continental Shelf planning areas.

Planning area	Sale	Year	Proceeds (dollars)
Beaufort Sea	BF ¹	1979	48°,691,138
	71	1982	2,055,632,336
	87	1984	865,860,327
	97	1988	115,261,636
Chukchi Sea	124	1991	16,807,025
	109	1988	47°,032,631
	126	1991	7,117,304
Gulf of Alaska	39	1976	559,836,587
	55	1980	109,751,073
	RS-1	1981	170,496
Lower Cook Inlet	CI	1977	39°,471,313
	60	1981	4,405,899
	RS-2	1982	0
Navarin Basin	83	1984	516,317,331
North Aleutian Basin	92	1988	95,439,500
Norton Basin	57	1983	317,873,372
St. George Basin	70	1983	42°,458,830
Total			6,457,126,798

¹ Held jointly with the State of Alaska: sale revenues totaled \$1,056,082,635.

results of *Exxon Valdez* oil spill studies. No active leases remain in the Cook Inlet planning area.

Thirteen exploratory wells and one COST well were drilled on OCS lands in the Lower Cook Inlet and Shelikof Strait between 1977 and 1985; all were permanently plugged and abandoned. However, in 1991, ARCO-Ak drilled its Sunfish 1 well in State waters and discovered the first Cook Inlet oil found since 1965. Although delineation drilling revealed reserves much smaller than originally estimated, the combination of the discovery, improved seismic technology, and new geologic interpretations of seismic data has renewed industry interest in the Cook Inlet planning area. Extended-reach and horizontal drilling technology, platform modifications, and upgrades to production equipment have also been important in the revitalization of Cook Inlet's hydrocarbon exploration and development. OCS Sale 149 in the Lower Cook Inlet area is scheduled for summer of 1996.

Gulf of Alaska planning area.—A total of 112 leases in the Gulf of Alaska planning area were awarded in three OCS sales held in 1976, 1980, and 1981; all of these leases have been relinquished or have expired. OCS Sale 114, a joint Gulf of Alaska/Lower Cook Inlet lease sale originally scheduled for September 1990 was postponed in May 1989 to allow time to assess the effects of the *Exxon Valdez* oil spill. OCS Sale 158 is being considered for the Gulf of Alaska/Yakutat area in July 1996.

Twelve exploratory wells and one COST well were drilled in the Gulf of Alaska between 1975 and 1983. All have been permanently plugged and abandoned.

Table 7. Producing oil leases, Beaufort Sea planning area.

[As defined by MMS regulations at 30 CFR 250.11, a "producing" lease is one from which oil, gas, or both can be produced in quantities sufficient to yield, after completion of the well, a return in excess of the costs of producing hydrocarbons at the wellhead]

Lease number	Prospect name	Number of wells drilled
OCS-Y-0181	Seal	1
¹ OCS-Y-0191	Salmon	2
² OCS-Y-0195	Tern	1
² OCS-Y-0196	Tern	1
³ OCS-Y-0197	Tern	1
OCS-Y-0370	Sandpiper	1
OCS-Y-0371	Sandpiper	1
OCS-Y-0849	Hammerhead	2
OCS-Y-0866	Kuvlum	3

¹ Relinquished 12/88.

² Relinquished 7/90.

³ Relinquished 6/90.

Kodiak planning area.—Six COST wells were drilled on the Kodiak Shelf in 1976 and 1977 to delineate the geologic framework and hydrocarbon potential of the area. Four lease sales have been tentatively scheduled for this area since 1980 but have not been held due to low industry interest and to administrative postponements. No lease sales are presently scheduled for the Kodiak planning area. The MMS plans to conduct additional studies to gain a better understanding of the hydrocarbon resources of this area.

Navarin Basin planning area.—In the Navarin Basin planning area, 163 leases were awarded in OCS Sale 83 in April 1984. Seventeen additional blocks located within an area of disputed American-Soviet jurisdiction also received bids, but these bid deposits were refunded with interest in December 1988. Only two leases remain active, but they are due to expire in 1995; the remainder have been relinquished. A second lease sale, OCS Sale 107, was scheduled to be held in 1991 but has been postponed indefinitely due to low interest by the oil industry.

One COST well was drilled in the Navarin Basin in 1983, and eight exploratory wells were drilled in 1985. All of these wells have been permanently plugged and abandoned.

North Aleutian Basin planning area.—OCS Sale 92 in the North Aleutian Basin planning area was initiated in January 1986, but legal proceedings postponed completion of the sale until October 1988. The 23 leases awarded subsequently were placed under a 1-year moratorium and concurrent 1-year suspension of operations from October 1, 1989, to September 30, 1990, in order to assess results of the *Exxon Valdez* oil spill studies and to evaluate possible environmental consequences of oil development on Bristol Bay fisheries. Five subsequent

moratoria resulted in suspension of operations in the North Aleutian Basin through September 30, 1995. Consequently, the lease owners sued the Federal Government, alleging breach of contract and illegal seizure without due compensation. On July 28, 1995, the affected companies agreed to surrender their leases pursuant to a settlement stipulated in Federal claims court in the case *Conoco v. U.S.* Upon completion of the provisions of the settlement, no active OCS leases will exist in the North Aleutian Basin planning area.

One COST well was completed in the North Aleutian Basin by ARCO-Ak in 1983. The moratoria and suspensions of operations have precluded any exploratory drilling.

Norton Basin planning area.—OCS Sale 57 awarded 59 leases in the Norton Basin planning area in 1983; all have been relinquished. OCS Sales 100 and 120 were scheduled for 1986 and 1992, respectively, but were canceled or indefinitely postponed due to low industry interest. Two COST wells were drilled in Norton Basin prior to OCS Sale 57, and six exploratory wells were drilled in 1984 and 1985; all of these wells have been permanently plugged and abandoned.

Saint George Basin planning area.—In the Saint George Basin planning area, 96 leases were awarded in 1983 in OCS Sale 70; all leases have been relinquished or have expired. The 1986 OCS Sale 89 and the 1990 OCS Sale 101 were canceled or postponed indefinitely due to low industry interest. For the same reason, the 1996 OCS Sale 153 has been delayed into the next 5-year (1997–2002) comprehensive program.

Ten exploratory wells and two COST wells were drilled in the Saint George Basin prior to 1986; all have been permanently plugged and abandoned.

FUTURE LEASE SALES

The OCS Lands Act requires that the DOI prepare a 5-year program that specifies the size, location, and scheduling of areas to be assessed for Federal offshore natural gas and oil leasing. Accordingly, the MMS has prepared a comprehensive program for the management and leasing of natural gas and oil on the Alaska OCS, 1992–1997 (Minerals Management Service, 1992). The proposal limits the amount of acreage offered for lease by excluding areas where resource potential and industry interest are low, thus reducing the uncertainty about potential effects of oil and gas development on other natural resources. Compared to previous 5-year programs, fewer sales will be considered in fewer areas.

Leasing will be considered in 3 of the 15 Alaska OCS planning areas during the 1992–1997 program (table 8); studies planned for those and 3 additional areas will focus on hydrocarbon potential and environmental characteristics of the areas. One sale each is being

Table 8. Proposed activity by Alaska OCS region and planning area, 1995–1997.

Region and planning area	Studies planned	Leasing considered ¹
Aleutian Arc	—	—
Aleutian Basin	—	—
Beaufort Sea	Yes	1997
Bowers Basin	—	—
Chukchi Sea	Yes	—
Cook Inlet	Yes	1996
Gulf of Alaska	—	—
Middleton Area	—	—
Yakutat Area	Yes	1996
Hope Basin	Yes	—
Kodiak	Yes	—
Navarin Basin	—	—
North Aleutian Basin	—	—
Norton Basin	—	—
Saint George Basin	—	—
Saint Matthew-Hall	—	—
Shumagin	—	—

¹ Actual dates will depend upon the outcome of the Area Evaluation and Decision Process.

considered for the Lower Cook Inlet/Shelikof Strait (summer 1996), the Gulf of Alaska/Yakutat area (July 1996), and the Beaufort Sea (early 1997). Lease sales that had been considered in the Chukchi Sea, Saint George Basin, and Hope Basin for the 1992-1997 program have been delayed into the 1997-2002 program. Plans for simultaneous American and Russian lease sales in June 1997 for the American Chukchi Sea/Hope Basin planning areas and for Russian areas to the west and southwest have been dropped from the current Federal program due to low industry interest and significant environmental concerns.

The MMS is preparing its next 5-year program for July 1997 through June 2002. More than 1,000 responses were received in answer to the Request for Comments on the Proposed Program. The MMS is analyzing these comments as part of the preparation for that next 5-year schedule.

OIL AND GAS RESOURCE ASSESSMENT

The MMS prepares estimates of the undiscovered, economically recoverable oil and gas resources on the OCS as part of the Federal National Oil and Gas Resource Assessment. Results from the 1987 assessment (Mast and others, 1989) were reviewed in 1989 with regard to newly available geologic and geophysical data; resource estimates were revised significantly for three Alaska OCS planning areas (Cooke, 1991). The next National Assessment is scheduled for completion in late 1995. Workshops are held to keep MMS scientists in close contact with other Alaska OCS researchers in order to produce the best resource assessment possible.

DATA ACQUISITION ON THE ALASKA OCS

Geophysical exploration on the Alaska OCS reached a 28-year low in 1991 but rebounded over the next 2 years. In 1992-1993, the oil industry acquired 6,382 line-kilometers of seismic reflection data on the Beaufort Shelf, Lower Cook Inlet, and Gulf of Alaska. In 1994, geophysical exploration focused on south-central Alaska: a total of 45,000 kilometers of airborne magnetic surveys was flown over Gulf of Alaska and Lower Cook Inlet waters. Spurred by ARCO-Ak's Kuvlum discovery, the industry acquired 267 line-kilometers of seismic reflection data in the Beaufort Shelf area.

JOINT FEDERAL-STATE STUDIES

In 1975, the MMS (then USGS Conservation Division) and the State of Alaska initiated joint geologic studies 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. From 1991 to 1994, an AMRAP study in the lower Cook Inlet involved the MMS, NPS, State of Alaska, and private industry. Data collected include information on lithology, structure, geochemistry, and paleontology. Geologic maps, measured stratigraphic sections, petrographic and palynologic thin sections, and rock specimens were turned over to the State's Geologic Materials Center in Eagle River for use by the public sector.

Laboratory equipment has been supplied to a number of research efforts around the State. A scanning electron microscope has been set up at the University of Alaska at Anchorage under a cooperative agreement with the MMS. A second cooperative agreement is responsible for the construction of a new analytical laboratory at the State Geologic Materials Center. The USGS received equipment for performing cathode luminescence microscopy, and the National Biological Service also received analytical laboratory equipment and furniture.

ENVIRONMENTAL STUDIES PROGRAM

The Alaska Environmental Studies Program (AESP) was created by the DOI in 1974 in response to the Federal Government's decision to lease areas of the Alaska OCS for gas and oil development. The purpose of the AESP is to determine information needs and implement studies to assist in predicting, assessing, and managing potential effects of oil and gas exploration and development on the human, marine, and coastal environments of Alaska and the Alaska OCS. Administered by the MMS, assessment information is provided to the AESP through cooperative Federal and State interagency agreements and direct MMS contracts with private enterprises. More

than half of the \$500 million spent on the national Environmental Studies Program has funded AESP studies in the 15 planning areas of the Arctic, Bering Sea, and Gulf of Alaska subregions.

The initial objective of the AESP was to obtain baseline information on the physical characteristics and biological resources of the Alaskan environment, via studies of basic oceanography and meteorology, investigations of geologic and sea-ice phenomena, and biological surveys of marine species. As the OCS leasing program accelerated in the late 1970's and early 1980's, the emphasis of AESP studies shifted to the potential effects of oil contamination on biological resources and to the probable transport and dispersion of oil that might be spilled in the marine environment. Because the Alaska OCS leasing program has matured and significant exploration activity has declined, the mission of the AESP has been to conduct postlease studies to monitor the possible effects of oil and gas exploration and drilling activities on the OCS environment and its resources. AESP studies can be categorized into several broadly defined subjects: living resources, endangered species, environmental geology, ecosystems, pollutant transport, environmental monitoring, oil spill fate and effects, and social and economic studies. Descriptions of ongoing and proposed AESP studies are presented in the Alaska Environmental Studies Strategic Plan, Fiscal Years 1996-1997 (Minerals Management Service, 1994).

U.S. GEOLOGICAL SURVEY

The assessment of undiscovered oil and gas resources, research on North Slope and interior Alaska basins, gas-hydrate studies, and the analysis of petroleum systems are principal USGS activities directed at an improved understanding of onshore oil and gas resources in Alaska. These projects are funded under the Onshore Oil and Gas Investigations, the Global Change and Climate History, and the Mineral Resource Surveys Programs. During 1994, USGS scientists conducted fieldwork, analyzed samples collected in the field, and prepared several maps and reports. Highlights of findings from these programs were presented at technical meetings of several professional societies, including the American Association of Petroleum Geologists, the American Geophysical Union, and the Geological Society of America.

OIL AND GAS RESOURCE ASSESSMENT

The most recent estimates of undiscovered oil and gas resources of Alaska's onshore and State offshore lands were completed by the USGS in late 1994 (Gautier and others, 1995; U.S. Geological Survey, National Oil and Gas Resource Assessment Team, 1995). Results will be incorporated into the Federal National Oil and Gas

Resource Assessment, which is scheduled for release in late 1995.

NORTH SLOPE

On the North Slope, USGS studies continued on the oil and gas potential of the Brooks Range foothills region, the framework geology of the youngest part of the Colville Basin, sequence stratigraphic analysis of Jurassic and Early Cretaceous strata in the western part of the NPRA, and a digital synthesis of gravity and magnetic surveys. A major North Slope geologic synthesis report and map were published (Moore and others, 1994a, 1994b).

The second of five proposed transects is being compiled for the Brooks Range foothills project. Progress includes development of balanced cross sections and an analysis of tectonic basin subsidence (Cole, Bird, and Howell, 1994a, 1994b; Cole, Howell, and Bird, 1994). In addition to USGS personnel, this effort is aided by scientists from the ADGGS, Adelaide University, Stanford University, the University of Missouri, Chengdu University in China, and the Institut Francais du Pétrole.

Helicopter-supported fieldwork was conducted for 14 days in the east-central part of the North Slope to investigate the framework geology of the Sagavanirktok Formation, the youngest rocks of the Colville Basin. The Sagavanirktok Formation is estimated to contain significant undiscovered oil, gas, and coal resources and is a current target of oil industry exploration. The USGS measured stratigraphic sections and described in detail more than 6 kilometers of sedimentary section (fig. 9). Samples were collected for radiometric and paleontologic dating (Frederiksen and others, 1994). Field data will be combined with available seismic and well data to produce an interpretation of the formation's regional geologic framework, which will lead to a better understanding of the basin's history and characteristics of the basin fill. This information is fundamental to improved resource assessment and for environmental studies. Collaborators on this project include personnel from the USGS, ADGGS, Alaska Division of Oil and Gas, and Bryn Mawr University.

INTERIOR ALASKA

A 390-meter-deep research borehole was drilled by the USGS in 1994 at Fort Yukon. Designed to investigate the climate and environment of interior Alaska over the past 15 million years, drilling operations were supported by the Global Change and Climate History Program of the USGS. Interpretation of the sediment cores from this well will provide valuable subsurface information on the age, thickness, and composition of sedimentary rocks that compose the Yukon Flats Basin (fig. 7),

one of the largest basins of interior Alaska (Kirschner, 1994), and a prospect for oil and natural gas reserves.

GAS HYDRATES

The North Slope Gas Hydrate project is funded by the USGS Onshore Oil and Gas Investigations program and the USGS Global Change and Climate History Program. In 1994, an onshore area of known gas-hydrate occurrence was used to characterize the seismic signature of gas hydrates. Results from that study were applied to the assessment of gas-hydrate accumulations on the Alaska continental shelf between Point Barrow and Prudhoe Bay; hydrates were identified in the Harrison Bay area.

The USGS carried out a 14-day field study in 1994 to quantify the amount of gas entering the atmosphere from decomposing hydrates. Soil-gas samples were collected from 150 sites, 4 stations analyzed active-layer gas flux, and 75 surface gas-flux surveys were conducted. The relation between pingo structures and active fluid migration along fault systems was analyzed. Reports of these and other studies were presented at vari-

ous conferences (Collett, 1994a, 1994b, 1994c; Collett and Cunningham, 1994; Cunningham and Collett, 1994).

PETROLEUM SYSTEMS

A recently published volume presents both the features that define a petroleum system and a compendium of such systems worldwide (Magoon and Dow, 1994); detailed reports on two petroleum systems on the North Slope and in Cook Inlet are included (Bird, 1994; Magoon, 1994b). Petroleum resources of Alaska are described in a synthesis volume on Alaskan geology (Magoon, 1994a).

BUREAU OF LAND MANAGEMENT

The BLM has authority over all onshore Federal lands in Alaska for mineral leasing, economic evaluation of mineral resources, appraisal of values associated with Federally managed lands, and the inspection and enforcement of statutes governing mineral development. Mineral potential information is a required component of

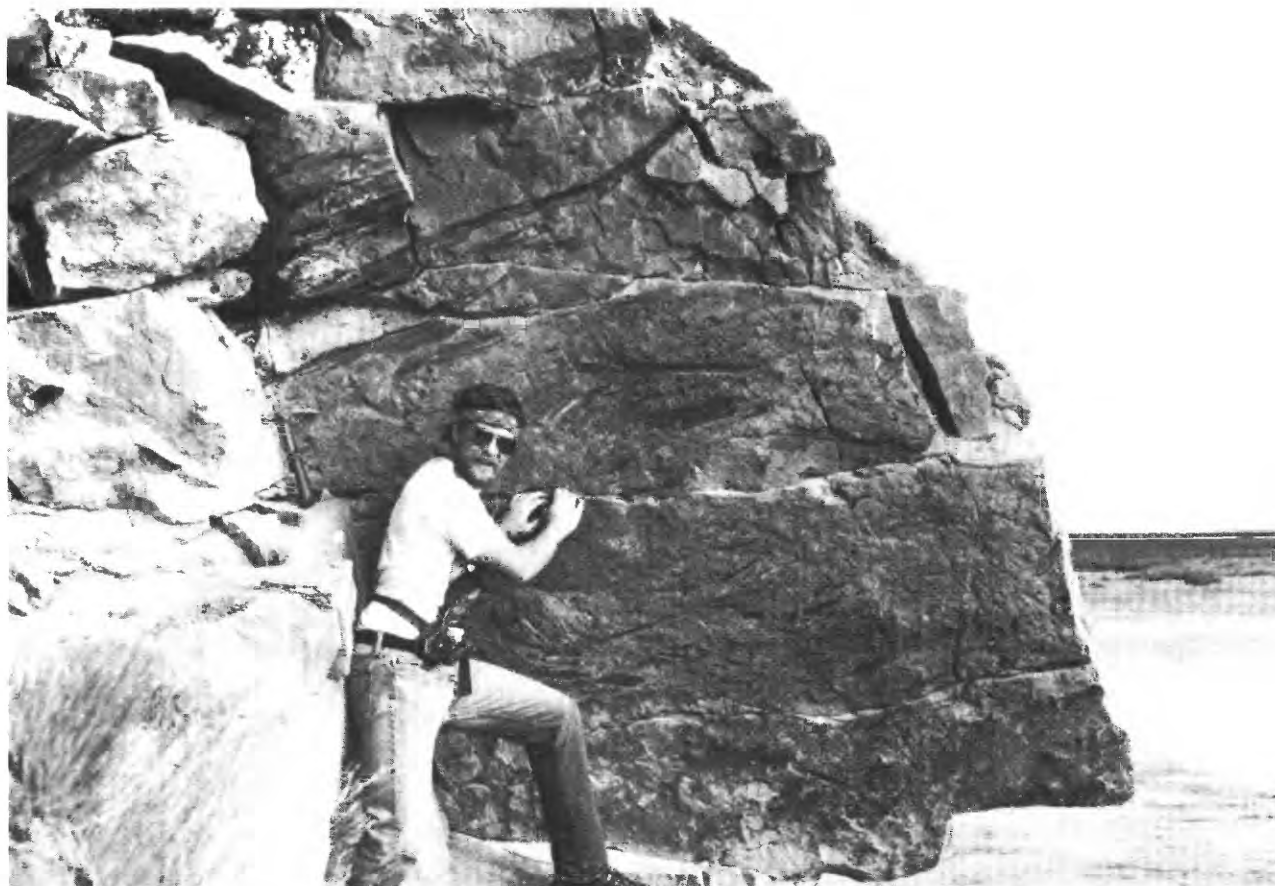


Figure 9. USGS geologist examines fossils and sedimentary structures in a sandstone outcrop of the Sagavanirktok Formation as part of the USGS investigation of oil and gas resources in the Colville Basin. Photograph by K. Franczyk, USGS.

BLM Resource Management Plans. In addition, the mineral potential of BLM-administered lands must be studied in relation to development impacts both to and from activities on adjacent, non-Federal leaseholdings. BLM scientists perform these mineral potential assessments using geologic and geophysical data gathered from Federal and State agencies and private industry. Nonproprietary data and the assessment results are subsequently published as BLM-Alaska technical and open-file reports.

RESOURCE EVALUATION

In 1994, the Division of Minerals completed the oil and gas resource evaluations and final technical reviews for the proposed Calista and Kenai land exchanges in southwestern Alaska and on the Kenai Peninsula. At the request of the Internal Revenue Service, the Division also analyzed hydrocarbon potential, appraised net economic worth, and determined the market value for 15 selected oil and gas properties across the State. The results of these geologic evaluations and subsequent appraisals will determine the economic values and mineral potential of lands conveyed to Alaska Native corporations. Division personnel adapted commercially available computer software to develop specific economic evaluation models and mineral-resource estimates, factoring into their calculations such parameters as reservoir extent and quality, oil proneness, crude oil pricing, and changing development scenarios.

Based on data from wells within and peripheral to both the NPRA and Arctic NWR, BLM geologists perform reservoir analyses via geologic interpretation of well logs, reservoir unit correlations, basin modeling, and petrographic and geochemical analysis of samples; field mapping is also crucial to this effort. Studies of the Breakup Sequence sandstones have been expanded from the Tunalik-Peard area of NPRA: north to OCS wells in the Chukchi Sea and south to outcrops in the Brooks Range. This project is in cooperation with the ADGGS as part of a more comprehensive study, evaluating and proposing a new hydrocarbon exploration target that is to be considered in the next USGS-MMS National Oil and Gas Assessment. The areal extent and reservoir characteristics of the Nuiqsut sands in northeastern NPRA, which are geologically similar to the oil-bearing Kuparuk Formation, are also being described. In addition, the oil-bearing Point Thomson sandstones, immediately west of the Arctic NWR, are being petrographically described and compared to their underlying bedrock to determine whether they correlate to similarly described bedrock that crops out within the Arctic NWR; these rocks may also exist within the Arctic NWR 1002 area. The analysis of recently available seismic data supports the reinterpretation of these depositional systems previ-

ously considered as unconducive to petroleum accumulations.

The Division of Minerals recently concluded several analytical studies of Arctic oil chemistry. Geochemical research on hydrocarbons from two wells in the Chukchi Sea showed that Chukchi oil has sufficient differences from both Umiat and Prudhoe oil types to indicate a unique type generated from an independent oil system (Banet, 1994b). Geologic and geochemical analyses were also performed on crude oils and petrographic samples from the Aurora well offshore of the Arctic NWR and the Nechelik 1 well in the Colville River Delta area (Banet, 1994c; Mowatt and Banet, 1994; Mowatt and others, 1994). Results from these and previous studies allowed a comparison of the chemistry of crude oils from wells in the Chukchi Sea, on the Alaska North Slope, and on Canada's Mackenzie Delta; the comparison showed that there are 10 distinct oil types in known Arctic reservoirs (Banet, 1994a). In addition, results of an analysis of all publicly available data pertinent to North Slope oil chemistry were presented to the American Institute of Professional Geologists in Anchorage for representatives of the MMS, oil industry, and private sector.

LEASE OPERATIONS

The BLM's Inspection and Enforcement (I&E) program governs operations associated with the exploration, development, and production of oil and gas from Federal onshore leases. Current I&E strategy evolves to follow a changing economic and development climate and is based on several factors pertaining to leasehold operations, such as reservoir production volume, additional resources, and operator compliance with health, environmental, and legal requirements. Data pertaining to these factors are tracked by the Automated Inspection Record System. The most active portion of the I&E program governs operations on Federal leases in Cook Inlet. Royalty revenues from Federal onshore oil and gas production in Alaska rank tenth in the United States.

The Branch of Lease Operations reports significant activity during 1994. On the Kenai Peninsula, two seismic prospecting permits were issued, and three new gas production wells were drilled in the Beaver Creek and Swanson River fields on BLM-managed subsurface within the Kenai NWR. The Sterling gas field began full operations, and the Swanson River field began production of the rental gas previously injected to enhance oil recovery. The growing demand for Cook Inlet natural gas will provide continued oil and gas activities on the Kenai Peninsula. There is also notable activity connected with Federal mineral estate lands on the North Slope. A seismic permit was issued to ARCO-Ak for prospecting in NPRA. In northeastern Alaska, BPX-Ak has requested

a permit for a pipeline to the TAPS from its Badami discovery at Mikkelsen Bay, approximately 45 kilometers west of the Arctic NWR 1002 area. BPX-Ak also drilled the Yukon Gold test well on State land immediately west of the Arctic NWR.

Oil and gas leases for the Kenai Peninsula and the North Slope are mandated under provisions in the National Petroleum Reserve Production Act and the ANILCA. The BLM currently maintains 37 active oil and gas leases on approximately 253 square kilometers on the Kenai Peninsula. Production from an additional 0.65 square kilometers is administered under a compensatory royalty agreement because it was determined that two wells in the West Fork field were producing hydrocarbons from the neighboring Federal mineral estate.

The Branch of Lease Operations also manages oil and gas activities mandated under section 1008 of ANILCA, consisting mainly of noncompetitive oil and gas leases for which the BLM has made land available in four areas south of latitude 68° N. (fig. 10). Current leases are in the Denali-Tiekel-Slana area, the Iditarod-George area, the Minchumina area, and the Seward Peninsula. As of October 1994, there were active files on 372 leases encompassing approximately 212 square kilometers. As per legislation, all of these leases are currently managed under the Federal Onshore Oil and Gas Leasing Reform Act of 1987 and the Energy Policy Act of 1992.

In order to streamline many oil and gas activities, the Branch of Lease Operations operates in conjunction with the Alaska Department of Environmental Conservation (ADEC) in various I&E related matters. These cooperative efforts include reviewing, assessing, and closing out various plugged and abandoned wells on Federal lands throughout Alaska, including the NPRA.

PIPELINE MONITORING

The Branch of Pipeline Monitoring has been reorganized in response to the new requirements of the oil-spill contingency plan and a heightened awareness of oil-spill effects and remedies throughout the TAPS. As a result, the Federal/State Joint Pipeline Office (JPO) no longer interacts with the Division of Mineral Resources but works directly with the Alaska Regional Director's office. Structure of the JPO is now based on an inter-agency command team model, and major organizational sections within JPO include Operations, Quality Assurance, Pipeline Surveillance, Engineering, Lands Administration, and a self-directed Oil Spill Team. This unique intergovernmental office involves 11 Federal and State agencies, including the BLM, U.S. Environmental Protection Agency (EPA), U.S. Department of Labor, U.S. Department of Transportation, and the Alaska Departments of Environmental Conservation, Natural Re-

sources, and Transportation. The BLM remains JPO's Authorized Officer.

The JPO maintains its pipeline monitoring, with each appropriate agency exercising its specific authority. In addition, work continues on wetlands mapping and the identification of possible seismic or unstable terrain hazards along the TAPS right-of-way. The JPO is evaluating the Federal Energy Regulatory Commission permit application for the Anderson Bay LNG facility near Valdez. BPX-Ak has also filed permits with the JPO to construct an oil pipeline from the Badami discovery at Mikkelsen Bay to TAPS Pump Station 1.

As a result of these varied activities and major reorganization, the JPO received Vice President Gore's Hammer Award for Reinventing Government.

NATIONAL PARK SERVICE

The NPS provided comments to the MMS regarding a proposed oil and gas lease sale in the Chukchi Sea. Comments were specific to the potential environmental impacts that might directly or indirectly affect coastal or wilderness values in Cape Krusenstern National Monument or Bering Land Bridge National Park.

U.S. FISH AND WILDLIFE SERVICE

KENAI NATIONAL WILDLIFE REFUGE

The Kenai NWR is the only refuge in Alaska where commercial oil and gas production currently is permitted. Surface operations are regulated by the FWS, and subsurface activities by the BLM. Data for 1994 production from the refuge's Swanson River and Beaver Creek oil fields are included in table 2.

A diesel fuel spill was discovered in 1990 in the Beaver Creek field, which is operated by Marathon Oil; the company's remediation plan was approved by the FWS, BLM, and ADEC in 1994. Marathon Oil completed a new gas well, Beaver Creek 9, in August 1994.

At the Swanson River oil field, an aromatic hydrocarbon spill was discovered in the pipe and supply yard in 1988. Initial efforts in 1990 to remove hydrocarbons from groundwater using recirculating and air-stripping technology were successful. Because the procedure is time-consuming and costly, cleanup is still ongoing to achieve cleanup levels that were established by the ADEC and are supported by the FWS. A comprehensive review of past, present, and future remediation efforts at the yard is scheduled with the field operator in early 1995. In 1991, an environmental audit of chronic crude oil spills and leaks at tank settings and flare pits throughout the Swanson River field was completed. A remediation pilot project was initiated in 1992 at one of



Figure 10. Onshore favorable petroleum provinces and land units referred to in text. 1:250,000-scale quadrangles are outlined and labeled.

the tank settings. Cleanup levels are being achieved; however, a decision has not yet been made as to applicability for remaining tank settings and flare pits. Unocal took over operation of the Swanson River field from ARCO-Ak in 1992.

ARCTIC NATIONAL WILDLIFE REFUGE

Section 1002 of the ANILCA sets out specific management constraints on a 6,070-square-kilometer strip within the coastal plain of the 78,914-square-kilometer Arctic NWR; this coastal strip is frequently referred to as the 1002 area (fig. 10). The FWS was designated as principal coordinator for a resource assessment required under Section 1002 and subsequently conducted a baseline study of the area's fish, wildlife, and habitats. The ANILCA also mandated a Report to Congress, which was prepared under the provisions of a 1983 inter-agency Memorandum of Understanding among the FWS, BLM, and USGS. The report (Clough and others, 1987) summarized the area's fish, wildlife, and hydrocarbon resources; described the development scenario and potential impacts of any future petroleum exploration and production; and outlined recommendations regarding possible oil and gas operations in the 1002 area, should they occur. However, the ANILCA prohibits oil and gas activities on the 1002 area unless authorized by an act of Congress, and no such action transpired in 1994.

The FWS and National Biological Service continue to pursue biological studies in the 1002 area. The goal of these studies is to achieve a better understanding of the area's natural dynamics, the altered ecosystem dynamics that might result from oil and gas activities, any associated adverse impacts, and the means to avoid, minimize, or rectify those adverse impacts. During 1994, studies relating to caribou productivity and habitat use, seismic impacts, snow goose staging habitat, musk oxen, polar bears, fisheries, weather data, and water resources were continued in order to address additional information objectives. In 1994, the FWS filed five applications with the State of Alaska for water rights on the Tamayariak River in the 1002 area. Reports recently released on the 1002 area include a study of the Porcupine caribou herd (Fancy, Whitten, and Russess, 1994) and a lake elevation survey (Global Positioning Services, 1993).

ACTIVITIES UNDER SECTION 1008 OF ANILCA

Section 1008 of the ANILCA provides for oil and gas studies on refuges in Alaska in order to gather information for use in future land-management decisions. In 1994, seven special-use permits were issued for minerals activities on the following national wildlife refuges in Alaska (number of permits in parentheses): Alaska Maritime—surficial geology (1); Alaska Peninsula/

Becharof—sample natural oil seep (1-permit not exercised); Arctic—surficial geology (2), helicopter operations (2); Koyukuk/Nowitna—government agency (1). All special-use permits include specific stipulations to ensure that the permitted activities remain compatible with the purposes of the refuge and to protect refuge resources and refuge users. Commercial permittees must post bonds. For oil and gas exploration on refuge lands, a report with specific data requirements must be submitted following the end of the permit authorization period. All data submitted are kept confidential to the extent permitted by law. The data may be used by the DOI in responding to Congress, but they will not be published.

RESOURCE ACTIVITY IMPACT ASSESSMENT

Permitting.—In 1994, the FWS commented on 29 individual Section 404 Clean Water Act Public Notices pertaining to oil and gas activities off refuges. Activities covered by these Public Notices included oil field activities at the Kuparuk, Lisburne, Milne Point, Point McIntyre, and Prudhoe Bay fields, as well as the TAPS.

Lease Sales.—The FWS reviewed and commented on Federal OCS Lease Sales 144 in the Beaufort Sea, 148 in the Chukchi Sea, and 149 in Cook Inlet; a review and comments were provided for the joint United States/Russia 5-year lease plan for the Chukchi Sea. The FWS also commented on five proposed State oil and gas lease sales.

Monitoring.—The FWS conducts annual water quality monitoring of 16 ponds and lakes in the Prudhoe Bay and Kuparuk oil fields, the summer feeding habitat of numerous migratory birds. Contaminant specialists also sample snow for metal and hydrocarbon contaminants at 11 sites on the North Slope, including 6 sites on the Arctic NWR and 2 sites at Prudhoe Bay; analytical results will provide baseline information to evaluate potential air emissions from oil field activities and the impact of fugitive dust pollution as a result of local and long-range atmospheric contamination of the Arctic. As follow-up to an EPA collection in 1992, collections of the moss *Hylocomium splendens* were made at 12 other North Slope sites during 1994. Metal and hydrocarbon concentrations in these samples will be compared to air pollution concentrations in other Arctic regions. This moss species is used as an air pollutant indicator by the Arctic Monitoring and Assessment Program, which was developed by the EPA for the collection of baseline data; researchers from the United States, Russia, Scandinavia, Canada, and other countries are cooperating in the effort. Contaminant uptake by this moss parallels contaminant uptake by lichens, which are important winter forage for caribou. Therefore, this research should provide information on the potential of atmospheric contaminants to bioaccumulate in wildlife.

Reclamation.—On the Arctic NWR, FWS personnel continued to monitor the progress of revegetation efforts at the Kaktovik Inupiat Corporation's exploratory well. Revegetation is advanced on the southern end of the drill pad, where grasses cover 55 percent to 66 percent of the disturbed area. Grasses and other vegetation cover 25 percent to 30 percent of the northern end of the pad.

REGULATION

Section 101(a)(5) of the Marine Mammal Protection Act gives the Secretary of the Interior the authority to allow, on request by U.S. citizens engaged in a specified activity (other than commercial fishing) in a specified geographical region, the incidental, but not intentional, taking of small numbers of marine mammals. The FWS can issue a Letter of Authorization (LOA), with appropriate conditions, to those applicants requesting such authorization. In accordance with the Marine Mammal Protection Act, monitoring and reporting programs are required for each LOA.

Two FWS rulings concerning the incidental take of marine mammals during specified activities are currently in effect in Alaska. On June 14, 1991, the FWS issued the ruling [56 CFR 27443] for the incidental, but not intentional, take of small numbers of walrus and polar bears during open-water exploration for oil and gas in the Chukchi Sea adjacent to the coast of Alaska; the ruling is valid for 5 years. On November 16, 1993, the FWS issued an 18-month ruling [58 CFR 60402] for the incidental, but not intentional, take of small numbers of walrus and polar bears during oil and gas industry operations (exploration, development, and production) year-round in the Beaufort Sea and adjacent coast of Alaska. The Beaufort Sea ruling required the FWS to develop and begin implementation of a Polar Bear Habitat Conservation Strategy by June 16, 1995, before the ruling could be extended for the full 5-year term. This process is currently underway.

COAL AND PEAT RESOURCES

The locations of coal deposits, mines, and areas of Federal agency activities described in this section are shown on figure 11; production statistics are given in table 9.

OVERVIEW OF INDUSTRY ACTIVITY

Alaska's 1994 coal production, valued at \$36.75 million, decreased 4.8 percent from 1993 levels to 1.37 million metric tons. This decrease is in contrast to the 9-percent increase in total estimated domestic output of a record 935 million metric tons (Weekly Coal Production,

January 7, 1995). All commercial Alaskan coal was produced at the Usibelli Mine near Healy, the only active coal mine in the State. Approximately one-half of the coal is used in Alaska for power generation, and the other half is exported to South Korea from a coal terminal at Seward. Undeveloped commercial coal ventures include the Kuchiak Research (formerly Aluaq) Mine in northwestern Alaska, the Beluga coal field west of Cook Inlet, and Wishbone Hill in the Matanuska Valley.

The Alaska Industrial Development and Export Authority (AIDEA) is proceeding with the Healy Clean Coal Project, part of a national program to demonstrate methods of burning coal with reduced emission of pollutants such as sulfur dioxide and nitrogen oxides, the major contributors to acid rain. The Golden Valley Electric Association (GVEA) of Fairbanks will operate the proposed 50-megawatt facility, which is to be built next to its existing 25-megawatt plant, near the Usibelli coal mine and 16 kilometers northeast of the entrance to Denali National Park and Preserve (Denali NP&P). Concerned that emissions from the new plant would adversely affect the air quality in Denali NP&P, an environmental law firm attempted to halt construction of the plant. An appeal to the Supreme Court protesting the project's operating license was denied in April 1994, and a settlement between the AIDEA, GVEA, and law firm was reached in June 1994, requiring air-quality and visibility monitoring and other controls on possible pollutants such as road dust. The law firm also agreed to drop any further challenges to the project (Alaska Journal of Commerce, June 13, 1994). The AIDEA awarded the construction contract in November 1994.

Usibelli Coal Mine Incorporated and the DOE Energy and Environmental Research Center in North Dakota are pursuing a \$25-million test project to develop a coal-slurry fuel. The low-rank coal/water fuel can be produced by high-temperature and high-pressure cooking of subbituminous coals; the resultant product can be burned in industrial boilers in place of heavy oil. Low-rank coal/water fuel is low in sulfur, easy to transport, and potentially cheaper to produce than fuel oil. Studies indicate that 907,000 metric tons of subbituminous coal could produce the equivalent of 2.5 million barrels of fuel oil.

On the western North Slope, the ASRC continues to pursue development of coal resources in the Deadfall Syncline area, where deposits contain measured reserves of 54.4 million metric tons of high quality bituminous coal (Bundtzen and others, 1994). For the past several years, the ASRC has produced small quantities of coal from their open-pit Aluaq Mine, located 145 kilometers north of the Red Dog zinc mine; this coal has been burned in local Native villages for heating purposes. In 1993 and 1994, the surface pit was back-filled, and development work began on the underground Kuchiak Research test mine. The new mine will allow improved

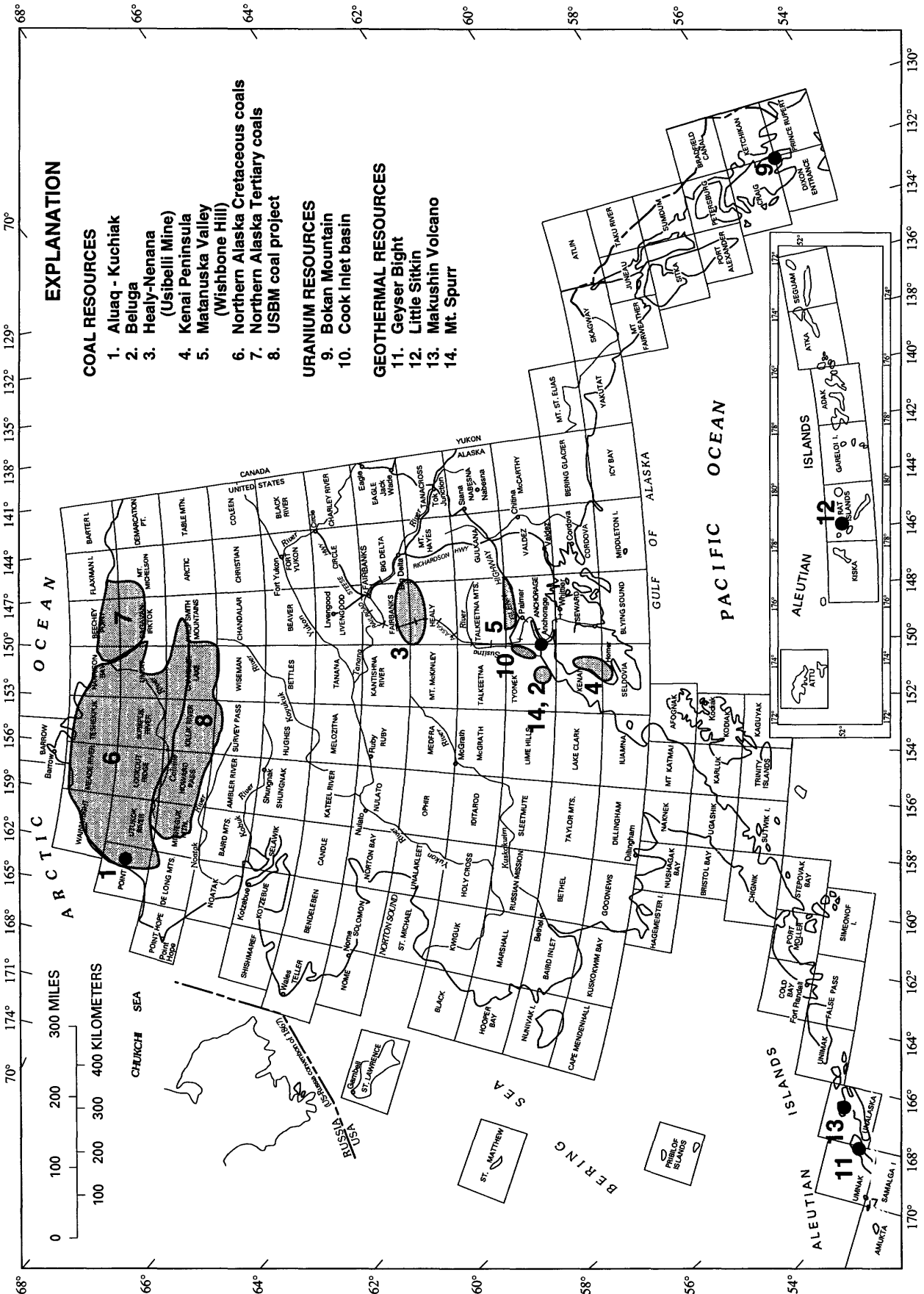


Figure 11. Areas of potential coal, uranium, and geothermal resources and areas of agency activities mentioned in text. 1:250,000-scale quadrangles are outlined and labeled.

Table 9. Mining production in Alaska, 1991–1994.

[Data from Swainbank and Bundtzen, 1995. Values calculated from 1994 price averages of gold, silver, platinum, zinc, and lead; other values directly supplied by mine operators. kg, kilograms; g, grams; NR, no report; W, information withheld by mine operators]

	VOLUME				VALUE (× \$1,000)			
	1991	1992	1993	1994	1991	1992	1993	1994
Zinc (metric tons)	252,398	249,029	243,823	298,466	\$ 278,221	\$ 301,958	\$ 236,517	\$ 296,103
Gold (kg)	7,586	8,166	5,949	5,801	88,292	88,463	68,641	71,989
Lead (metric tons)	63,132	62,291	34,674	33,064	33,404	31,585	13,759	25,513
Silver (kg)	282,322	283,532	176,013	61,212	39,114	34,913	24,333	10,391
Tin (kg)	3,084	680	9,525	W	22	6	51	W
Platinum (g)	467	W	93	156	5	W	1	2
Sand and gravel	12.9	13.2	12.0	12.6	45,449	42,200	40,637	41,950
(million metric tons)								
Building stone	2.7	2.6	3.3	3.1	22,500	22,971	26,206	25,600
(million metric tons)								
Jade and soapstone	14.5	1.4	2.4	2.1	12	30	20	20
(metric tons)								
Coal (metric tons)	1,397,064	1,389,626	1,439,516	1,369,849	39,000	38,300	38,104	36,750
Peat (cubic meters)	57,342	53,519	55,048	67,204	450	400	445	439
TOTALS					\$ 546,469	\$ 560,826	\$ 448,714	\$ 508,757

access to more coal with less environmental impact than surface mining. The USBM is conducting research at the site on permafrost, water quality, and reclamation concerns. The principal coal seam at the Kuchiak Research Mine has an average heat value of 7,220 kilocalories per kilogram, moisture content of 3.26 percent, and a low sulfur content of 0.23 percent (Arctic Slope Regional Corporation, 1994). The ASRC wants to establish an international market for this coal, then look for domestic markets. A test shipment of Kuchiak Research coal to Japan was delayed until 1995.

The Alaska Mental Health Lands (AMHL) issue has affected coal development in Alaska. In 1956, the U.S. Congress created a 4,047-square-kilometer land trust in Alaska, from which the proceeds of management and development would fund mental health programs in the State; significant coal deposits in interior and south-central Alaska were included in these lands. The State legislature dissolved the AMHL in 1978, but mental-health advocates filed suit in 1982 to restore the trust. In 1985, the Supreme Court ordered the trust recreated, halting development on any lands designated for possible inclusion in the new AMHL. A settlement was adopted by the State legislature in September 1994 and endorsed by Superior Court in December. The new AMHL contains 1,501 square kilometers of original holdings, plus 2,250 square kilometers of new lands, plus a \$200-million account to make up the difference in value between the original and new trusts. Although development of coal resources on AMHL lands is now possible, the settlement came too late for one project: in August 1994, Idemitsu Alaska suspended development of its Wishbone Hill coal project, citing the AMHL litigation for the decision to sell its claims in the Matanuska Valley.

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 1994 for the second year in a row to 67,204 cubic meters, up 22 percent from 1993. 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

Branch of Coal Geology personnel continue to investigate the coal-bearing Tyonek, Beluga, and Sterling Formations of the Kenai Group in south-central Alaska. In 1994, field geologists measured 107 stratigraphic sections on the western Kenai Peninsula: 12 sections in the Tyonek Formation between Seldovia and Barabara Points on the south side of Kachemak Bay, 45 sections in the Beluga Formation between Homer and Anchor Point, and 50 sections in the Sterling Formation between Happy Valley and Ninilchik. Geologists also described the sedimentary features and structural characteristics of 25 drill cores from the Tyonek Formation on the western side of Cook Inlet; the cores had been drilled in the mid-1980's in the Beluga coal field near the Chuitna River, on the property of the proposed Diamond Chuitna coal project, 72 kilometers west of Anchorage.

The USGS and ADNRC joined resources to drill Alaska's first coalbed-methane test well near Wasilla in the Susitna Valley from April 13 to May 22, 1994. Coalbed methane is a natural gas that can be used for heating and power generation. The test well intersected

18 coal seams in its total depth of 379.5 meters. Preliminary results show methane values ranging from 1.25 to 7.66 cubic centimeters of methane per gram of coal (Tyson, 1994). It is estimated that the Cook Inlet Basin could contain 1.4 trillion cubic meters of coalbed methane, nearly 18 times the estimated conventional natural gas reserves in the region.

For a research project funded by the Global Change and Climate History Program, the USGS cored a test hole near Fort Yukon in northeastern Alaska (fig. 12);

core rock totaling 390 meters will be analyzed for resource and climatic indicators spanning the past 20 million years. Unexpectedly, the bore hole intersected several thin stringers of coal during the coring operation and terminated in a coal bed of 7 meters minimal thickness (Ager, 1994). This basal coal is lignite in apparent rank, has low ash content, and is low in total sulfur (Stricker, written commun., 1995). Analytical results from the borehole's core will be used to assess the coal resource potential of the Yukon Flats Basin.



Figure 12. Drill rig used to penetrate 390 meters into Yukon Flats Basin. Analysis of the core rock will allow interpretation of Alaska's climatic history over the past 15 million years, as well as provide data for assessing the oil, gas, and coal resources of the basin. Photograph by T. Ager, USGS.

U.S. BUREAU OF MINES

Colville Mining District.—The USBM contracted the ADGGS to digitize and calculate the coal resources of the Colville Mining District and southwestern NPRA; the USGS assisted the ADGGS in this effort, as part of the USBM-USGS-BLM interagency study of the district's mineral potential. Coal resources of the Nanushuk Group, located in the central and eastern part of the study area, were estimated at 253 billion metric tons of high-rank bituminous coal and 47 billion metric tons of subbituminous coal; 237 billion metric tons of the high-rank coals occur between 0 and 150 meters of the surface (Clough and Stricker, 1994). Lower grade Colville Group coals, which occur north of the Nanushuk coals, were not evaluated.

Western Arctic coal.—In 1994, the USBM continued its research at the ASRC's Aluaq/Kuchiak Research Mine in northwestern Alaska. Blasting methods, temperature profile modeling, water quality, and restoration techniques were evaluated this year. Specific project goals are (1) to determine the stability of pits, spoil piles, and underground openings; (2) to provide suitable models for evaluating hydrologic flow; (3) to evaluate the impact of mining activities on surface waters and recommend suitable controls and treatments; (4) to determine the necessary reclamation technology for tundra and permafrost; and (5) to evaluate the impact of social and economic issues on mining operations. The project will provide the technological basis for treatment of ore and mine wastes, protection of water quality, and post-mining reclamation in the arctic environment.

U.S. DEPARTMENT OF ENERGY

The Healy Clean Coal Project is one of 45 DOE projects nationwide to demonstrate the new and clean methods for burning coal while limiting the emission of pollutants commonly cited as the causes of acid rain. Using advanced combustion and flue-gas-cleanup technologies, the plant is intended to illustrate the combined removal from stack emissions of nitrogen-oxide compounds, sulfur dioxide, and particulate matter. The Alaska Public Utilities Commission gave its approval to the project in September 1992, and the ADEC issued the necessary air-quality permit in March 1993. The DOE published the project's final Environmental Impact Statement (EIS) in December 1993 (U.S. Department of Energy, 1993). The DOE also signed the Record of Decision to approve Federal funds for construction and operation of the project in March 1994.

The \$267-million project is being financed by \$117.3 million of DOE funds provided under a Clean Coal Technology Program cooperative agreement monitored by the DOE's Pittsburgh Energy Technology Center; the agreement was awarded in April 1991. A

consortium headed by the AIDEA will provide the remaining funds for the project's completion. Proposed construction is sited adjacent to GVEA's existing Healy Unit 1, and the plant will burn low-sulfur coal from the Usibelli Mine.

URANIUM RESOURCES

OVERVIEW OF INDUSTRY

Over the last 5 years, an oversupply on the world's uranium market has led to the lowest market prices ever recorded, causing reductions in nearly all segments of the uranium industry (Underhill, 1994). In 1994, national uranium production was only 1.54 million kilograms U_3O_8 (Pool, 1995), derived from a few in-situ leach plants and byproduct plants; the last conventional open-pit uranium mine in the United States closed in March 1992 (Odell, 1993). Domestic nuclear power plants consumed 19 million kilograms of stockpiled and imported U_3O_8 to produce about 21 percent of total U.S. electrical energy (Chenowith, written commun., 1993; Pool, 1995).

No significant amount of money was spent on uranium exploration or development in Alaska in 1994. In southeastern Alaska, exploration continues on claims at Bokan Mountain (fig. 11). Numerous uranium-thorium prospects there also hold potential for niobium and rare-earth-element production (Bundtzen and others, 1994).

ACTIVITY BY FEDERAL AGENCIES

U.S. GEOLOGICAL SURVEY

Recent USGS uranium research in Alaska has focused on the upper Cook Inlet Basin (fig. 11). Scientists have described occurrences of enriched uranium and the relation between uranium distribution and sediment sources for rocks of the Tertiary West Foreland Formation and Kenai Group (Dickinson, 1995; Dickinson, Campbell, and Dula, 1995).

The USGS terminated its uranium/radon program on September 30, 1994. Uranium research carried out after that date will be done under the new energy program, which emphasizes the environmental aspects of energy minerals. The new program will include research on natural and manmade radionuclide dispersal in the environment and its accompanying impact.

GEOTHERMAL RESOURCES

Hot springs occur throughout Alaska and continue to be used locally for recreation, space heating, and agriculture. Widespread active volcanism in the Aleutian Islands and Alaska Peninsula sustains the potential for

commercial geothermal energy production on a regional scale. The OESI Power Corporation has submitted plans to the Alaska Energy Authority for a 12-megawatt geothermal power plant at the Makushin Valley geothermal area (fig. 11); the plant would furnish electrical power for the neighboring communities of Dutch Harbor and Unalaska, centers of the fishing industry in the northwestern Pacific Ocean. The Geyser Bight area on Umnak Island is probably the largest Alaskan geothermal resource and potentially could provide 246 megawatts of electrical power over a period of 30 years (Motyka, Nye, and others, 1993). On mainland Alaska, leaseholders on State land southeast of Mount Spurr have proposed developing their site for hydroponic gardening.

The ADGGS has published a comprehensive inventory of 89 volcanoes and 56 hot springs and fumaroles in the Aleutian Arc, stretching from Little Sitkin Island in the southwest to Mounts Spurr and Hayes in the northeast (fig. 11) (Motyka, Liss, and others, 1993). Most of the sites are too remote for economic development, but three areas are identified for their commercial potential to serve population centers: (1) Makushin Valley, for the Port of Dutch Harbor and Unalaska village; (2) northern Atka Island, for the village of Atka; and (3) Hot Springs Bay, for Akutan village. The Geyser Bight and Mount Spurr areas also possess geothermal systems capable of electrical power generation.

No Federal research was funded for geothermal studies in Alaska in 1994.

NONFUEL-MINERAL RESOURCES

METALLIC MINERALS

The locations of mineral deposits and mines discussed in the following review of industry activity are shown on figure 13; production and ore reserve statistics are derived from the State's preliminary report on Alaska's mineral industry for 1994 (Swainbank and Bundtzen, 1995).

ECONOMIC OVERVIEW

The value of Alaska's mineral industry for 1994 was estimated at \$584.74 million and represents the sum of mineral production values (\$508.76 million) plus exploration (\$30.78 million) and development (\$45.2 million) expenditures; the total is a 15-percent increase over 1993 levels (Swainbank and Bundtzen, 1995). Metallic minerals represented 79 percent of total mining production value, which rose 18 percent in 1994 to \$404 million (table 9). The increase was due mainly to a 25-percent growth in production at the Red Dog zinc-lead-silver mine in northwestern Alaska. Exploration expenditures

were up 2 percent from 1993, dominated by gold projects in interior, western, and southeastern Alaska. Development expenditures rose 63 percent over 1993 levels, spurred by work at the Fort Knox gold property near Fairbanks, the Greens Creek polymetallic mine near Juneau, and the Healy Clean Coal Project; both the Fort Knox and Clean Coal projects received final permit approvals in 1994. The mining industry employed 3,152 people in Alaska in 1994.

Zinc is the most valuable metallic commodity in Alaska at \$296.1 million. The Red Dog Mine is the largest zinc mine in North America and accounted for 7 percent of 1994 world zinc production. Higher gold prices in 1994 kept gold in second place at \$72 million, despite lowered production levels; 26 percent of Alaska's gold is produced from the Valdez Creek property in central Alaska. For the first time, lead production was more highly valued than silver in 1994. Silver production has dropped significantly in the State since the Greens Creek Mine in southeastern Alaska was closed in April 1993.

Of Alaska's 1.5 million square kilometers of land, 60 percent is owned by the Federal government, 28 percent by the State, and 12 percent by Alaska Native regional corporations. Alaska Natives are actively pursuing mineral resource opportunities on their lands. More than half of the Federal land is off-limits to mining, but over 90 percent of the State's land is open to mineral entry. In early 1994, the State opened an additional 37.5 square kilometers of land on the Seward Peninsula, 64 kilometers north of Nome. The number of registered mining claims in Alaska at the end of 1994 was 12,280 Federal claims and 25,050 State claims.

The ADGGS has carried out airborne magnetic and electromagnetic geophysical surveys in the Bethel Basin and in the Circle, Fairbanks, Nome, Nyak, Richardson, and Valdez Creek mining districts. The resultant maps have spurred minerals exploration, especially in the Fairbanks Mining District, because mineral deposits and altered rocks associated with mineralization often have distinct magnetic signatures that are evident in the survey results.

PRECIOUS METALS

FAIRBANKS MINING DISTRICT

The Fairbanks Mining District has produced 295,483 kilograms of placer gold since gold was first discovered there in 1902.

Fort Knox gold mine.—Fairbanks Gold Mining Incorporated received final permit approvals in 1994 for its Fort Knox lode gold mine, located 24 kilometers northeast of Fairbanks in the Fish Creek drainage. The U.S. Army Corps of Engineers (ACE) issued a permit to allow clearing of the land, reservoir excavation, construction of two impoundment sites, and placement of several

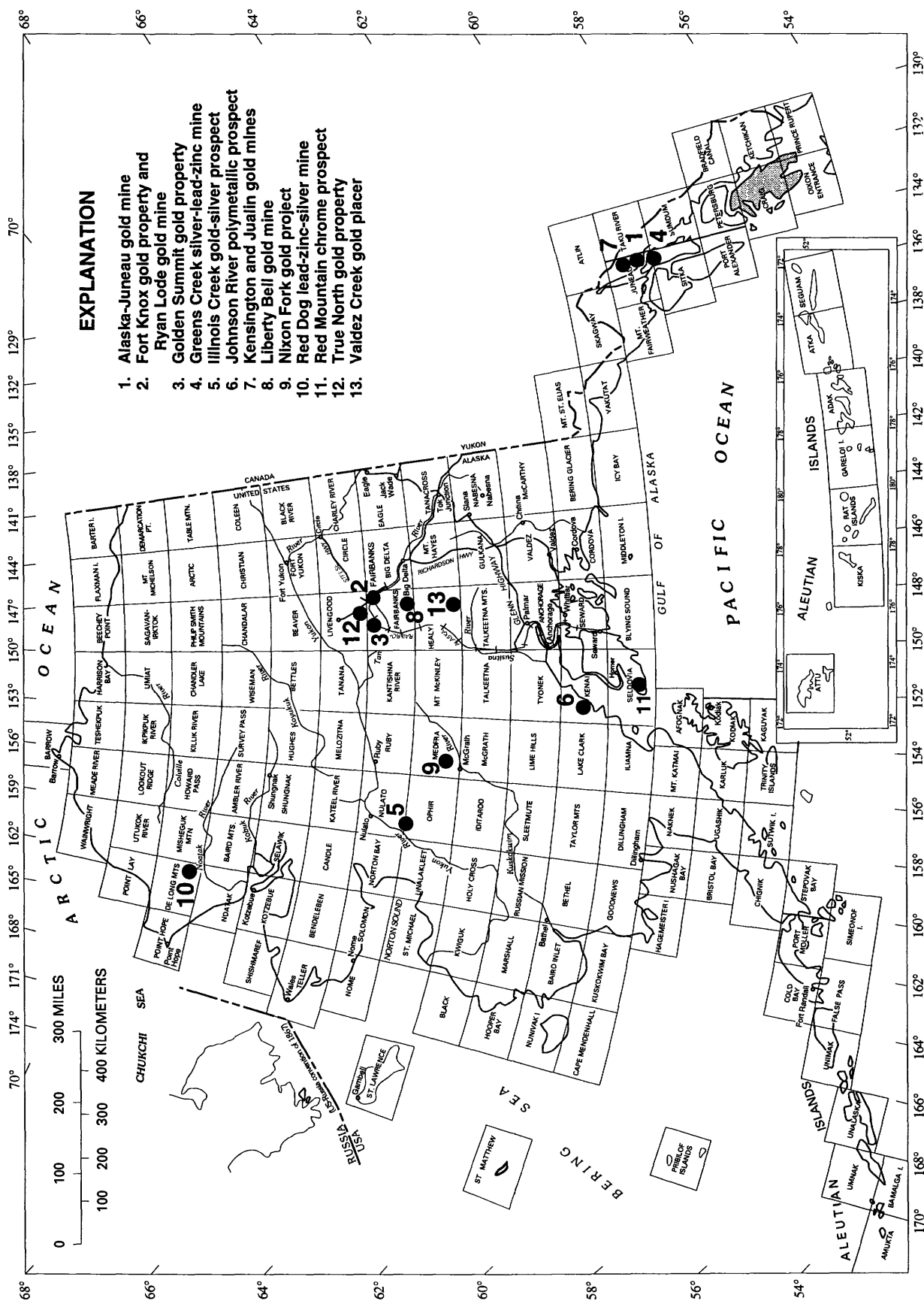


Figure 13. Areas of significant industry activity involving metallic minerals (excluding uranium) in 1994, with mine and deposit locations referred to in text. 1:250,000-scale quadrangles are outlined and labeled.

stockpiles; the State issued an upland-mining lease, mill-site permit, three fish-habitat permits, four water-rights permits, and a solid-waste permit for the tailings impoundments. Design and construction costs for the 28-square-kilometer mine site are estimated at \$255 million. Startup is planned for the fourth quarter of 1996, and the mine is expected to employ 250 workers during its estimated 12 years of production. The Fort Knox deposit has proven reserves of 158 million metric tons of ore containing 128,700 kilograms of gold; annual production is estimated at 9,300 kilograms to 10,900 kilograms of gold. A drill program of 28 bore holes east of the mine site was conducted in 1994 to explore for further ore reserves. Fairbanks Gold Mining is a subsidiary of Colorado-based Amax Gold, and the Fort Knox Mine represents 56 percent of Amax Gold's reserve base; the mine's 10,900 kilograms of gold per year will be half of Amax Gold's annual worldwide production.

The Fort Knox property is owned partly by Fairbanks Gold Mining and partly by the State. This is the first major hard-rock mining operation to be permitted on State lands, and estimated royalties to the State will total \$400,000 annually. Fairbanks Gold Mining will transfer its property holdings to the State after mining is completed.

Golden Summit project.—Freegold Recovery is exploring three lode gold sites at its Golden Summit project, 32 kilometers northeast of Fairbanks. The property covers 18 kilometers along the strike of the Chatanika thrust fault, and lode mineralization occurs in fractures and shears along the fault zone. Historically, more than 208,400 kilograms of placer gold and 15,900 kilograms of lode gold have been recovered from the Golden Summit area. The Cleary Hill lode mine was the district's largest producer, yielding 8,710 kilograms of gold between 1908 and 1946; recently discovered maps of the underground workings suggest mineralization is present below the old mine's lowest level of 122 meters from the surface. The Newsboy lode mine closed in the late 1930's after producing an estimated 1,250 kilograms of gold. The Too Much Gold prospect covers a northwest-trending arsenic-and-gold soil anomaly that extends for more than 3 kilometers; gold mineralization is exposed in trenches over a strike length of 1.3 kilometers. Approximately \$1.5 million will be spent on the Golden Summit property in 1995, including drilling on the Newsboy Mine, Cleary Hill Mine, and Too Much Gold prospect.

True North prospect.—La Teko Resources acquired the True North gold property from Amax Gold in early 1994; the 11-square-kilometer prospect is located 19 kilometers north of Fairbanks. As at Golden Summit, mineralization is localized along structures parallel to the Chatanika thrust fault. No lode gold has been mined on the property, but 10,880 kilograms of placer gold has been recovered from two local streams. The two main

lode targets on the property are the Shepard deposit and the old Hindenburg Mine, from which stibnite was mined during World Wars I and II. Geochemical sampling indicates that the two targets may be connected, totaling a minimum length of 1.4 kilometers of mineralization. La Teko has cored 45 drill holes on the property, totaling 3,674 meters. After the 1994 exploration season, proven and probable resources were estimated at 6.1 million metric tons of ore containing 13,750 kilograms of gold, 84 percent of which is in the Hindenburg deposit. Exploration via soil sampling, trenching, and drilling will continue in 1995.

Ryan Lode.—La Teko Resources owns Ryan Lode Mines Incorporated, which is developing the Ryan Lode property on Ester Dome, 19 kilometers northwest of Fairbanks. The Ryan Lode contains an estimated proven and probable reserve of 13.2 million metric tons of ore containing 25,400 kilograms of gold. Development on the property in 1994 included blasting tests and measurements of water well discharge. The mine is expected to employ 120 people and begin production in mid-1997. Overall gold recovery is estimated at 80 percent from the planned gravity mill and heap-leach operation.

EAST-CENTRAL ALASKA

Liberty Bell Mine.—Hemlo Gold Mines tested the overall potential of the past-producing Liberty Bell gold mine, located 129 kilometers south of Fairbanks. Historical production from the underground mine is reported to be 261 kilograms of gold from 15,900 metric tons of ore. Work at the mine site in 1994 included 12,100 meters of reverse-circulation drilling in 150 holes and 3,600 meters of core drilling in 33 holes. Current estimates put reserves at 1 million metric tons of ore containing 3,560 kilograms of gold.

Valdez Creek Mine.—Cambior's Valdez Creek gold mine, located 240 kilometers north of Anchorage, is the largest placer gold operation in North America, producing 1,480 kilograms of gold in 1994. However, available reserves have been exhausted, and Cambior began reclamation work in 1994 in preparation for the mine's closure in mid-1995.

WEST-CENTRAL ALASKA

Illinois Creek prospect.—North Pacific Mining, a subsidiary of the Alaska Native-owned CIRI, continued exploration at its Illinois Creek gold-silver property in western Alaska. Since its discovery in 1980, the property has been explored by more than 30,480 meters of drilling; the 1994 drill program totaled 2,470 meters. Extractable reserves are estimated at 3.54 million metric tons of ore containing 10,675 kilograms of gold and 206,216 kilograms of silver. Engineering and metallurgical studies

indicate that the deposit is amenable to conventional open-pit, heap-leach mining with recoveries in the 85-percent range. USMX Incorporated purchased the rights to the Illinois Creek property in late 1994, and production could start as early as mid-1996, at an annual rate of about 1,555 kilograms of gold.

Nixon Fork property.—Consolidated Nevada Goldfields Corporation is developing the Nixon Fork lode gold property near McGrath. Surface and underground drilling totaled 7,620 meters in 1994, and declines were driven to access the 2 main orebodies. Proven and probable reserves in the Crystal and Mystery deposits have been calculated at 111,175 metric tons of ore containing 5,070 kilograms of gold; possible reserves are an additional 35,525 metric tons of ore containing 1,169 kilograms of gold. Three other orebodies at the site are also being explored. The company plans to begin mining in late 1995.

SOUTHEASTERN ALASKA

Berners Bay region.—In November 1994, a business alliance was formed by Coeur Alaska, Goldbelt Village Corporation, Kake Tribal Corporation, and Klukwan Village Corporation to promote mining development and Native employment in the Berners Bay Region.

Kensington gold mine.—The Kensington gold project, a 50/50 joint venture partnership between Echo Bay Alaska and Coeur Alaska, is located about 64 kilometers north of Juneau in the Berners Bay Mining District near the northern end of the Juneau Gold Belt. The mine's reserves are calculated at 12.4 million metric tons of ore containing 55,000 kilograms of gold. The mine is expected to operate for 12 years and employ 340 workers. A legal challenge to the large-mine permit issued by the Juneau Planning Commission was denied by the State Superior Court in March 1994, but an appeal has been filed with the Alaska Supreme Court; objections focus on the mine's possible environmental effects on fishing in Lynn Canal. As of December 1994, over \$80 million had been spent on the Kensington project.

Jualin gold prospect.—The Jualin gold property is located approximately 4 kilometers southeast of the Kensington project. Coeur Alaska acquired an undivided 100-percent interest from International Curator in June 1994. Exploration activities during 1994 included completion of a high-quality topographic-base map from aerial photographs acquired during late 1993, continued geologic mapping and drill-target identification, re-examination of previous drill core, and limited drill testing of extensions of the No. 4 vein. Drilling totaled approximately 914 meters in 3 holes. Estimated gold resources of the Jualin property total 12,400 kilograms.

Alaska-Juneau Mine.—Echo Bay Alaska is nearing completion of an 18-month, \$15-million underground ex-

ploration program at the Alaska-Juneau (A-J) gold mine in the State's capital city; the mine has been closed since 1944. Mine reserves are estimated at 91 million metric tons of ore containing 159,000 kilograms of gold. The Juneau Planning Commission authorized a large-mine permit for the A-J Mine in May 1993, setting over 160 restrictions on the mine's operation regarding noise, water quality, insurance, hazardous material handling, and air quality. A State Superior Court judge upheld the operator's permit, but another appeal by environmental groups was filed with the State Supreme Court in November 1994. The company still needs an additional 20 State and Federal permits before the mine can open.

Also in late 1994, the EPA released a Technical Assistance Report on the A-J Mine, criticizing Echo Bay's proposed tailings impoundment dam on Sheen Creek. The proposed dam would be 101 meters high and 275 meters long, impounding 91 million metric tons of tailings over a 1.6-square-kilometer area. A proposed hydroelectric plant for the mine, sited at the tailings dam, would have to be licensed by the Federal Energy Regulatory Commission. The EPA report also expressed concerns as to Echo Bay's ability to meet Federal water quality standards for its proposed wastewater discharge in Gastineau Channel. The company is currently re-evaluating all options to address the above concerns. This process will involve a second look at three EIS alternatives for tailings impoundment on FS lands.

In a related case, a Juneau-area miner is petitioning the courts to determine ownership of mine tailings from the original working of the A-J Mine. Reprocessing of the tailings could yield an estimated \$200 million in gold.

OTHER METALS

Red Dog Mine.—Increased capacity of grinding circuits at the ore-processing mill allowed a 25-percent increase in concentrate production from the Red Dog zinc-lead-silver mine in northwestern Alaska. Red Dog is North America's leading zinc mine, producing 298,466 metric tons of zinc in 1994; this was 100 percent of Alaskan zinc production and 64 percent of total domestic production. Measured reserves at the mine are 58.2 million metric tons of ore containing 10.7 million metric tons of zinc, 3.2 million metric tons of lead, and 5.4 million kilograms of silver. A major upgrade of the mill facility that will allow the production of a cleaner zinc concentrate was completed in 1994. The Red Dog Mine is owned by the NANA Native regional corporation and operated by Cominco-Alaska Incorporated.

Johnson River property.—Westmin Resources Limited continued exploration at the Johnson River polymetallic prospect in Lake Clark NP&P. The property is owned by CIRI, which received title to interests in the

Johnson tract by terms of the 1976 Cook Inlet Land Exchange. Over the past 12 years, 70 boreholes have been drilled into the orebody; reserves are estimated at 1.03 million metric tons of ore containing 10,650 kilograms of gold, 8,850 kilograms of silver, 86,200 metric tons of zinc, 12,050 metric tons of lead, and 7,800 metric tons of copper. Ore from the proposed underground mine would be trucked 23 kilometers to Cook Inlet and barged to Westmin's mill at Stewart, British Columbia. Because the Johnson River property is surrounded by National Park lands, the transportation route from the mine to the inlet needs mutual agreement between CIRI and the NPS. Work to assess the alternative transportation routes is ongoing.

Red Mountain ultramafic body.—Metallurgical testing on chrome samples from the Red Mountain deposit near Seldovia has shown the ore suitable for production of chrome and ferrochrome products, used in the manufacture of stainless steel; ore was last taken from the area during the Korean War. North Pacific Mining also sampled the deposit to test olivine for industrial uses.

Greens Creek Mine.—The Greens Creek silver-lead-zinc mine, operated by the Kennecott Greens Creek Mining Company, remained closed during 1994, but the company continued work toward reopening the mine in late 1996 or early 1997. Exploration and underground development work occurred throughout the year. The one active surface site for waste rock deposition approached capacity, and site preparation began on a new waste site in close proximity to the mill. Measures were incorporated into the design of the site to divert groundwater and reduce zinc concentrations in the runoff. The mine's environmental monitoring program was refined. Revisions to the General Plan of Operations included a timber sale, rerouting of a portion of the main access road, and construction of an additional sediment settling pond.

ACTIVITY BY FEDERAL AGENCIES

U.S. GEOLOGICAL SURVEY

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. Published products include geologic maps and cross sections; mineral-resource assessments, maps, and tables; geochemical and geophysical surveys; and research summaries and reports. The status of AMRAP quadrangles and locations of site-specific AMRAP projects are shown on figures 14 and 15.

Level I AMRAP.—Level I studies are statewide in scope, and published maps are generally at a scale of 1:2,500,000. A tectonostratigraphic terrane map for the State was recently published (Nokleberg, Moll-Stalcup,

and others, 1994). The State of Alaska Mineral Resource Assessment project (SAMRAP) was initiated by the USGS in 1993 to compile geologic and mineral-resource data. The purpose of the SAMRAP assessment is (1) to prepare tables of significant lode and placer deposits by revising data from the MRDS into an Alaskan Resource Data File (ARDF); (2) to prepare regional maps, with data tables, showing permissive mineral-resource assessment tracts; and (3) to prepare quantitative estimates of the undiscovered resources of copper, lead, zinc, gold, and silver in selected mineral-deposit types for selected tracts. There are presently 4,428 records in the ARDF. SAMRAP involves members of the Branches of Alaskan Geology, Geophysics, Geochemistry, and Resource Analysis.

Level II AMRAP.—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 of geology and mineral resources are ongoing on the Alaska Peninsula and in the eastern Alaska Range. Several papers of regional scope have been published on the mineral deposits of southeastern Alaska (Alpha and Ford, 1994; Brew, 1994; Miller and others, 1994).

Level III AMRAP.—Level III studies consist of multidisciplinary evaluations involving team studies of selected 1:250,000-scale quadrangles; these continue to be the primary focus of AMRAP. Areal assessments are based on the integration of geologic, geochemical, and geophysical data to estimate the probability of occurrence of certain mineral resources within delineated tracts of geologic favorability. Favorability is ranked as low, medium, or high based on an evaluation of geologic features and attributes present within each tract. Fieldwork is complete, and reports are in preparation or in press, for the Baird Mountains, Bethel, Chandler Lake, Craig/Dixon Entrance, Goodnews Bay/Hagemeister Island, Gulkana, Iditarod, Killik River, Lime Hills, Livengood, Port Moller/Stepovak Bay/Simeonof Islands, and Survey Pass quadrangles. Fieldwork will continue, as funding permits, in the Atlin/Juneau/Skagway/Taku River, Howard Pass, Sitka, and Sleetmute quadrangles. Mineral-resource maps were released for the Anchorage quadrangle (Madden-McGuire and Winkler, 1994), and geologic maps were released for the Iditarod quadrangle (Miller and Bundtzen, 1994) and Mt. Katmai quadrangle (Riehle, Detterman, and others, 1994). Geochemical studies were published for the Medfra quadrangle (King, Risoli, and Cooley, 1994), Mt. Katmai quadrangle (Church, Riehle, and Goldfarb, 1994), and the Craig area in southeastern Alaska (Cathall, 1994). To date, Level III AMRAP assessments have been completed for 34 quadrangles. There now have been approximately 715 reports published under AMRAP.

Level IV AMRAP.—Level IV studies consist of areal mineral-resource assessments, framework or process studies, and exploration geochemistry; projects incorporate

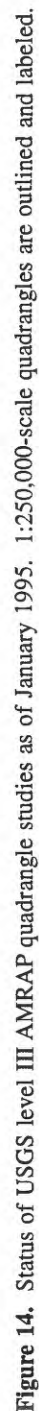


Figure 14. Status of USGS level III AMRAP quadrangle studies as of January 1995. 1:250,000-scale quadrangles are outlined and labeled.

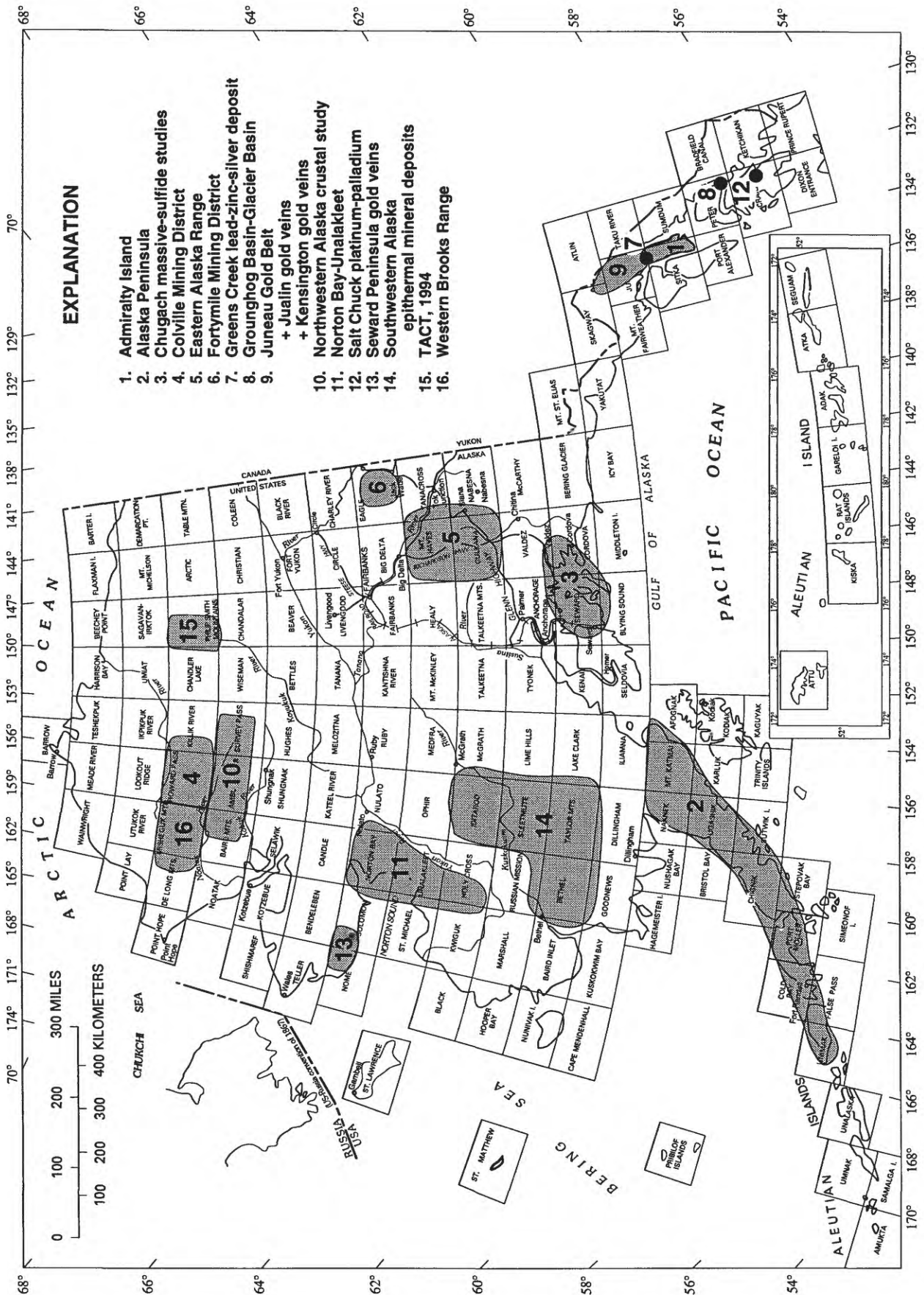


Figure 15. Locations of USGS level II and level IV AMRAP metallic-mineral studies and TACT studies in 1994. 1:250,000-scale quadrangles are outlined and labeled.

detailed mapping (1:63,360 or larger scale), sampling of individual mineral deposits or mining districts, and related field and laboratory research. Ongoing Level IV activities in Alaska (fig. 15, table 10) include four projects that are statewide in scope; four studies of general geology, mineral resources and deposits, and metamorphic terranes in the central and western Brooks Range; a study of lode gold veins on the Seward Peninsula; five studies of mineral resources and the geologic evolution of eastern and south-central Alaska; four studies of general geology and mineral resources in southwestern Alaska; and six studies of precious- and base-metal deposits in southeastern Alaska. The geologic map of the Gulkana A-1 quadrangle was released (Richter and others, 1994).

Research summary.—The annual report on USGS field and laboratory studies of mineral and energy resources and the geology of Alaska has been issued for 1993 (Till and Moore, 1994). Metallic mineral resource studies in this publication include reports on isotopic constraints on the genesis of base-metal-bearing mineral occurrences near Columbia Glacier, northern Prince William Sound (Goldfarb and others, 1994); gold in heavy-mineral-concentrate samples from the Howard Pass quadrangle (Kelley and others, 1994); and calculated gold resources in Circle and Fortymile placers (Yeend, 1994). Mineral-resource studies related to environmental problems include reports on mercury in the environment in the Kuskokwim River region (Gray and others, 1994); high arsenic content in sediments from the Koyukuk NWR in west-central Alaska (Eppinger, Motooka, and Sutley, 1994); and environmental geochemistry of mesothermal gold deposits in Kenai Fjords National Park, south-central Alaska (Cieutat and others, 1994).

Geology of Alaska.—A recently published synthesis volume on the geology of Alaska was largely the work of USGS researchers (Plafker and Berg, 1994a). The 2-volume publication contains chapters on the geology of individual regions of the State, plus topics of statewide magnitude, including an overview of the geology and tectonic evolution of Alaska (Plafker and Berg, 1994b). Chapters also describe the metallic minerals (Nokleberg, Brew, and others, 1994), petroleum (Magoon, 1994a), coal and peat (Wahrhaftig, Bartsch-Winkler, and Stricker, 1994), and geothermal resources (Miller, 1994) of Alaska.

PRECIOUS METALS

USGS geologists were involved in two studies of precious-metal occurrences in Alaska. A comprehensive study of the Fortymile Mining District covers placer geology, heavy minerals, bedrock geology, stream and terrace profiles, gold source and resource, and current mining operations, as well as a history of mining in the

Table 10. Level IV studies of USGS AMRAP and related projects active in 1994.

[Project chiefs are listed in parentheses. Projects marked by asterisk are of statewide scope; other locations shown on figure 15]

Areal mineral-resource assessments	
Alaska Peninsula, geology and mineral resources (F.H. Wilson)	
Aleutian Islands, geology and mineral resources (F.H. Wilson)	
Chugach Special Study Area, geology and mineral resources (S. Nelson, USGS; G. Sherman, USBM)	
Colville Mining District, geology and mineral resources (J.H. Dover, USGS; S. Fechner, USBM)	
Eastern Alaska Range, metallogenesis (W.J. Nokleberg)	
Fortymile Mining District, placer gold deposits (W.E. Yeend)	
Juneau Gold Belt, lode gold deposits (R.J. Goldfarb)	
Norton Bay-Unalakleet area, geology and mineral resources (W.W. Patton, Jr.)	
* Placer gold deposit studies (W.E. Yeend)	
Western Brooks Range, mineral deposits (J.M. Schmidt)	
Framework or process studies	
* Alaska mafic and ultramafic rocks (R.A. Loney)	
* Alaska metamorphic-facies map (C. Dusel-Bacon)	
Central Alaska metamorphic studies and structural analysis (J.H. Dover)	
Chugach massive sulfide deposits, geochemistry (S.W. Nelson)	
Greens Creek lead-zinc-silver massive-sulfide deposit (R.S. Newberry and D.A. Brew)	
Groundhog Basin-Glacier Basin silver-tin-lead-zinc deposits (R.J. Newberry and D.A. Brew)	
Jualin and Kensington low sulfide gold-quartz-vein deposits (R.S. Newberry and D.A. Brew)	
Northwestern Alaska crustal study (A.B. Till)	
* Paleomagnetism of accreted terranes (C.S. Gromme)	
Salt Chuck platinum-palladium deposits (R.A. Loney)	
Seward Peninsula gold veins (B.M. Gamble)	
Exploration geochemical studies	
Western Brooks Range, stratabound base-metal deposits (K.D. Kelley)	
Southwestern Alaska, epithermal mercury deposits (J.E. Gray)	
Admiralty Island geochemistry (C.D. Taylor)	

region on a creek-by-creek basis (Yeend, 1995). A second study focuses on the structure, tectonic setting, and origin of turbidite-hosted lode gold deposits in the Kenai and Chugach Mountains.

STRATEGIC AND CRITICAL MINERALS

Current research on the occurrence of undiscovered strategic and critical minerals in Alaska includes studies of mafic and ultramafic rocks and their associated deposits of platinum-group metals (PGM), chromium, nickel, and cobalt.

ENVIRONMENTAL STUDIES

The USGS and ADGGS continued working on a cooperative study of the geology and mineral resources of

the Sleetmute quadrangle in southwestern Alaska, a project that began in 1993. Because mercury mining has occurred extensively throughout the Kuskokwim River corridor where the regional population is concentrated, an assessment of environmental mercury and potential related hazards was included in the study. In addition to mercury mines (frontispiece) and occurrences of native mercury, mercury may have been introduced into the area at some gold placer sites during the milling process. When the USBM joined the project in 1994, studies were expanded to include abandoned mine hazards and mine-site mercury contamination.

Approximately 1.24 million kilograms of mercury have been produced from mines in the area (fig. 16). Mercury, particularly in organic compounds such as methylmercury, is toxic to human and animal life. To evaluate this possible hazard, studies were designed to (1) determine the natural background levels of mercury in the area, (2) determine if mining has increased the bioavailability of mercury, and (3) determine whether hazardous levels of mercury are locally present. Helicop-

ter-supported fieldwork was conducted for 3 weeks in 1994. Regional geochemical sampling was completed for seven 1:63,360-scale quadrangles. The USBM visited the known mercury mines and prospects to collect water, stream-sediment, soil, and tailings samples. The USGS sampled stream sediments, soil, water, plants, and fish at sites downstream from the mercury mines and in areas away from known mineralization (Gray and others, 1994). These geologic and geochemical studies provide not only a framework for evaluating environmental mercury, but also the necessary data to assess the potential for undiscovered mineral deposits.

The USGS is also investigating the environmental effects of unmined silver-lead-zinc deposits in the northwestern Brooks Range. Geochemical data were used to assess metal contamination in local streams due to weathering of the deposits; some waters were found to be toxic to fish and exceed the maximum levels allowed for safe drinking water. Knowledge of the natural concentrations of metals in these waters will aid in predicting the potential effects of mining these deposits.

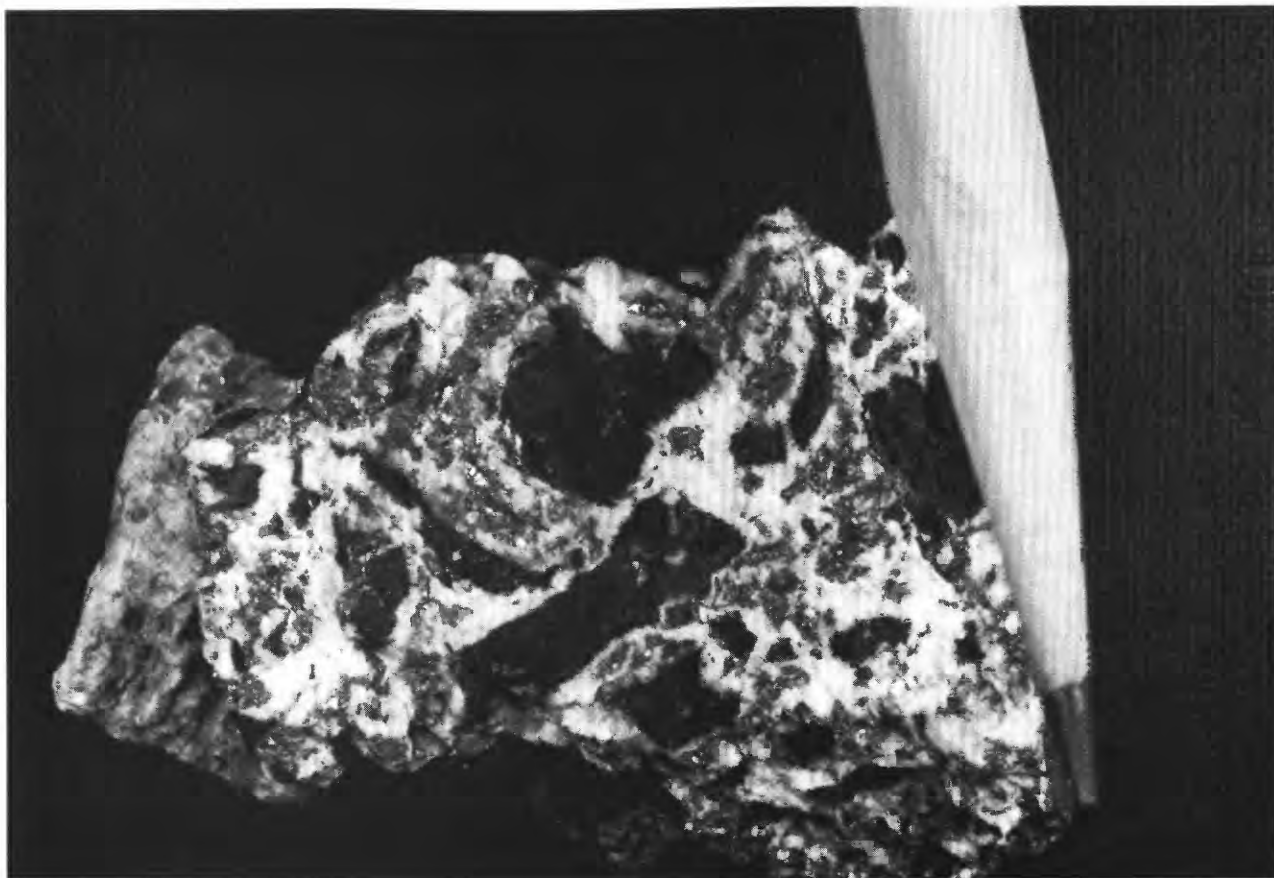


Figure 16. A specimen of cinnabar, the mercury-bearing ore mineral, from Red Devil Mine in Sleetmute quadrangle in southwestern Alaska. The USGS, USBM, and FWS are assessing the potential hazards of mercury in the environment in the region. Photograph by J. Gray, USGS.

COOPERATIVE PROGRAMS WITH FOREIGN SCIENTIFIC AGENCIES

The USGS has been involved since 1989 in a collaborative project to produce a series of mineral deposit, metallogenic, and tectonic maps; tabular descriptions of mineral deposits; and a 3-D time-space model for metallogenesis in the Russian Far East, Alaska, and western Canada (Bundtzen and others, 1994; Nokleberg, Bundtzen, and others, 1994). This study is a cooperative effort of the Russian Academy of Sciences, Russian Committee on Geology, ADGGS, Geological Survey of Canada, and USGS. The USGS and Russian Academy of Sciences are also producing an analysis of the ophiolites and associated mineral deposits that occur in the Russian Far East (Khanchuk, Palandzjan, and Panchenko, 1994). Funded by a U.S. State Department grant, computer equipment and software were purchased and delivered to four Russian institutes in November 1994 to facilitate publication of the reports and maps in Russian.

The Russian Far East is relatively unexplored for mineral deposits with respect to modern prospecting. If Western scientific techniques and concepts are utilized, the region holds great potential for (1) discovery of new deposits, (2) development of known deposits, and (3) reprocessing of old mine dumps; the technology also could be employed to clean up abandoned mining sites. At present, USGS scientists are creating a computerized data base of approximately 450 lode deposits and 75 placer mineral districts of the Russian Far East. A comparable data base has also been created for Alaska and western Canada. The data consist of mineral deposit maps, extensive tabular descriptions, and modern-day tectonic maps for the regions.

A 1-week trip by USGS scientists in November 1994 to southern Siberia generated discussion for a new project on the mineral resources, fuel resources, and tectonics of eastern and southern Siberia. The new project will be a collaborative study of the Russian Academy of Sciences, Russian Committee on Geology, Academy of Sciences of Mongolia, and USGS. Funding for the new project will be pursued through national government agencies, international organizations, and private industry. The new project is modeled on the study of metallogenesis in the Russian Far East, Alaska, and Canadian Cordillera described above.

TRANS-ALASKA CRUSTAL TRANSECT

The TACT program is an integrated, multi-disciplinary study of the Earth's crust along a transect from the Gulf of Alaska to the Arctic Ocean. The program combines data from geologic and geophysical surveys to decipher the deep-crustal structure of Alaska. Research includes geologic mapping; specialized structural, isoto-

pic, geochemical, and paleontologic studies; seismic reflection and passive seismic studies; magnetotelluric studies; and gravity and magnetic surveys. In 1994, scientists continued the compilation of geologic maps and interpretation of geophysical data for the Brooks Range section of the transect (Fuis and others, 1994; Levander and others, 1994; Wallace, Moore, and Plafker, 1994; Wissinger and others, 1994); geologic and geophysical data were also integrated to produce geologic and structural cross sections of Alaska's crust (Beaudoin and others, 1994; Moore, Grantz, and Roeske, 1994). Although mainly a deep-crustal structure program, results from the TACT program are used for mineral-resource assessment studies, formulation of tectonic models of mineralization, and minerals exploration by private industry.

COLVILLE MINING DISTRICT

At the request of the BLM, the USGS and USBM initiated a cooperative 4-year investigation of the mineral resources in the Colville Mining District in 1990; the BLM will use the results of the study in its land-planning decisions for the district. Geologic information from USGS fieldwork and analytical research was provided to the USBM for inclusion in the final reports. Results from further USGS investigations in the Howard Pass quadrangle, which includes part of the Colville Mining District, will be made available to the BLM as they are produced.

CHUGACH NATIONAL FOREST SPECIAL STUDY AREA

At the request of the FS, the USGS and USBM completed an estimation of the undiscovered and discovered mineral endowment of a selected area in the Chugach National Forest between Unakwik Inlet and Columbia Glacier in Prince William Sound. The investigation included geologic mapping, prospect evaluation, rock and stream geochemistry, structural analysis, geochronology, and isotopic studies. The mineral assessment has been published (Nelson and others, 1994), and a geologic map is planned for release in late 1995. During the summer of 1994, the USGS began a pilot study of abandoned mines to determine the environmental impacts of past mining on drainage systems in the Chugach National Forest. Selected copper-sulfide mines were evaluated in the first year of the study (fig. 17); lode gold and other mines will also be inspected. The results of these studies will be incorporated into the Chugach Land Management Plan, a part of which seeks to develop and maintain an inventory of all resources, including mineral values and the environmental effects of mineral development.

U.S. BUREAU OF MINES

The USBM's Alaska Field Operations Center is responsible for conducting four programs under the USBM's Directorate of Information and Analysis and for coordinating work with other USBM field and research centers throughout the United States. The USBM's Research Directorate was responsible for several projects in Alaska during 1994, through both the Mineral Institute program and the nine USBM research centers.

MINERALS AVAILABILITY PROGRAM

Submarine tailings disposal.—In some coastal mining situations, deep marine disposal of mill tailings may be the preferred method of tailings disposal from an environmental standpoint. In 1991, the USBM initiated studies to assess the technology, environmental aspects, and current regulations relating to this method of tailings disposal, and to project effects on the availability of minerals from domestic sources if this disposal tech-

nique were permissible in the United States. Publications include an overview with extensive bibliography (Baer, Sherman, and Plumb, 1992), compilations of North American (Poling and others, 1993) and worldwide (Ellis, Poling, and Pelletier, 1994) case studies, and an analysis of the biological literature related to the potential consequences of submarine disposal (Kline, 1994). Alaska-specific reports are a study identifying seven known mineral deposits along Alaska's southern coast that could benefit economically from the use of submarine disposal, three in the near term and four in the long term (Coldwell and Gensler, 1993), and a study documenting the regulatory aspects of the 14-year attempt to obtain operating permits for a submarine disposal operation at the proposed Quartz Hill Mine (Hesse and Reim, 1993).

Ore characteristics.—The USBM is compiling a data set outlining ore mineral characteristics that are specific to mining and milling scenarios for a given commodity; information on costs and engineering is also included. These data will provide for the rapid analysis of mineral-related issues and policies.



Figure 17. Abandoned and leaking fuel barrel at Duchess Mine in Chugach National Forest. The USGS has begun an investigation to assess the environmental impacts of past mining activities on drainage systems within the forest, and the USBM is evaluating hazards associated with inactive and abandoned mines for the FS. Photograph by S. Nelson, USGS.

Public minerals information.—Using a Geographic Information System (GIS), the USBM developed computer files of data describing mineral terranes and known mineral deposit areas of hard-rock mineral resources in Alaska (Resource Data, 1995); this should prove a useful tool for land planners and others who require up-to-date and accurate mineral-resource data. Also in 1994, the MAS data base was enhanced with the entry of minerals information from the Colville Mining District and the Fortymile River/Black River BLM planning units. Mineral data were provided in digital format and as map overlays and deposit reports to the State of Alaska, the FS, mineral consultants, and private individuals.

POLICY ANALYSIS

Mine permitting in Alaska and British Columbia.—The United States and Canada each have a well-developed regulatory process for permitting mine development while evaluating the potential environmental impact of a proposed operation. The USBM has published a comparative analysis of the environmental regulatory structures and permitting required for mine development in Alaska and British Columbia (Cocklan-Vendl and Hemming, 1993), case studies of regulatory permitting for four mines in Alaska and British Columbia (Andrews, 1993; Brownlow, 1992; Cocklan-Vendl and Hemming, 1992; Gardner, 1992), and a preliminary analysis of the effects of environmental regulation on mines in southeastern Alaska (McDonald and Martin, 1992). Case studies of mines in Alaska and three other western States evaluate the effect of regulatory structures on project design and timelines (Martin and McDonald, 1995) and the efficiency of the regulatory structures on environmental compliance (McDonald and Martin, 1995).

Ecosystem-based regulation and the mining industry.—The FS and other Federal land management agencies are incorporating the concepts of ecosystem management into their land-planning and management decisions. As a cooperating agency, the USBM is developing an analytical framework for evaluating the mining-related implications of proposed policies and regulations, such as the effect that ecosystem management concepts have had on the environmental permitting process for major mines in Alaska (Plumb and Gensler, 1993). The USBM also used digital environmental data from the FS and impact analysis scenarios from other agencies to create a GIS-based model of the ecosystem surrounding the Greens Creek Mine on Admiralty Island near Juneau (Plumb and Gensler, 1994); this model can be used to evaluate the impacts of mine development on wildlife habitat, both with and without the mitigation required by the FS, the mine's land management agency.

STATE MINERAL ACTIVITIES

The annual preliminary "Mineral Industry Survey of Alaska in 1993" summarized significant nonfuel-mineral activity. State legislative and executive actions of interest to the mineral industry were monitored and reported throughout the USBM on a monthly basis. News items were prepared for the weekly "Mineral Alerts" and for the bimonthly "Minerals and Materials." Mineral briefing profiles were prepared for DOI and USBM officials as required. Mineral news of interest to USBM staff and its commodity specialists was forwarded to them weekly.

Minerals information and analysis are provided through a series of scheduled and unscheduled publications and reports and through responses to inquiries from State and Federal agencies, industry, and the public. One priority is the identification and evaluation of issues, problems, and trends, in order to provide the USBM additional opportunities for constructive action in the minerals field.

MINERAL LAND ASSESSMENT

USBM mining district studies (fig. 18, table 11) are designed to determine the mineral-development potential of each district by inventorying mineral resources and reserves, evaluating the probability that more resources exist, and determining the feasibility of mining certain deposit types. Site-specific evaluations are undertaken when the presence of significant minerals is noted. The studies are done in cooperation with Federal and State agencies. In 1994, the USBM investigated the Colville and Ketchikan mining districts, the Sitka and Hoonah ranger districts, the Gulf of Alaska, and two BLM planning units. The USBM also is assessing abandoned mine hazards for the FS, BLM, and NPS.

Colville Mining District.—The Colville Mining District is located in northern Alaska and includes the southern part of NPRA. Since 1990, the USBM, USGS, and BLM have cooperated in a study of the geology and mineral deposits of the area, providing much new information on the mineral-resource potential of the district. The USBM identified 48 mineral deposits and occurrences, 27 of which were new discoveries (Meyer, 1994). Lead-zinc-silver mineralization occurs primarily in massive stratiform deposits, vein breccias, and sandstone-hosted disseminated deposits in the southwestern third of the district. Bedded barite deposits occur in the western half of the district, and sedimentary phosphate deposits in the eastern half. Coal is abundant in the northwestern part of the district. Mining feasibility studies of the lead-zinc-silver, barite, and coal resources found no economically viable deposits at the present time (Coldwell and Gensler, 1995). Areas in the central and eastern parts of

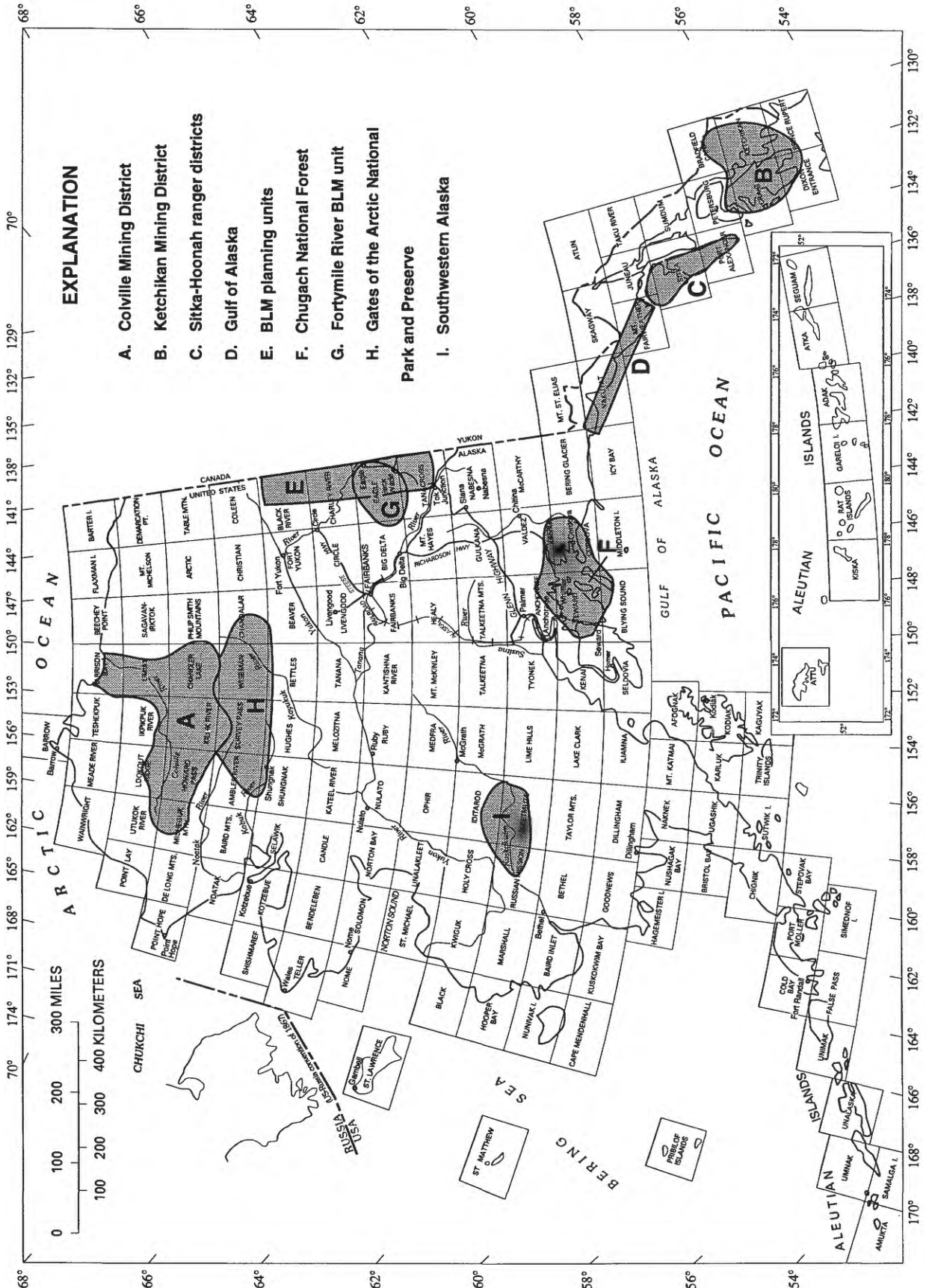


Figure 18. Locations of 1994 USBM study areas listed in table 11. 1:250,000-scale quadrangles are outlined and labeled.

Table 11. USBM study areas in 1994.

[Locations shown on figure 18. REE, rare-earth elements; PGM, platinum-group metals]

Area of study	Deposit or element of major interest
District Studies	
A. Colville Mining District	Lead, zinc, barite, phosphate, coal
B. Ketchikan Mining District	Placer and lode gold, massive sulfide, chromium, REE, PGM
C. Sitka-Hoonah ranger districts	Copper, lead, zinc, nickel, gold
Site-Specific Mineral Investigations	
D. Gulf of Alaska	Titanium
BLM Planning Units	
E. Fortymile River/Black River units	
Abandoned-Mine Land Hazards	
F. Chugach National Forest	
G. Fortymile River BLM unit	
H. Gates of the Arctic National Park & Preserve	
I. Southwestern Alaska	

the district have the highest potential for future mineral discoveries.

Ketchikan Mining District.—The USBM's 4-year study of the Ketchikan Mining District provided mineral data to the FS for revision of the Tongass Land Management Plan. Work was performed on 446 mines, prospects, and mineral occurrences within the 28,288-square-kilometer district. Over 4,800 mineral samples were collected, and several kilometers of underground and surface workings were mapped. A variety of mineral deposits were examined; metallic resources include copper, silver, gold, uranium, lead, zinc, tungsten, molybdenum, chromite, iron, PGM, and rare-earth elements. Limestone deposits were also investigated (Harvey and Murray, 1994). The final reports for this study will cover resource descriptions and evaluations, beneficiation techniques, economic feasibility studies, and a discussion of ecosystem issues relevant to mineral development activities (Coldwell and Gensler, 1995; Maas, Bittenbender, and Still, 1995).

Sitka and Hoonah ranger districts.—The FS requested the USBM to perform a mineral-resource evaluation of the Sitka and Hoonah ranger districts of the Tongass National Forest in southeastern Alaska. The study area covers 10,436 square kilometers, of which the FS manages 87 percent and the State, 9 percent; the remainder is Native and community lands. Mineralization has been identified at 211 localities, and the areal geology is favorable for a variety of mineral deposit types, including copper-zinc-silver massive sulfide, vein gold,

copper-molybdenum porphyry, and nickel-copper-cobalt-PGM magmatic segregation. A field reconnaissance of the area was conducted during August 1994. Major deposits, important geologic features, and logistics were reviewed in preparation for fieldwork during 1995 and 1996.

Gulf of Alaska.—The USBM completed field investigations to determine the titanium resource potential of beach sands along the coast of the eastern Gulf of Alaska during 1993; data compilation and analysis continued in 1994. Titanium is found in ilmenite and rutile in the valuable heavy-mineral fraction of the sands. A total of 546 samples were collected in the Cape Yakataga, Yakutat, and Mt. Fairweather areas from the intertidal zone, beach face, back beach, and wave-cut beach terraces. Analytical results allowed calculation of identified resources in modern shoreline deposits at 450 to 500 million metric tons of sand containing 0.57 to 3.4 percent valuable heavy minerals; an undetermined gold byproduct was estimated at less than 0.06 grams per metric ton. Unexplored resources also exist both inland and offshore of the areas investigated in this study. A final report will be completed in 1995.

BLM planning units.—The BLM requested the USBM to conduct a mineral-resource inventory of the Fortymile River and Black River planning units to be used in completing the Resource Management Plan for the areas. The 3-year study began with fieldwork in 1993 (Burleigh, 1994). Continuing field research will concentrate on refining the areal geology in order to better understand the known and potential mineral resources. Personnel from the University of Alaska at Fairbanks remapped the geology of parts of the Charley River, Eagle, and Tanacross quadrangles.

Abandoned-mine land inventory.—In 1994, the USBM evaluated abandoned mine sites in the Chugach National Forest for the FS, in the Fortymile River planning unit for the BLM, in Gates of the Arctic NP&P for the NPS, and in southwestern Alaska. Potential hazards at abandoned-mine sites include explosives, underground workings, collapsed structures, and process chemicals. In the Chugach National Forest, 93 sites were assessed, and a GIS data base was constructed. Most of the abandoned mines in the Fortymile River planning unit were visited in 1994, and a preliminary report will be completed in 1995. The USBM and NPS visited 10 abandoned mines in Gates of the Arctic NP&P. The USBM worked with the USGS to assess mercury contamination in southwestern Alaska; the data will be available in 1995.

MINERALS RESEARCH

Subaqueous disposal of mining wastes.—At the USBM Spokane Research Center, laboratory simulations of the subaqueous disposal of mining wastes have shown

no long-term release of toxic metals from depyritized tailings in an oxidizing environment. Because the tailings are benign, permits were granted for a site demonstration of the project in Auke Bay in southeastern Alaska. Approximately 1.4 metric tons of inert tailings has been placed in several containers on the bottom of Auke Bay; these will be retrieved individually over a 2-year period. The primary purpose of the demonstration will be to determine the benthic organism recolonization characteristics of the tailings and correlate these characteristics with pore water chemistry. Personnel from the University of Alaska/Southeast at Juneau will conduct the recolonization characterization, and USBM personnel in Spokane will characterize the pore water chemistry.

Analysis of underground mining.—Using data from the Greens Creek Mine in southeastern Alaska, the USBM is using computer simulations of mine design to plan maximum resource recovery with minimum waste and environmental impacts (fig. 19). A new technique called geovoxel modeling employs hexahedral volume elements to represent not only physical and chemical properties of a rock mass, but also abstract data such as safety factors, failure stress, displacement, and subsidence calculated from structural analysis. The results will enhance the environmental assessment of mining methods in sensitive and pristine areas, without the extensive preliminary development and test mining that is nor-

mally required. The success of the Greens Creek test case will ultimately allow for computerized design of environmentally compatible mining processes for other massive sulfide deposits in southeastern Alaska and coastal British Columbia.

Mining in permafrost.—To evaluate the structural stability of underground openings excavated in permafrost, the USBM installed monitoring equipment in a retreat room-and-pillar section of the Dome Creek drift mine, a small underground placer operation near Fairbanks (fig. 20). Data analysis indicates that (1) subfreezing temperatures did not impair instrument function; (2) substantial stress changes occurred in the frozen gravel pillars, even though permafrost gravels normally are slow to deform; (3) roof-to-floor closure depended on the span of the underground opening, proximity to active mining, and time since excavation; (4) the mine roof moved as a single unit, developing slabs along silt horizons or other planes of weakness; and (5) efforts to regulate the temperature of the underground workings were effective. Closure measurements validated the computer model of a typical cross section of the mine. Reports documenting the investigation are being completed.

Borehole slurry mining.—A public field trial of a prototype tool for selectively mining buried frozen placer deposits was conducted in 1994 on Rose Creek near Fox in central Alaska; Alaska placer miners were

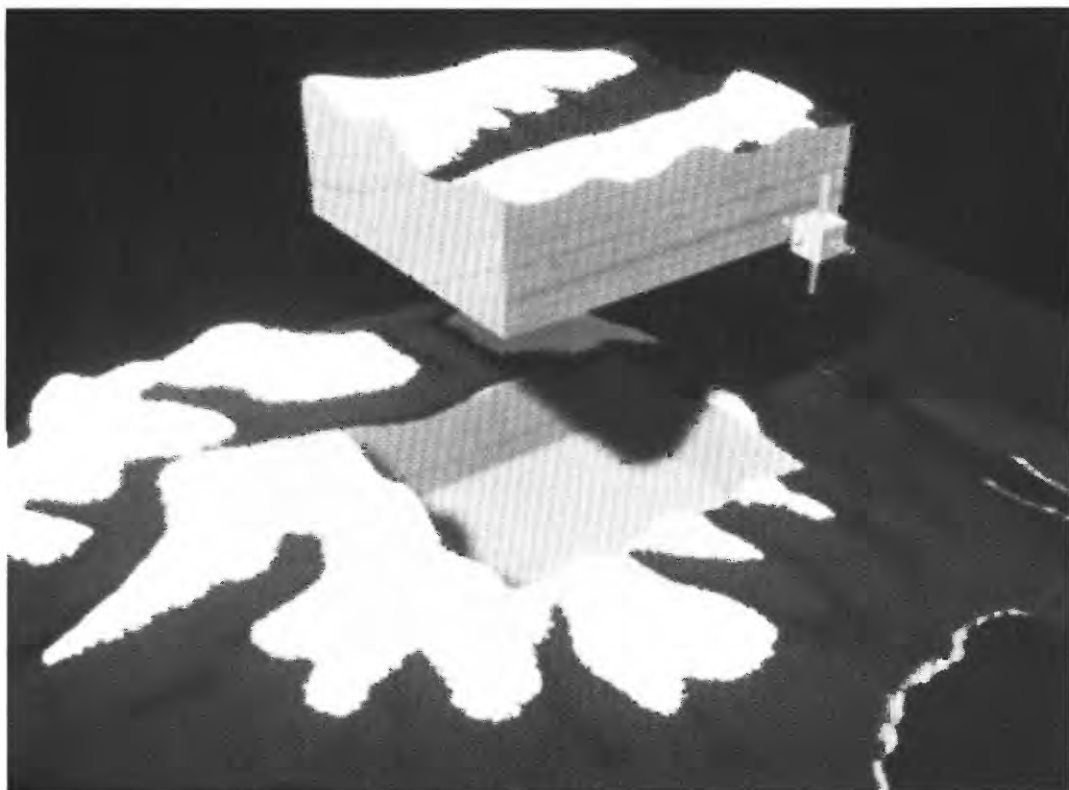


Figure 19. USBM computer analysis of the 3-D stress field surrounding the Greens Creek Mine area on Admiralty Island in southeastern Alaska. Photograph by M. Beus, USBM.

invited to provide feedback about the demonstration. After site preparation and preparatory exploration drilling, the borehole mining tools used high-pressure water streams to thaw and hydraulically lift placer gravel at approximately 4.5 metric tons per hour from 30-centimeter-diameter production holes. Optimum extraction resulted when two devices were placed within several meters of each other and alternately used in in-flow and production modes. After the test, in which a total of four holes was created, the resultant subterranean caverns were measured and photographed. Project reports will be prepared during 1995. This research will be redirected to address selective extraction of buried wastes for remediation.

Process mineralogy of Alaskan resources.—Beach sands from the Gulf of Alaska were mineralogically characterized. Ilmenite is the dominant titanium-bearing mineral in the valuable heavy-mineral fraction. The valuable heavy minerals average 0.57 percent by weight in Cape Yakataga samples, 3.4 percent in Yakutat samples, and 2.4 percent in Mt. Fairweather area samples.

Maritime archaeological project.—An experimental ground penetrating radar, developed at the USBM Pitts-

burgh Research Center, is being used to identify ancient Inupiat fishing village sites near Point Franklin in northwestern Alaska. The radar uses electromagnetic measurements to distinguish between materials such as bone, wood, coal, and rock, and 3-D images of the sites can be configured. Archaeological investigations can be directed to identified sites, avoiding costly excavation efforts at inappropriate localities. Begun in 1994, the project is funded by the National Science Foundation's Office of Polar Research and is a partnership of universities; private businesses; the North Slope Borough Commission on History, Language and Culture; and DOI agencies, including the USBM, NPS, BLM, and FWS. The project will continue for at least two more field seasons.

BUREAU OF LAND MANAGEMENT

In 1993, the U.S. Government began to require a fee of \$100 to be paid on each Federal mining claim, replacing the previous obligation of performing annual assessment work valued at \$100. As a result of this change, the



Figure 20. USBM monitor in the Dome Creek underground placer mine to determine the amount of roof subsidence from mining operations. Photograph by B. Seymour, USBM.

total number of filings on claims was down, and Small Miner Exemptions were also fewer. Some 5,519 claims were closed, and only 538 claims were accepted for recording, resulting in 12,280 Federal mining claims in Alaska at the end of 1994. No claims were patented, and none rejected.

The BLM's Division of Minerals extended its public outreach program in 1994. The Division provided support for gold panning activities as part of the Anchorage School District's annual Outdoor Week, and personnel gave classroom presentations on minerals and fossils in area schools. BLM geologists also began work on a roadside geologic guide for the Taylor Highway and Fortymile Wild and Scenic River area. This guide will identify rock types and mineral occurrences and will describe their geologic history. The work will also delve into the history of gold discovery and mining in the Fortymile district (fig. 21). This guide will supplement two previous BLM guides to the Dalton Highway (Diel and Banet, 1993) and the Denali Highway (Diel, 1991).

NATIONAL PARK SERVICE

MINING CLAIMS MANAGEMENT

Mining Plans of Operations.—In Bering Land Bridge National Preserve, one mining Plan of Operations was approved. In Denali NP&P, the NPS evaluated three proposed Plans of Operations and completed review on a fourth. One Plan of Operations was approved for Kenai Fjords National Park. In Wrangell-St. Elias NP&P, one Plan of Operations was received and reviewed, and a supplement to an existing Plan was received and approved. The only mining within Alaska park units in 1994 occurred in Wrangell-St. Elias NP&P, where two mining operations were active under existing permits.

Mineral validity examinations.—After the August 31, 1994, rental fee deadline, there were 584 administratively valid, unpatented Federal mining claims in Alaska park units. The NPS mineral validity program determines the mineral-resource validity of these mining claims. Va-



Figure 21. Gold-bearing creek in BLM Fortymile planning unit. The USBM is conducting a mineral-resource inventory of the area, the BLM is compiling a geologic guidebook for the road system, and the USGS is publishing a comprehensive study of resources and mining history of the Fortymile Mining District. Photograph from USBM files.

lidity determination is a necessary component in mining plan review and claim acquisition. In 1994, NPS mineral examiners investigated 9 lapsed mineral claims in Denali NP&P, 21 in Gates of the Arctic NP&P, and 9 in Wrangell-St. Elias NP&P, in order to determine their eligibility for selection by Native regional corporations under the Alaska Native Claims Settlement Act land entitlements. Mineral reports for these examinations should be completed within 2 years. In 1994, the BLM approved six NPS mineral reports and was reviewing six others. Seven additional reports were in preparation by NPS staff.

Mining claim acquisition.— Since 1991, Congress has appropriated \$11.8 million for mining claim acquisition in Denali NP&P, and the NPS has obligated \$6.4 million of this amount. During 1994, hazardous substance recertification surveys were completed for 5 patented and 13 unpatented mining properties; real estate appraisal inspections were completed for 6 patented and 6 unpatented properties. Offers were made for three properties: one patented property was purchased; a binding agreement was reached for the purchase of one unpatented property; and the offer to purchase a second unpatented property was met with an unsupported counteroffer that is pending documentation. In addition, a second patented property is the subject of an exchange proposal. The owners of six of the seven mining camps in the Kantishna Hills have entered into agreements for the relocation of their personal property from Denali NP&P. They will be reimbursed under the authority of the Uniform Relocation Assistance and Real Property Acquisition Policies Act.

Cultural resources mining inventory.—The Cultural Resources Mining Inventory and Monitoring Program continued to ensure that all mining-related activities in Alaska's national parks are in full compliance with Federal historic and cultural resource protection laws and regulations. Field crews conducted cultural resource surveys and performed compliance monitoring on mining activities in Denali NP&P, Gates of the Arctic NP&P, Wrangell-St. Elias NP&P, and Yukon-Charley Rivers National Preserve. The crews documented 10 historic mining sites during the 1994 season.

Land surveys.—The NPS conducts cartographic surveys to determine the locations of unpatented mining claims and claim boundaries within park units. In 1994, the NPS surveyed 8 claims in Bering Land Bridge National Preserve, 17 claims in Gates of the Arctic NP&P, and 6 claims in Wrangell-St. Elias NP&P. Computer-generated plots of the claims were produced at a scale of 1:1,200. These maps are used to facilitate minerals and resource management projects, including claim acquisition, validity examinations, mining plan reviews, hazardous waste surveys, reclamation projects, and property appraisals. The NPS also produced over 4,000 computer-generated cartographic, graphic, and engineering prod-

ucts in support of its management programs. Roughly 25 percent of those products was supplied to mining claimants, consultants, concessionaires, and other interested parties.

ABANDONED MINERAL LANDS RECLAMATION

Restoration program.—Within the NPS, abandoned mineral lands are managed under a multiphase Mineral Land Restoration program containing eight major components: inventory, explosives removal, hazard signing and reduction, hazardous material removal, debris removal, tailings and acid mine drainage remediation, recontouring and revegetation, and flood-plain restoration. The program is designed to eliminate or mitigate health and safety hazards, preserve significant cultural features, and re-establish natural environmental processes.

Restoration activities.—In 1994, restoration program activities took place in five park units. In Denali NP&P, cleanup activities were conducted at three former mining sites; 225 fuel drums, 4 lead-acid batteries, and 511 liters of abandoned fuel were removed from the park (fig. 22). In Gates of the Arctic NP&P, one site was cleaned; 275 empty fuel drums and a fuel bladder were removed (fig. 4). In Glacier Bay NP&P, one site was cleaned; three tons of debris and six drums of waste fuel were removed. Personnel used explosives and expanding polyurethane foam to seal three mine adits at the site. In Wrangell-St. Elias NP&P, 21 sites were cleaned; 226 empty fuel drums and 19 batteries were removed. In Yukon-Charley Rivers National Preserve, three sites were cleaned; 900 fuel drums, 18 batteries, and 9,436 liters of fluids were removed. The drums, batteries, and fluids from all site cleanups were delivered to recycling companies for metals and waste-fuel recycling.

Reclamation research.—During 1994, the NPS completed its sixth year of reclamation studies on an abandoned placer mine on Glen Creek in the Kantishna Hills of Denali NP&P. Research has focused on techniques for tailings stabilization, flood-plain and stream channel design and stabilization, and revegetation. Building on ideas that had been tested in previous field seasons (Densmore, 1994; Karle and Densmore, 1994a, 1994b), park staff modified stream channels and revegetated flood plains that had been impacted by flooding in 1992. Channel profiles were narrowed and deepened, stone weirs installed, and pool and riffle segments installed. On adjoining flood plains, stream banks and flood-plain surfaces were stabilized by root wad placement, brush bundle installation, willow planting, and a mixed top dressing of newly excavated soil and vegetation.

Hazardous waste.—The NPS responds to the Comprehensive Environmental Response, Compensation, and Liability Act for the cleanup of hazardous waste on mining properties. In 1994, the NPS completed one prelimi-

nary survey in Kenai Fjords National Park and three preliminary site assessments in Denali NP&P on former mining properties.

AMRAP AUTHORIZATIONS

As mandated in Section 1010(b) of the ANILCA, the NPS has regulations to authorize AMRAP activities within park units. During 1994, four AMRAP projects were approved in four park units: the USGS worked in Kenai Fjords National Park, Noatak National Preserve, and Wrangell-St. Elias NP&P; and the USBM conducted studies in Gates of the Arctic NP&P.

U.S. FISH AND WILDLIFE SERVICE

Valid mining claims on lands established as national wildlife refuges by the ANILCA in 1980 remain valid if they are kept active. In 1994, there were 127 claims on 6 of the 16 refuges in Alaska: 70 claims on the Alaska

Peninsula NWR, 2 on the Arctic NWR, 2 on the Innoko NWR, 4 on the Tetlin NWR, 36 on the Togiak NWR and 13 on the Yukon Delta NWR. A mill site claim and six placer claims in the Arctic NWR were disallowed in 1993 by the BLM for nonconforming uses of a mining claim, lack of activity, and failure to pay filing fees; claimants are appealing the disallowance of four of the placer claims.

The FWS prepared reports of contaminant monitoring on the Innoko, Koyukuk, Nowitna, and Selawik NWR's, where placer mining occurs upstream of the refuges, but did not conduct fieldwork in 1994. The FWS responded to 67 ACE permit applications or permit modifications for mining-related activities. The FWS also provided comments and recommendations concerning the EPA's 1994 Technical Assistance Reports for the proposed A-J and Kensington gold mines in southeastern Alaska. The reports analyzed the proposed discharge of mine effluent into estuarine waters, the potential degradation of water quality, and potential effects on fish and wildlife resources.



Figure 22. NPS Abandoned Mineral Lands Reclamation crew members cut up 2 of the 1,632 abandoned fuel drums recovered from 29 former mining properties in 5 park units during the 1994 field season. Over 27 metric tons of empty drums, 41 lead-acid batteries, and 9,947 liters of waste fuels and oil were removed from park lands and delivered to recycling companies by the project team. Photograph from NPS files.

FOREST SERVICE

The FS oversees minerals exploration and development on 93,000 square kilometers of National Forest lands in 14 ranger districts in Alaska (table 1). Minerals-related work on National Forest lands requires FS authorization via approved Notices of Intent or approved Plans of Operations. There was a decrease in the number of requests filed with the FS in 1994: 41 Notices and 74 Plans, down from 51 Notices and 76 Plans filed in 1993.

MINERALS DEVELOPMENT ON FOREST SERVICE LANDS

Admiralty Island National Monument.—Low metals prices forced closure of the Greens Creek silver mine in April 1993, but the operator is working toward reopening the mine in late 1996 or early 1997. Kennecott Greens Creek Mining has installed a new telecommunications system, has completed the construction of a wastewater treatment facility, and continues to perform underground development work. In 1994, site preparation began on additional FS-approved waste-rock storage at the mine.

Juneau Ranger District.—The FS completed its final EIS for the Kensington gold project in early 1992; the EPA and ACE were cooperators in the EIS but have not issued their Records of Decision. In summer 1992, the FS also approved the Plan of Operations for mine development, contingent on the successful acquisition of all necessary Federal and State permits and certifications. The FS, Kensington Venture, and other agencies are cooperating to meet those conditions. The EPA completed its Technical Assistance Report to evaluate both short- and long-term impacts on water quality and the long-term ecological consequences of the project. Their findings and recommendations were developed to assist the ACE in determining compliance with Clean Water Act Section 404(b)(1) guidelines. Six recommendations were made for changes to the project; if accepted by Kensington Venture, these changes will need to go through the permitting process for approval by other agencies.

The FS cooperated with the BLM in the preparation of the EIS for the A-J Mine project, located near downtown Juneau. Sheep Creek was identified as the preferred alternative for tailings disposal in the final EIS, but a lawsuit was filed to prevent the exemption of the proposed tailings dam from regulation by the Clean Water Act. If the Sheep Creek site is ultimately overruled in court, the new preferred alternative might be one of three sites located on National Forest lands. The FS would then have to approve the selection before any tailings disposal could occur; approval would be extended through a Plan of Operations or a special-use permit.

MINERAL PATENTS

Admiralty Island National Monument.—The Pyrola Partnership application involves four lode claims at Pyrola, a barite-bearing lead-zinc-silver massive-sulfide deposit on Admiralty Island. The field examination on this case was conducted in July 1993, and completion of the report is expected in July 1995.

Juneau Ranger District.—The Tracy Partnership applied for patent on three lode claims at the Tracy zinc-copper-silver deposit, located in the Tracy Arm-Fords Terror Wilderness Area. The mineral report on this case was completed in 1994 but is being re-evaluated based on additional data submitted by the applicants.

Thorne Bay Ranger District.—The Newman application sought patent for 2 millsite claims and 11 lode claims covering the Poorman magnetite-copper-gold deposit on the Kasaan Peninsula, Prince of Wales Island. In September 1993, the FS mineral report recommended patent approval for only two of the lode claims, rejecting the remaining lode claims and millsites. The report is being re-evaluated at the request of the BLM.

EXPLORATION ON NATIONAL FOREST LANDS

Craig Ranger District.—Exploration continues for various metals in this area: base-metal volcanogenic massive sulfides at Trocadero Bay, copper and zinc on the Ruby Tuesday claims in Cholmondeley Sound, zinc-copper-lead at the Lucky Nell Mine, and gold on Lancaster Peninsula and the Nutka area. Mining claims are maintained at the Bokan Mountain uranium and rare-earth deposits (fig. 11). McLean Arm and Dall Island were prospected for high-quality limestone.

Hoonah Ranger District.—Assessment work on the Apex-El Nido gold property across Lisianski Inlet from Pelican consisted of surveying boundaries and access road alignment. In December 1993, the FS issued its Decision on the project's Environmental Assessment, and the Apex-El Nido project proponents are currently modifying their Plan of Operations for conformance.

Juneau Ranger District.—The Jualin gold project's claims lie adjacent to the Kensington claims, and both projects are exploring the geologic structure known as the Jualin Shear Zone. The Jualin property is owned by Coeur Alaska. 1994 exploration activities included geologic mapping and drilling of three holes to test extent of mineralization.

Sitka Ranger District.—Activities include gold prospecting near the head of Silver Bay and jade exploration in the vicinity of Blue Lake.

Yakutat Ranger District.—A validity examination was initiated on a mining claim within the Russell Fjord Wilderness Area. Before the report could be prepared,

the claim was voided by the BLM for not filing Annual Assessment Affidavits.

Ketchikan Mining District.—The USBM completed its 4-year study of the Ketchikan Mining District, which spreads out over several FS ranger districts in southeastern Alaska. Mineral data provided to the FS will be used in the revision of the Tongass Land Management Plan. Prince of Wales Island, in the western half of the district, is a likely exploration target because it has a substantial mineral endowment and an established road system; much of the land is also open to Federal mineral entry. The USBM reports will be published in early 1995.

ABANDONED MINE HAZARDS

From 1990 to 1994, the FS, USBM, and contracted consultants performed an inventory of abandoned and inactive mines in the Chugach National Forest. Of the 489 localities indicated by the USBM as associated with mining activities, 118 were examined during the inventory. Two classes of potential problems were identified: the physical hazards of deteriorated mine shafts and adits, cave-ins, unstable structures and equipment, and explosives; and the environmental hazards of toxic materials associated with mining and milling, such as mercury, cyanide, heavy metals, polychlorinated biphenols, asbestos, and petroleum products. Physical hazards were identified at 39 sites, and environmental hazards at 20 sites. Abandoned explosives were removed from 11 sites, and 10 sites were established for further environmental evaluation under the Comprehensive Environmental Response, Compensation, and Liability Act. Further remediation efforts will occur as funding permits.

INDUSTRIAL MINERALS

OVERVIEW OF INDUSTRY ACTIVITY

Production of sand, gravel, and building stone has remained relatively level for the past 8 years, both in value and quantity. In 1994, 12.6 million metric tons of sand and gravel was valued at \$41.95 million, and 3.1 million metric tons of building stone was valued at \$25.6 million (table 9). The value of jade and soapstone fluctuates yearly due to the varying quantities of raw and processed materials sold.

ACTIVITY BY FEDERAL AGENCIES

U.S. BUREAU OF MINES

In the Colville Mining District, the ADGGS completed a cooperative program with the USBM to compile

and generate digitized maps of industrial mineral localities. Numerous bedded barite deposits were located in the Cutaway Basin area in the central part of the district, and sedimentary phosphate deposits have been identified in the eastern part of the district near Monotis and Skimo Creeks. Potential exists for further discoveries of each deposit type in its respective area.

The USBM completed its assessment of industrial minerals in the Ketchikan Mining District. The district contains significant high-purity limestone resources (Harvey and Murray, 1994).

BUREAU OF LAND MANAGEMENT

By the end of fiscal 1994, the BLM had conducted 38 sand and gravel sales, 10 less than in 1993. Production was approximately 145,150 metric tons. In addition, 57 Free-Use Permits were issued to local governments for the extraction of sand and gravel for infrastructure development.

U.S. FISH AND WILDLIFE SERVICE

When compatible with refuge purposes, the FWS issues special-use permits for the sale and extraction of sand and gravel to support development activities in rural communities. No gravel sales occurred on Alaska refuges in 1994.

The Koyukuk and Nowitna NWR's jointly issued a special-use permit to the BLM for their Obsidian Hydration Study, a geologic and archaeological investigation of the Batza Tena obsidian source located near the confluence of the Indian and Koyukuk rivers (fig. 10). The project seeks to unravel the area's geologic record and to understand the history of human usage of obsidian from this site. Using the potassium-argon method, BLM archaeologists date the Batza Tena obsidian deposit at 43 to 46 million years in age. It is the oldest obsidian deposit in North America and has been used for at least the last 12,000 years by indigenous peoples to make spear, knife, and arrow points. The Batza Tena source is one of only three known obsidian sources in Alaska, and obsidian from this locality has been found in archaeological sites both on the North Slope and in the Tanana Valley. The site is considered important by both geologists and archaeologists because of its age and integrity.

FOREST SERVICE

The FS annually issues permits for the removal of many thousands of metric tons of sand, gravel, and stone from National Forest lands. Approximately 67,000 cubic

meters of shot rock was extracted through material sales and free-use permits on the Tongass National Forest in 1994; most of this material was utilized for Native corporation timber road construction. On the Chugach National Forest, approximately 826,000 cubic meters was extracted through material sales and free-use permits. The majority of this quantity was utilized by the Alaska Department of Transportation for public road construction and realignment, including the Exit Glacier Road and Seward Highway reconstruction projects.

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APPENDIX—ROLES OF FEDERAL AGENCIES IN MINERAL PROGRAMS

U.S. 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; and geohazards assessments, including toxic waste studies. Other mission work includes participation in multidisciplinary projects, maintenance of data bases, and publication of reports and maps.

Among other geologic activities in Alaska, the USGS is active in assessing the mineral potential of Federal lands in the State. Field and laboratory researchers gather information about petroleum, coal, uranium, and metalliferous mineral 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, California. During the summer field season, many USGS scientists from other branches within the Geologic Division conduct mineral-related research in Alaska. In this report, specific information on USGS programs, projects, and data bases is given under the USGS heading in the "Activities by Federal Agencies" sections of the chapters on Oil and Gas Resources, Coal and Peat Resources, Uranium Resources, and Metallic Minerals.

U.S. BUREAU OF MINES

The mission of the USBM is to help ensure that our country has an adequate, dependable supply of minerals and materials to meet its national security and economic needs at acceptable social, environmental, and economic costs. In 1994, the USBM's Alaska Field Operations Center had headquarters in Anchorage and an office in Juneau. The Center carries out its mission through five programs:

1. *Minerals availability program.*—This program is part of a worldwide USBM program responsible for developing the MAS computerized data base and the 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 in-

formation 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 cross-indexed to several other minerals-information data bases.

2. *Policy analysis.*—This program emphasizes the analysis of newly developed and existing mineral data to interpret their significance in the context of 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 program also provides the USBM with direct communication to the ADGGS, the Alaska Division of Mining, other minerals-oriented government agencies, industry, private firms, and individuals. The USBM collects, analyzes, and reports mineral data and develops information regarding activities and trends in the mining industry. This program produces the annual USBM Minerals 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 areal and commodity-oriented. In support of the Secretary of the Interior's mandate to assess the mineral potential of public lands in Alaska, the USBM 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 their economic feasibility. Legislative effects on mineral development will also be addressed. The USBM has completed its study of the Juneau and Valdez Creek mining districts; studies of the Colville and Ketchikan mining districts are in progress. The USBM also provides minerals data in support of FS and BLM activities in Alaska. The USBM acts as a mineral information resource in support of FS planning statewide and assists the FS in identification of mine hazards.

A statewide program provides an inventory and specific technical evaluations of Alaska's strategic and critical mineral and advanced materials deposits on Federal lands that are closed to mineral entry and on lands that are 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 by USBM research centers or at universities sponsored by the USBM's Mineral Institute Program. USBM and university research centers cooperate to solve mineral utilization problems.

MINERALS MANAGEMENT SERVICE

The MMS was created in 1982 with a twofold mission: (1) to collect and disburse revenues generated from mineral leases on Federal and Indian lands, and (2) to oversee the orderly development of America's offshore energy and mineral resources while properly safeguarding the environment. The MMS supervises mineral leasing, exploration, development, and production on the OCS. It is responsible for oil rig safety, oil rig pollution control regulations, determination of the environmental impact of resource development, and estimation of oil and gas resources. The MMS also has the authority to lease the OCS for ocean mining of hard minerals. At present, revenues from the Alaska OCS are primarily derived from competitive leasing activities; no development or production is occurring on the OCS at this time. The responsibility of the MMS for onshore Alaskan minerals is limited to the collection of royalties, bonuses, and rents from Federal and certain Native lands.

The MMS holds synthesis meetings, information transfer meetings, regional technical working group meetings, coordination team meetings, and public hearings on EIS's. To determine public concerns for consideration and inclusion in EIS's, scoping meetings related to specific planning or subject areas are held in the villages local to the area of concern. The public is invited to attend these meetings and can contact the MMS Regional Office for specific subjects, dates, and times.

In Alaska, the MMS is active in assessing the oil and gas potential of offshore basins through the analysis of geophysical and geologic data. This work is integrated into the Federal National Oil and Gas Resource Assessment and is a basis for evaluations of the potential monetary worth of individual OCS lease blocks, for appraisals of the resource potential of entire basins, and for the formulation of geologic models of basin development. The MMS conducts specialized studies of geologic and geophysical data obtained from COST wells and exploratory wells drilled on OCS lands. The results of these studies are published through the MMS OCS Report series or in appropriate scientific 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.

BUREAU OF LAND MANAGEMENT

The BLM manages Federal onshore mineral resources. The BLM also works cooperatively with the NPS, FWS, and FS to provide technical evaluation of the mineral-related issues on lands under these agencies' jurisdiction.

Management decisions concerning all minerals on the 372,312 square kilometers of land currently managed by the BLM in Alaska (fig. 1) are made through the Resource Management Planning process. The BLM first identifies the mineral potential of each planning unit. The effects of minerals exploration, development and production, and land abandonment and rehabilitation are then analyzed in regard to the needs and sensitivities of the other resources present. Mitigation measures are developed and evaluated to reduce or avoid adverse impacts of the anticipated mineral activities. Field monitoring of

all phases of mineral activity attempts to ensure that no unnecessary or undue degradation occurs. The BLM also provides resource management for retained Federal mineral estates on an additional 404,673 square kilometers.

NATIONAL PARK SERVICE

In 1916, Congress established the NPS and stated in its Organic Act that the fundamental purpose of the Nation's parks, monuments, and other reservations was "to conserve the scenery and natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" [39 Stat. 535, NPS Organic Act]. NPS management policies are based on the concept of ecosystem stewardship, conservation, and preservation, while providing for appropriate public enjoyment of the natural and cultural resources within individual units of the National Park System.

Congress enacted the Mining in the Parks Act in 1976, declaring that the continued application of the Mining Law of 1872 on park lands conflicts with the purposes for which parks were established. The Act closed all park lands to further mineral entry and stipulated that mining operations with prior existing rights "...be conducted so as to prevent or minimize damage to the environment and other resource values" [90 Stat. 1342].

The passage of the ANILCA in 1980 increased NPS involvement with minerals management issues. The Act expanded the National Park System in Alaska to over 206,391 square kilometers and incorporated over 4,000 unpatented and 1,800 patented mining claims and other private inholdings within park unit boundaries. The ANILCA identified specific minerals management directives for some park units and directed the NPS to permit mineral resource assessments by other federal agencies under the AMRAP.

The NPS manages mining-related activities on patented and unpatented mining claims via regulations found in Title 36 CFR, Part 9, Subpart A; non-Federal oil and gas development via regulations found in Subpart B; and AMRAP program activities via regulations found in Subpart D. Since 1990, NPS mineral management activities in Alaska have been directed by three U.S. District Court and 9th Circuit Court approved EIS's on the cumulative impacts of mining in Denali NP&P, Wrangell-St. Elias NP&P, and Yukon-Charley Rivers National Preserve. The Records of Decision in all three EIS's directed the NPS to acquire all mining properties within park boundaries, manage all future mining within the stringent guidelines of NPS regulations, and reclaim all lands impacted by mining. Since that decision, the NPS has developed and implemented a claim acquisition program, refined and expanded its claim management program, and developed and implemented a mineral lands restoration program.

U.S. FISH AND WILDLIFE SERVICE

The FWS provides Federal leadership to conserve, protect, and enhance fish and wildlife and their habitats for the con-

tinuing benefit of people. In Alaska, the FWS seeks to accomplish this mission through programs that implement provisions of the Endangered Species Act, Marine Mammals Protection Act, Fish and Wildlife Coordination Act, National Wildlife Refuge System Administration Act, ANILCA, Rivers and Harbors Act, Clean Water Act, various migratory bird laws and treaties, and other statutes.

Under the ANILCA, 16 refuges in Alaska (fig. 5) 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. Excepting Arctic NWR, the refuges are open to entry under leasing laws but are closed to oil and gas leasing by Secretarial discretion [43 CFR 3101.5(b)] and to mining of coal by the Federal Coal Leasing Amendments Act of 1975. Refuges are closed to geothermal resource leasing by the Geothermal Steam Act of 1970. Although many traditional activities have been deemed appropriate for these refuges, any uses will be permitted only when such activities are compatible with the purposes for which a specific refuge was established.

U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

One mission of the FS 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. It is the responsibility of the FS to encourage and support environmentally sound mineral enterprises on Federal lands under its administration. In managing the use of these resources, the FS objective is to minimize unnecessary adverse environmental impacts to surface and cultural features and values that 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 FS also provides research information and technology to help with post-mining reclamation. In implementing this policy, the FS Chief 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 that the FS manages.
3. FS managers must develop a good understanding of the minerals industry, its practices, and the minerals laws and regulations.
4. Managers must develop a strong working relationship with the minerals industry.
5. Visibility and interaction with the minerals 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.

U.S. DEPARTMENT OF ENERGY

The DOE'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) DOE's Natural Gas Technology Program, which emphasizes

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

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 to facilitate the development of commercial projects.

SELECTED SERIES OF U.S. GEOLOGICAL SURVEY PUBLICATIONS

Periodicals

Earthquakes & Volcanoes (issued bimonthly).

Preliminary Determination of Epicenters (issued monthly).

Technical Books and Reports

Professional Papers are mainly comprehensive scientific reports of wide and lasting interest and importance to professional scientists and engineers. Included are reports on the results of resource studies and of topographic, hydrologic, and geologic investigations. They also include collections of related papers addressing different aspects of a single scientific topic.

Bulletins contain significant data and interpretations that are of lasting scientific interest but are generally more limited in scope or geographic coverage than Professional Papers. They include the results of resource studies and of geologic and topographic investigations, as well as collections of short papers related to a specific topic.

Water-Supply Papers are comprehensive reports that present significant interpretive results of hydrologic investigations of wide interest to professional geologists, hydrologists, and engineers. The series covers investigations in all phases of hydrology, including hydrogeology, availability of water, quality of water, and use of water.

Circulars present administrative information or important scientific information of wide popular interest in a format designed for distribution at no cost to the public. Information is usually of short-term interest.

Water-Resource Investigations Reports are papers of an interpretive nature made available to the public outside the formal USGS publications series. Copies are reproduced on request unlike formal USGS publications, and they are also available for public inspection at depositories indicated in USGS catalogs.

Open-File Reports include unpublished manuscript reports, maps, and other material that are made available for public consultation at depositories. They are a nonpermanent form of publication that may be cited in other publications as sources of information.

Maps

Geologic Quadrangle Maps are multicolor geologic maps on topographic bases in 7 1/2- or 15-minute quadrangle formats (scales mainly 1:24,000 or 1:62,500) showing bedrock, surficial, or engineering geology. Maps generally include brief texts; some maps include structure and columnar sections only.

Geophysical Investigations Maps are on topographic or planimetric bases at various scales; they show results of surveys using geophysical techniques, such as gravity, magnetic, seismic, or radioactivity, which reflect subsurface structures that are of economic or geologic significance. Many maps include correlations with the geology.

Miscellaneous Investigations Series Maps are on planimetric or topographic bases of regular and irregular areas at various scales; they present a wide variety of format and subject matter. The series also includes 7 1/2-minute quadrangle photogeologic maps on planimetric bases that show geology as interpreted from aerial photographs. Series also includes maps of Mars and the Moon.

Coal Investigations Maps are geologic maps on topographic or planimetric bases at various scales showing bedrock or surficial geology, stratigraphy, and structural relations in certain coal-resource areas.

Oil and Gas Investigations Charts show stratigraphic information for certain oil and gas fields and other areas having petroleum potential.

Miscellaneous Field Studies Maps are multicolor or black-and-white maps on topographic or planimetric bases on quadrangle or irregular areas at various scales. Pre-1971 maps show bedrock geology in relation to specific mining or mineral-deposit problems; post-1971 maps are primarily black-and-white maps on various subjects, such as environmental studies or wilderness mineral investigations.

Hydrologic Investigations Atlases are multicolor or black-and-white maps on topographic or planimetric bases presenting a wide range of geohydrologic data of both regular and irregular areas; principal scale is 1:24,000, and regional studies are at 1:250,000 scale or smaller.

Catalogs

Permanent catalogs, as well as some others, giving comprehensive listings of U.S. Geological Survey publications are available under the conditions indicated below from the U.S. Geological Survey, Books and Open-File Reports Sales, Federal Center, Box 25286, Denver, CO 80225. (See latest Price and Availability List.)

"Publications of the Geological Survey, 1879-1961" may be purchased by mail and over the counter in paperback book form and as a set of microfiche.

"Publications of the Geological Survey, 1962-1970" may be purchased by mail and over the counter in paperback book form and as a set of microfiche.

"Publications of the Geological Survey, 1971-1981" may be purchased by mail and over the counter in paperback book form (two volumes, publications listing and index) and as a set of microfiche.

Supplements for 1982, 1983, 1984, 1985, 1986, and for subsequent years since the last permanent catalog may be purchased by mail and over the counter in paperback book form.

State catalogs, "List of U.S. Geological Survey Geologic and Water-Supply Reports and Maps For (State)," may be purchased by mail and over the counter in paperback booklet form only.

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