

1996 Annual Report on Alaska's Mineral Resources

JILL L. SCHNEIDER, *Editor*

U.S. GEOLOGICAL SURVEY CIRCULAR 1142



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 U.S. Department of Agriculture, 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

A summary of mineral resource activities in Alaska during 1995

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON: 1997

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, *Secretary*

U.S. GEOLOGICAL SURVEY

GORDON P. EATON, *Director*

Free on application to the
U.S. Geological Survey, Information Services
Box 25286, Federal Center
Denver, CO 80225

Any use of trade, product, or firm names in this publication is for descriptive purposes only
and does not imply endorsement by the U.S. Government

CONTENTS

Summary	1
Energy Resources	1
Oil and Gas	1
Coal and Peat	2
Uranium	3
Geothermal Resources	3
Nonfuel-Mineral Resources	3
Metallic Minerals	3
Industrial Minerals	4
Introduction and Background	5
Federal Mineral Programs	5
U.S. Department of the Interior	5
U.S. Geological Survey	5
U.S. Bureau of Mines	7
Minerals Management Service	7
Bureau of Land Management	9
National Park Service	9
U.S. Fish and Wildlife Service	11
U.S. Department of Agriculture	11
Forest Service	11
U.S. Department of Energy	12
Contacts for Further Information	14
Energy Resources	15
Oil and Gas Resources	15
Overview of Production and Prices	15
Leasing Activity	15
Exploration and Development	15
Permits Issued	15
Exploration Drilling	15
Geophysical Surveys	16
Oil Field Development	16
Production	17
North Slope	17
Cook Inlet	20
Transportation	20
Activity by Federal Agencies	20
Minerals Management Service	20
Leasing and Exploration Activity	20
Future Lease Sales	23
Environmental Studies Program	23
Oil and Gas Resource Assessment	24
Data Acquisition on the Alaska OCS	24
U.S. Geological Survey	24
North Slope	24
Gas Hydrates	26
Oil and Gas Assessments	26
Drilling Waste Site Closures	26
Petroleum Systems	26

Energy Resources—Continued	
Oil and Gas Resources—Continued	
Activity by Federal Agencies—Continued	
Bureau of Land Management	26
Lease Operations	26
Resource Evaluation	27
Pipeline Monitoring	27
National Park Service	27
U.S. Fish and Wildlife Service	27
Kenai National Wildlife Refuge	27
Activities under Section 1008 of ANILCA	28
Resource Activity Impact Assessment	28
Activities under Section 302 of ANILCA	28
Regulation	28
Exxon Valdez Oil-Spill Restoration Project	29
Arctic National Wildlife Refuge	29
U.S. Department of Energy	30
Coal and Peat Resources	30
Overview of Industry Activity	30
Activity by Federal Agencies	32
U.S. Geological Survey	32
U.S. Bureau of Mines	32
U.S. Department of Energy	32
Uranium Resources	34
Geothermal Resources	34
Nonfuel-Mineral Resources	35
Metallic Minerals	35
Economic Overview	35
Mines and Prospects	35
Northern Alaska	37
Western and Southwestern Alaska	37
Fairbanks Mining District	37
East-Central Alaska	39
Southeastern Alaska	39
Activity by Federal Agencies	40
U.S. Geological Survey	40
Mineral-Resource Assessments	40
Cooperative Work with Federal Agencies	43
Cooperative Work with Alaska Native Corporations	43
Cooperative Work with Foreign Scientific Agencies	43
Environmental Studies	44
Trans-Alaska Crustal Transect	45
U.S. Bureau of Mines	45
Policy Analysis	45
Mineral Land Assessment	45
Minerals Research	47
Minerals Availability Program	47
Bureau of Land Management	48
Mining Claim Activities	48
Other Activities	49
National Park Service	49
Mineral Lands Management	49
Abandoned Mineral Lands Reclamation	51
AMRAP Authorizations	53
U.S. Fish and Wildlife Service	53

Nonfuel-Mineral Resources—Continued	
Metallic Minerals—Continued	
Activity by Federal Agencies—Continued	
Forest Service	53
Minerals Development on Forest Service Lands	53
Mineral Patent and Validity Examinations	54
Exploration on National Forest Lands	54
Abandoned Mine Hazards	54
Industrial Minerals	54
Overview of Industry Activity	54
Activity by Federal Agencies	55
U.S. Geological Survey	55
U.S. Bureau of Mines	55
Bureau of Land Management	56
U.S. Fish and Wildlife Service	56
Forest Service	56
Selected References	57
Appendix 1. Roles of Federal Agencies in Mineral Programs	66
U.S. Department of the Interior	66
U.S. Geological Survey	66
U.S. Bureau of Mines	66
Minerals Management Service	67
Bureau of Land Management	67
National Park Service	67
U.S. Fish and Wildlife Service	68
U.S. Department of Agriculture	68
Forest Service	68
U.S. Department of Energy	68
Appendix 2. Listing of USGS Circulars in ANILCA Annual Mineral Report Series	70

FIGURES

1. Map of Federal land ownership in Alaska	6
2. Photograph of USBM geologist measuring pH of water at Peterson Mine near Juneau	8
3. Map of National Park Service units in Alaska	10
4. Photograph of FWS scientist retrieving data at stream gauging station in Kenai NWR	12
5. Map of national wildlife refuges in Alaska	13
6. Graph showing fluctuation in annual average price of Alaska North Slope crude oil, 1988-1995 ...	17
7. Map showing locations of 1995 exploratory oil wells listed in table 4, known oil and gas fields, and possible petroleum-bearing sedimentary basins	18
8. Map showing Alaska Outer Continental Shelf Region planning areas and lease sale history	21
9. Map showing selected Federal land units	25
10. Photograph of FWS scientist measuring stream discharge in Yukon Flats NWR	29
11. Map showing areas of potential coal, uranium, and geothermal resources; industry activities; and agency activities	31
12. Photograph of coal seam in Wishbone Hill coal district, south-central Alaska	33
13. Map showing areas of significant industry activity involving metallic minerals in 1995, and mine and deposit locations	36
14. Photograph of Illinois Creek gold-silver property in western Alaska	38
15. Map showing status of USGS AMRAP quadrangle studies as of January 1996	41
16. Map showing locations of USGS regional and topical AMRAP and TACT studies in 1995	42
17. Photograph of soil sampling in Stuyahok River-Flat Creek area, western Alaska	44
18. Map showing locations of 1995 USBM study areas listed in table 11	46

19. Photograph of USBM geologist examining mineralization at Stewart Mine near Sitka	48
20. Map showing locations of 1995 active Federal mineral patent case files	50
21. Photograph of NPS reclamation crew processing fuel drums from Mascot Creek mining property, Gates of the Arctic NP&P	52
22. Photograph of USBM geologist at abandoned Lucky Chance Mine near Sitka	55

TABLES

1. Forest Service ranger districts in Alaska	12
2. 1995 Alaskan oil and gas production statistics	16
3. Fluctuation in price of Alaska North Slope crude oil, 1995	17
4. Alaska exploratory oil wells drilled on State lands in 1995	19
5. Alaska Outer Continental Shelf leases and wells drilled, 1976-1995	22
6. Proceeds from lease sales on Alaska Outer Continental Shelf planning areas	22
7. Producing oil leases, Beaufort Sea planning area	22
8. Proposed activity by Alaska OCS region and planning area, 1992-1997	23
9. Mining production in Alaska, 1992-1995	32
10. Regional and topical studies of USGS AMRAP projects in 1995	40
11. USBM study areas in 1995	47

INTERNATIONAL SYSTEM OF UNITS (SI) CONVERSION TABLE ⁽¹⁾

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 ⁽²⁾	Btu per pound	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	0.00046873
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

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
A-J	Alaska-Juneau
AML	Abandoned mine lands
AMRAP	Alaska Mineral Resource Assessment Program
ANILCA	Alaska National Interest Lands Conservation Act
AOGCC	Alaska Oil and Gas Conservation Commission
ARCO-Ak	ARCO Alaska
ARDF	Alaskan Resource Data File
bb/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
GSC	Geological Survey of Canada
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
MOU	Memorandum of Understanding
MRDS	Mineral Resources Data System
NGL	Natural Gas Liquid
NFS	National Forest 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
REE	rare-earth element
SAMRAP	State of Alaska Mineral Resource Assessment project
TACT	Trans-Alaska Crustal Transect
TAPS	Trans-Alaska Pipeline System
UAF	University of Alaska-Fairbanks
USBM	U.S. Bureau of Mines
USGS	U.S. Geological Survey

CONTRIBUTORS

U.S. DEPARTMENT OF THE INTERIOR

Bureau of Land Management

Arthur C. Banet, Jr.
Stan Bronzyk
Joe Dygas
Bob Merrill
Evvie Panches

Minerals Management Service

Richard C. Newman

National Park Service

Judith E. Alderson
Page Spencer

U.S. Bureau of Mines

Gary Sherman

U.S. Fish and Wildlife Service

Jerald Stroebele

U.S. Geological Survey

Kenneth Bird
John Galloway
Donald Grybeck
Terry Keith
Jill Schneider
Gary Stricker
Judy Weathers
Ellen White

U.S. DEPARTMENT OF AGRICULTURE

Forest Service

Ginny R. Grove
John J. Kato

U.S. DEPARTMENT OF ENERGY

Robert M. Kornosky
Harold D. Shoemaker
Arden R. Strycker

1996 ANNUAL REPORT ON ALASKA'S MINERAL RESOURCES

Jill L. Schneider, *Editor*

— SUMMARY —

Section 1011 of the Alaska National Interest Lands Conservation Act (ANILCA) of 1980, 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." This is the fifteenth annual report that has been prepared in response to that requirement: current Alaskan mineral projects and events that occurred during 1995 are summarized. For the purpose of this document, the term "minerals" encompasses both energy resources (oil and gas, coal and peat, uranium, and geothermal) and nonfuel-mineral resources (metallic and industrial minerals).

The U.S. Geological Survey (USGS), U.S. Bureau of Mines (USBM), and Minerals Management Service (MMS) were the principal Federal agencies that published information about energy and mineral resources in Alaska in 1995, and their activities are detailed in this report. Additional agencies in the U.S. Department of the Interior (DOI) that contributed to this document are the Bureau of Land Management (BLM), National Park Service (NPS), and U.S. Fish and Wildlife Service (FWS); the U.S. Department of Agriculture, Forest Service (FS), and U.S. Department of Energy (DOE) also reported on their respective mineral activities. Other sources of public information for this report include State publications, trade and professional journals, presentations at public meetings, and press releases.

This report addresses both onshore and offshore areas of Alaska.

ENERGY RESOURCES

OIL AND GAS

Alaskan oil production in 1995 totaled 571.3 million barrels of oil and natural gas liquids, a decrease of 4 percent from 1994 levels and a 23-percent decline from

Alaska's peak production of 738 million barrels in 1988. The Prudhoe Bay field produced its 9-billionth barrel of oil in September 1995. Dry natural gas production in 1995 totaled 5.11 billion cubic meters, a decline of less than 1 percent from 1994. North Slope oil prices during the year averaged \$16.81 per barrel (West Coast), a 14-percent increase from the previous year; prices ranged from \$15.46 in January to \$18.37 in May, declining to \$15.88 by December. Alaska provided 24 percent of total United States oil production, and 80 percent of the State's income was derived from royalties and taxes paid on State-owned oil and gas leases. The oil industry and Federal and State agencies joined together to create the Alaska Energy InfoBank, a centralized repository of nonproprietary oil and gas data.

The State of Alaska held five lease sales in 1995: four in the Cook Inlet region and one on the North Slope. Total high bids brought \$4.3 million for 64 tracts covering 1,001 square kilometers. No Federal lease sales were held during 1995. The Alaska Oil and Gas Conservation Commission issued 216 drilling permits in 1995, a 34-percent increase from 1994. Nine exploratory wells were drilled on Alaska State lands; the Niakuk NK-27 well intercepted oil and became a producing well in April.

The State of Alaska received \$13.7 million in minerals revenues collected by the MMS in 1995 from both onshore and offshore Federal leases. At year's end, the oil industry continued to hold 57 active leases in the Beaufort Sea planning area on the Alaska Outer Continental Shelf (OCS). Leases in the North Aleutian Basin planning area were redeemed by the Federal Government after 6 years of suspended operations. The MMS proposed future lease sales for 1996 and 1997 in the Beaufort Sea. Lower Cook Inlet, and Gulf of Alaska/Yakutat planning areas of the Alaska OCS. The Draft Environmental Impact Statement (EIS) for the next 5-year (1997-2002) leasing program was released by the MMS. The mission of the MMS's Alaska Environmental Studies Program has shifted to monitoring the possible effects of oil and gas exploration or drilling after lease sales. The MMS completed its update of the Alaska OCS lands section of the Federal National Oil and Gas Resource Assessment.

Petroleum research by the USGS in Alaska is

aimed at onshore oil and gas resources. In 1995, the USGS released results of geologic, geophysical, and geochemical investigations in the National Petroleum Reserve—Alaska (NPRA). The second transect of the Brooks Range foothills region was completed, and field work began in the Arctic National Wildlife Refuge (Arctic NWR). North Slope gas-hydrate studies included a quantitative assessment of in-place resources and an evaluation of possible climatic effects from decomposing hydrates. The National Oil and Gas Resource Assessment released in 1995 by the USGS included estimates for Alaska. The Alaska Department of Environmental Conservation gave approval to the USGS and BLM for closure of 27 drilling waste sites in the NPRA. The American Association of Petroleum Geologists presented its award for best publication to a USGS geologist and his co-editor for their book on petroleum systems.

The BLM managed lease agreements and governed leasehold operations for 38 producing oil and gas leases and a Compensatory Royalty Agreement on the Kenai Peninsula. Four applications for drilling permits on the Kenai NWR were processed; one exploratory well was completed. The BLM also administered 330 noncompetitive oil and gas leases in central and western Alaska.

The BLM has examined the petroleum systems in northern Alaska; one new hydrocarbon exploration target on the western North Slope was identified. The BLM also responded to inquiries for information on hydrocarbon resource estimates and on oil and gas leasing in the Arctic NWR Coastal Plain.

The Joint Pipeline Office (JPO) is a cooperative effort between the BLM and 10 other Federal and State agencies to monitor the Trans-Alaska Pipeline System (TAPS). Both wetlands and potential seismic hazards along the TAPS right-of-way are being re-evaluated, and applications are being reviewed for additional pipelines on the North Slope.

The NPS provided comments to the MMS regarding the proposed oil and gas OCS lease sale in Lower Cook Inlet. Oil and gas development in that area has the potential to impact coastal NPS lands in Katmai and Lake Clark National Parks and Preserves.

During 1995, the FWS maintained oversight for remedial cleanup programs in the Beaver Creek and Swanson River oil fields of the Kenai NWR and issued 21 special-use permits for exploration activities in the Arctic, Izembek, Kenai, Koyukuk, and Selawik NWR's; the FWS also reviewed 20 permit applications to the U.S. Army Corps of Engineers (ACE) for oil and gas activities off refuges. Reviews and comments were provided for one Federal OCS leasing plan and six proposed State oil and gas lease sales.

Contaminant research continued on the North Slope. Water-resources inventories and assessments were carried out at the Kenai and Yukon Flats NWR's to reserve water rights for fish and wildlife purposes in areas of possible oil and gas activities. Six Letters of Authorization were

issued in 1995 under FWS rulings concerning the incidental or intentional take of marine mammals during specified activities. Several *Exxon Valdez* oil-spill restoration projects issued their final reports in 1995.

The FWS also continued wildlife and related studies on the Coastal Plain of the Arctic NWR. Seven applications were filed with the State of Alaska for water rights on three rivers on the Coastal Plain. In 1995, the FWS conducted a preliminary review of the 1987 Coastal Plain Resource Assessment and Final Legislative EIS, based on data collected during 8 years of additional studies.

The DOE approved a cooperative research and development agreement with BP Exploration (BPX) to develop a process to recover heavy oil from the Prudhoe Bay oil field; research and development will be conducted at the DOE's National Institute for Petroleum and Energy Research at Bartlesville, Oklahoma. BPX will fund 78 percent of the \$6.3-million project and will undertake a pilot study of any economically viable recovery process developed.

COAL AND PEAT

Alaskan coal production increased 10 percent in 1995 to 1.49 million metric tons, valued at \$41.3 million; peat production dropped 60 percent, totaling 26,759 cubic meters worth \$157,500. Coal and peat combined represented 8 percent of total mining production value in 1995. The Cook Inlet Native regional corporation purchased all rights to the Wishbone Hill coal property near Palmer in August 1995 and was negotiating for an experienced operator to develop the mine. The University of Alaska-Fairbanks researched the commercial viability of low-rank coal/water fuel production. Lapp Resources received State permission to produce coalbed methane from three wells near Houston in south-central Alaska.

USGS geologists measured 52 stratigraphic sections in the coal-bearing *Befuga* and *Sterling* Formations of the Kenai Group on the western Kenai Peninsula. At the Kuchiak Research coal mine in northwestern Alaska, the USBM continued to monitor project investigations on mining methods and mine safety, treatment of ore and mine wastes, protection of water resources, and postmining reclamation in the arctic environment.

The Healy Clean Coal Project is one of 40 projects sponsored nationwide by the DOE to demonstrate new, clean-burning coal technologies. The DOE issued the Healy project's Final EIS in December 1993, signed a Record of Decision in March 1994, and is providing \$117.3 million in Federal funding for design, permitting, construction, and operation of the project. Construction began in May 1995, and operations are scheduled to begin January 1998. A second DOE Clean Coal project in Alaska will design and test an advanced coal-fuel diesel engine for electrical generation.

URANIUM

Neither the mining industry nor the Federal government conducted uranium activity in Alaska in 1995.

GEOTHERMAL RESOURCES

State geothermal leases are still active in the Makushin Valley area in the Aleutian Islands, but no development has occurred. Geothermally heated greenhouses are being operated at Circle Hot Springs and Manley Hot Springs. No Federal geothermal research was funded in 1995.

NONFUEL-MINERAL RESOURCES

METALLIC MINERALS

The value of Alaska's mining industry (exploration, development, and production) expanded by 24 percent in 1995. Exploration expenditures rose 9 percent from 1994 levels to \$34 million, development outlays tripled to \$147.8 million, and production values rose 6 percent to \$539.5 million; metallic minerals represented 82 percent of total mining production value. The four major metallic minerals produced in Alaska were zinc (\$345.6 million), gold (\$54.3 million), lead (\$34.4 million), and silver (\$6.7 million). At the Red Dog lead-zinc-silver mine in northwestern Alaska, production increased 15 percent, and new mineralization was discovered that doubled the mine's known reserves. The Valdez Creek placer gold mine closed in September after all reserves were exhausted. The mining industry employed 3,405 people in Alaska in 1995, an increase of 10 percent.

Commercial mine development focused on lode gold deposits. The Nixon Fork Mine in west-central Alaska came into production in October, and the Fort Knox Mine near Fairbanks was scheduled to begin production in 1996. The Illinois Creek deposit in southwestern Alaska; True North, Ryan Lode, and St. Paul deposits near Fairbanks; and Kensington, Jualin, and Alaska-Juneau deposits in southeastern Alaska were also under development. Notable gold placers include those on the Seward Peninsula and in the Fairbanks area. Gold exploration took place in the Wiseman District of northern Alaska, the Nome Mining District, Donlin Creek in southwestern Alaska, and Cleary mineral belt near Fairbanks. The Kennecott Greens Creek Mining Company was working to reopen the Greens Creek polymetallic mine in southeastern Alaska by early 1997.

The USGS continued its program of geologic mapping and assessment of undiscovered mineral resources. The statewide assessment for five mineral commodities was completed, and a digital bibliography of geologic mapping was published. Regional assessments were underway for

the western Brooks Range, eastern Alaska Range, west-central Alaska, Alaska Peninsula, and Aleutian Islands; aeromagnetic and gravity maps for interior Alaska were published in conjunction with the State. Geologic or geochemical studies were published for the Chandler Lake, Craig and Dixon Entrance, Gulkana, Healy, Killik River, and Unalakleet 1:250,000-scale quadrangles. A study of geology, mineral deposits, and mining history of the Fortymile Mining District continued, and the annual research report of current USGS activities in Alaska was compiled. Regional environmental geochemistry studies focused on mercury deposits in southwestern Alaska and massive-sulfide deposits in the Brooks Range. Preliminary results were published for the northernmost section of the Trans-Alaska Crustal Transect, which provides a geologic framework for mineral-resource assessment in Alaska.

The USGS conducted numerous cooperative studies with Federal, Native, and foreign entities. Stratigraphic studies were conducted in Denali National Park and Preserve (Denali NP&P) by USGS and NPS personnel, and a guide to the volcanoes of Wrangell-St. Elias NP&P was published. Geologic mapping and resource assessment took place in the Chugach and Tongass National Forests; the USGS and FS produced a geologic summary and hiker's guide for the Mount Edgecumbe volcanic field in southeastern Alaska. The USGS worked with the Calista Native regional corporation to assess the mineral resources of Native lands in southwestern Alaska, and USGS earth-science and natural-resource data bases and maps were provided to the Inter-Tribal Youth Practicum. Foreign cooperative projects included an integrated geologic map of northeastern Alaska and northwestern Yukon Territory and metallogenic studies of the Circum-North Pacific Terrane, which covers the Russian Far East, Alaska, and Canada.

In 1995, the USBM continued to study the impact of the permitting process on mine development and the effect of ecosystem-management concepts on mining and mineral development. Final USBM reports were released for mineral investigations in the Colville and Ketchikan mining districts, the eastern Gulf of Alaska, and the Fortymile and Black River BLM planning units. At the request of the FS, the USBM evaluated mineral resources in the Tongass National Forest and compiled a spatial data base of mining claims in the Chugach National Forest. The USBM also evaluated hazards associated with abandoned mine sites for the BLM, NPS, and FS. The USBM studied submarine tailings disposal and joined an interagency team with the Environmental Protection Agency (EPA) to evaluate this practice for possible use in southeastern Alaska. The USBM compiled a spatial data set for mineral terranes and known mineral deposit areas in Alaska and updated the Minerals Availability System data base.

The BLM accepted 162 new Federal mining claims during fiscal 1995; total recorded claims were 9,705. The BLM also processed 195 mining Plans and Notices of Operations and conducted 328 site inspections to ensure

operator compliance to the permitted Plans and Notices. Field examinations were conducted for seven mineral patent applications, and nine mineral patent reports were reviewed. The BLM also completed 38 mineral reports for land use planning. Other BLM mineral activities targeted bonding and reclamation standards, unauthorized occupancy of Federal mining claims, and abandoned mine lands. Field work continued on the geologic guide for the Taylor Highway-Fortymile Wild and Scenic River area. BLM geoscientists worked with the Anchorage School District to improve the district's earth science curriculum.

The NPS reviewed six, and approved two, Plans of Operations for mining or sampling in two National Park units; 37 mineral validity examinations were also conducted. Denali NP&P acquired eight unpatented mining claims in the Kantishna area, and a block of unpatented mining claims was donated to Kenai Fjords National Park. A Cultural Landscape Inventory of historic mining camps and operations was being compiled for the Gold Hill-Chisana Historic Mining District in Wrangell-St. Elias NP&P. Land surveys were conducted to determine the boundaries of 215 claims in 2 parks. Under the Mineral Land Restoration program, 41 former mining sites in 2 parks were cleaned, and 5 mine adits were surveyed for closure in 2 additional parks. The NPS conducted four surveys, one assessment, and one mitigation of hazardous waste sites in three park units. Restored stream channels and revegetated flood plains were monitored for stability at the Glen Creek placer reclamation project in the Kantishna area of Denali NP&P; a second placer reclamation project was planned for Eureka Creek in the same area. One permit was issued to the USGS for an AMRAP project in Wrangell-St. Elias NP&P.

In 1995, there were 68 active mining claims in 5 of the 16 national wildlife refuges in Alaska. The FWS reviewed 77 ACE permit applications for mining-related activities off refuges, 2 task reports for the EPA on the

Alaska-Juneau and Kensington mines, and mining plans for the Illinois Creek and Red Dog mines.

The FS received 15 Notices of Intent and 71 Plans of Operations for mineral activities in Alaska's national forests in 1995. Two patent examination reports and two validity reports for claims in the Tongass National Forest were in preparation or review, and inventories of environmental and safety hazards on abandoned and inactive mining claims were in progress on the Tongass National Forest.

INDUSTRIAL MINERALS

The combined value of Alaska's industrial minerals comprised 11 percent of the State's total mineral production in 1995. The value of sand, gravel, and building stone production fell 16 percent in 1995 to \$57.1 million; jade and soapstone production value increased by 25 percent to \$25,000.

The USGS and FS began to assess the limestone resources on Chichagof Island in southeastern Alaska. The USBM conducted a survey in the Chugach National Forest to determine location, accessibility, quantity, and quality of construction materials; an economic analysis of the resources will consider access to the available transportation infrastructure.

In fiscal 1995, the BLM conducted 49 sales for 128,000 metric tons of sand and gravel and one sale for 34,000 metric tons of rock. The FWS made eight gravel sales on the Izembek NWR in 1995. The FS disposed of approximately 2.3 million cubic meters of sand, gravel, and quarried stone via material sales, Free-Use permits, and FS in-service utilization. These commodities are primarily used for the construction of Federal timber-sale roads, State roads, breakwaters, airports, and other large public use projects.

—INTRODUCTION AND BACKGROUND—

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, and this circular is the fifteenth in its series (see appendix 2). The report summarizes information made public in 1995 and early 1996 for the two broad categories of "minerals": energy resources (oil, gas, coal, peat, uranium, and geothermal) and nonfuel-mineral resources (metallic and industrial minerals).

In 1995, the USGS and the U.S. Bureau of Mines (USBM) were the principal Federal agencies that generated information about onshore mineral resources in Alaska; the Minerals Management Service (MMS) was the prime agency reporting on resource activities in Alaska's coastal waters. Their data, analyses, and reports were used by other agencies for resolving questions on land use, access, environmental impacts, and mining claim evaluation. Additional Federal agencies that contributed to this report were the Bureau of Land Management (BLM), National Park Service (NPS), and U.S. Fish and Wildlife Service (FWS) in the U.S. Department of the Interior (DOI); the U.S. Department of Agriculture, Forest Service (FS); and the U.S. Department of Energy (DOE).

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 mining 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 document.

Current mineral programs of the Federal mineral-resource and land-management agencies in Alaska that contributed to this report are outlined below, and the roles of these agencies as they relate to minerals are discussed in appendix 1. The distribution of lands under Federal management is shown in figure 1.

FEDERAL 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 statewide, regional, quadrangle-based, and topical studies. Statewide geologic investigations are published at the 1:1,000,000 scale; regional studies at the 1:500,000 scale. Investigations at the quadrangle level draw on many geologic disciplines to produce resource assessments at scales of 1:250,000 and 1:125,000. Topical research focuses on detailed studies of specific mining districts, mineral deposits, or questions relating to the genesis of mineral deposits. These studies are funded under the Mineral Resource Surveys program. In 1995, 24 quadrangle-scale projects were underway, and 22 regional and topical 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 1995, 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 Energy Resource Surveys Program, which includes studies of petroleum-forming processes and potential source regions in order to produce reliable estimates of undiscovered

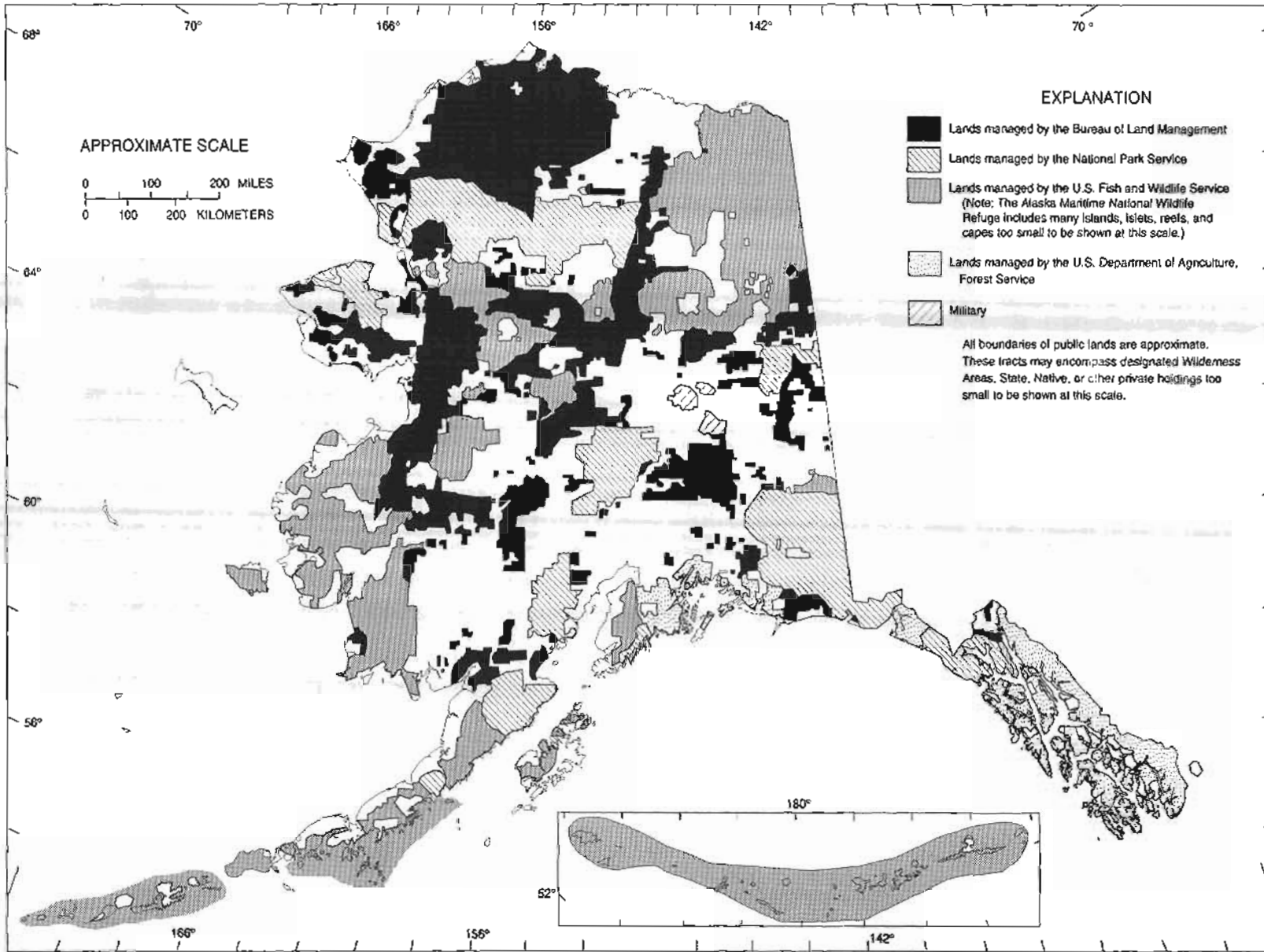


Figure 1. Federal land ownership in Alaska (Bureau of Land Management, 1990).

petroleum resources. In addition, the Trans-Alaska Crustal Transect (TACT) project, which is a multidisciplinary approach to study the Earth's crust along a corridor from the Pacific Ocean to the Arctic Ocean, has provided information fundamental to resource assessments. 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.

The USGS Mineral Resources Data System (MRDS) is a digital data base of mineral deposits and occurrences in the United States and worldwide. Each MRDS record includes up to 200 pieces of information related to a site's geographic location, geology, deposit type, commodity, known exploration and development, mine workings, production, reserves, resources, and references (Leonard and Huber, 1987). In Alaska, there are presently 4,156 records for deposits and occurrences in 100 1:250,000-scale quadrangles. Geologic 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 Bruce Lipin, MRDS Project Chief, U.S. Geological Survey, 954 National Center, Reston, VA 22092-0001.

U.S. BUREAU OF MINES

Despite reduction of USBM activities by agency reorganization and downsizing during 1995, the USBM was active in the programs outlined below; see appendix I for further information on the scope and nature of these programs. In late 1995, the USBM was defunded as a Federal agency, and personnel and programs of the Alaska Field Operations Center were transferred to the BLM-Alaska State Office in early 1996.

Policy analysis.—The policy analysis program analyzed mineral data with respect to local and national needs. Technical, institutional, political, social, and economic criteria were used to identify mineral issues.

Mineral land assessment.—The USBM's major emphasis in Alaska was the development of areal and commodity-oriented mineral assessments requested by Federal land-management agencies. Much of the work focused on mineral evaluations of mining districts, BLM planning units, and national forests; evaluations included the assessment of type, quantity, distribution, reserves, beneficiation characteristics of known mineral deposits, and environmental considerations of potential development. The program also included the investigation and analysis of

hazards associated with abandoned mine lands (fig. 2).

Minerals research.—Minerals research by the USBM included the improvement of mining techniques for maximizing mineral extraction while minimizing the environmental impacts of mining. Much of this work involved speculative, long-range research designed to develop major technological improvements. Research in Alaska also considered the State's distinctive climate and geologic conditions. Minerals research was administered by 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-Fairbanks Mineral Institute were active in Alaska in 1995. A primary goal of the USBM research mission was the communication of research results to academia, government, and the general public.

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 up to 91 pieces of information on the identification and location of each known mineral deposit. These global minerals information activities have been transferred to the USGS, except in Alaska where the activities have been transferred to the BLM.

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, but 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 postlease exploration, development, and production activities to ensure that operations are 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 rents and royalties generated by the leased properties. Although 57 leases were

active at the end of 1995 on the Alaska OCS, no energy or mineral resources were produced.

Federal OCS lands begin at the 3-mile offshore limit, but the OCS Lands Act entitles coastal states to 27 percent of the revenues from leases occurring between 3 miles and 6 miles offshore from their borders. During 1995, the State of Alaska's share of such revenues amounted to \$9.4 million; this included some monies attributable to revenues generated in previous years.

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 and Kenai Gas fields, provide the bulk of this kind of revenue. The State of Alaska received \$4.3 million as its 1995 share of minerals revenues collected from such



Figure 2. USBM geologist measures pH level of discolored water below main waste-rock dump at the Juneau-area Peterson Mine, which produced small amounts of gold from quartz-arsenopyrite ore between 1905 and the early 1920's. Although iron-stained, the water was only slightly acidic at pH 6.5. The USBM was evaluating the mine as part of the FS program on abandoned mine hazards in the Tongass National Forest. Photograph from USBM files.

regional, and park levels. The Alaska System Support 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 mine lands; 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 Field Office's Lands Resource Division conducts mineral and land valuation appraisals, administers property relocations, and negotiates acquisitions and donations; the Cultural Resources Division surveys historic 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 appendix 1.

U.S. FISH AND WILDLIFE SERVICE

In Alaska, the FWS manages 310,866 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 latter function includes the investigation, review, and comment on Federal permits and Environmental Impact Statements (EIS's).

Mineral-related activities of the FWS occur both on and off NWR lands and include environmental monitoring, permit review and comment, contaminant analysis, water-resources inventory and assessment (fig. 4), and regulation of certain exploration activities. Some commercial 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 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 1995, 21 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 permitted projects. The FWS also reviews U.S. Army Corps of Engineers (ACE) 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. In 1995, the FWS reviewed 97 Section 404 applications for oil, gas, and mining activities.

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 mammal 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. Six Letters of Authorization (permits) were issued in 1995 in conjunction with oil and gas industry activities in the Beaufort Sea.

U.S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

Under a memorandum of understanding (MOU) with the BLM, the FS jointly administers the general mining laws on National Forest System lands in Alaska. As part of the process, the FS conducts field examinations for claim validity and mineral patent applications.

The FS cooperates with DOI agencies, particularly the BLM, in issuing mineral leases and assuring mitigation of surface impacts from lease activities. The FS also cooperates with State agencies and the private sector in the development of energy and mineral resources on inholdings. One such inholding is the Bering River

Coal Field in Chugach National Forest, which is under consideration for possible development in a joint venture by Chugach Alaska Corporation and others.

In Alaska, 93,000 square kilometers of land in 14 ranger districts (table 1) is administered by the FS, whose regional office is in Juneau. Offices for the Chugach National Forest are located in Anchorage, Cordova, Girdwood, and Seward; Tongass National Forest offices are in Craig, Hoonah, Juneau, Ketchikan, Petersburg, Sitka, Thome Bay, Wrangell, and Yakutat.

U.S. DEPARTMENT OF ENERGY

The DOE administers Congressional mandates relating to energy, monitors grants, and oversees contracts for energy-resource studies. In Alaska, DOE is focusing its efforts on petroleum and coal resources.

To develop a better understanding of petroleum resources and to provide fundamental information to

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
	Thome Bay Ranger District



Figure 4. FWS scientist downloads data from electronic meter at Fox River stream gauging station in Kenai NWR. Flagging in base of tree at left (circled) indicates high-water mark from September 1995 flood. Photograph from FWS files.

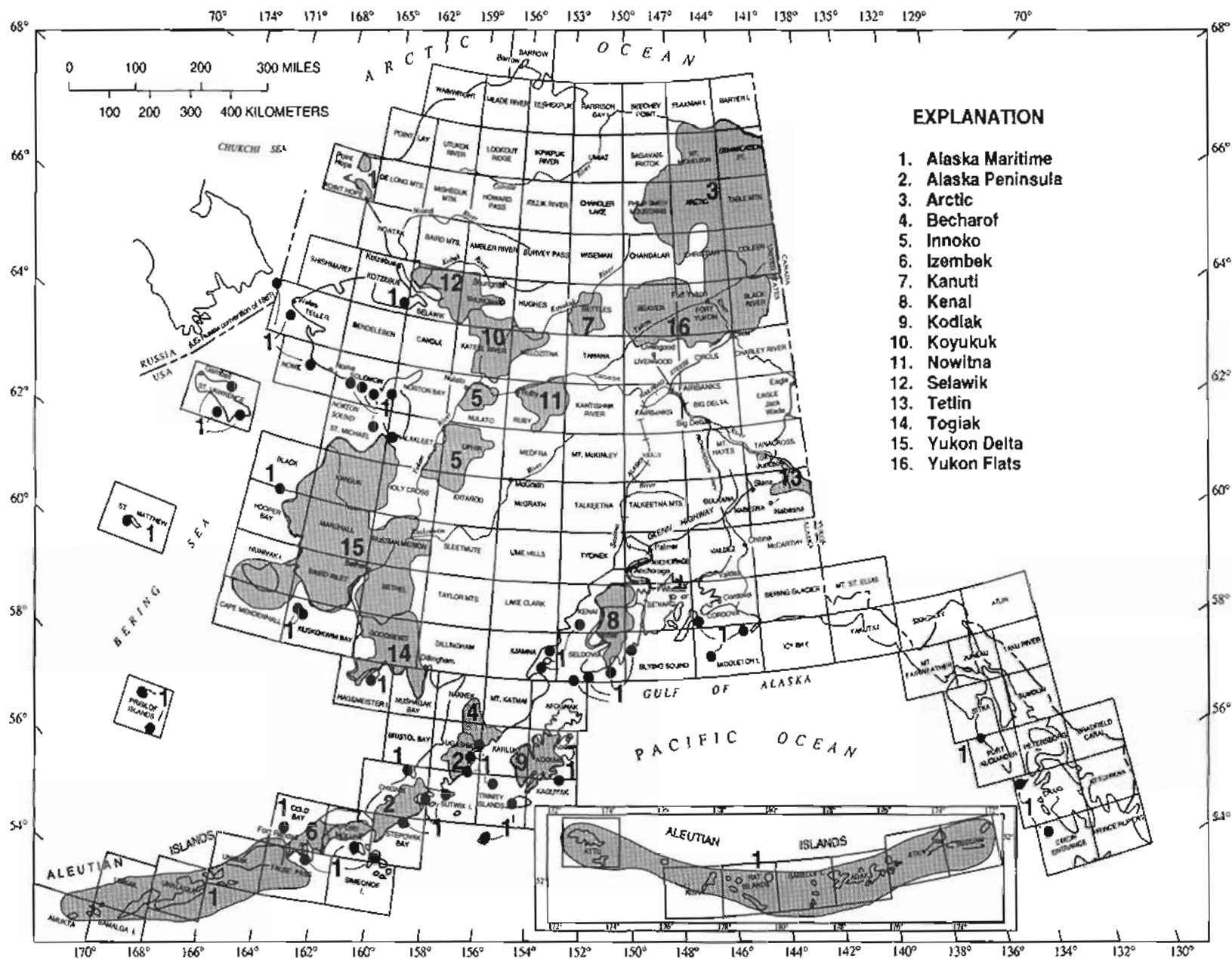


Figure 5. National wildlife refuges in Alaska. 1:250,000-scale quadrangles are outlined and labeled.

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. A cooperative research and development agreement has been negotiated with BP Exploration to investigate the economic recovery of heavy oil from the Prudhoe Bay oil field on Alaska's North Slope.

The DOE is working to evaluate Alaskan coal in terms of its potential contribution to total national resources. Coal research currently centers on utilization methods suitable to Alaskan coals and conditions. The DOE's Clean Coal Technology Program is funding two projects in Alaska: the Healy Clean Coal Project, under construction in central Alaska, will demonstrate new, clean-burning technology that limits the emission of pollutants commonly cited as the causes of acid rain; and the Coal Diesel Combined-Cycle Project, currently in the design stage, will demonstrate an advance coal-fueled diesel engine to generate electricity at the University of Alaska-Fairbanks.

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
Acting 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
BLM Division of Resources
222 West 7th Avenue, #13, AK930
Anchorage, AK 99513-7599

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

U.S. Geological Survey
Alison B. Till, Associate Chief Scientist
Mineral Resource Surveys Program-
Western Region
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

—ENERGY RESOURCES—

OIL AND GAS RESOURCES

OVERVIEW OF PRODUCTION AND PRICES

Oil and gas remained the most valuable mineral-resource commodities produced in Alaska in 1995. The Arctic North Slope and Cook Inlet regions provided a total of 541.7 million barrels (1 barrel = 159 liters) of oil, 29.6 million barrels of natural gas liquids (NGL's), 5.11 billion cubic meters of dry natural gas, and 90.8 billion cubic meters of casinghead gas (table 2); 82.1 billion cubic meters of gas and 698 million barrels of water were reinjected for enhanced oil recovery. Oil production decreased 4 percent from 1994 levels, and dry gas production declined less than 1 percent. Daily oil production averaged 1.565 million barrels per day (bbl/d), 64,600 bbl/d less than in 1994 and well below peak production of 1.98 million bbl/d in 1988. North Slope fields produced 97.3 percent of Alaska's oil, and Cook Inlet produced 99 percent of its dry natural gas. Alaska provides about 24 percent of domestic oil production.

Alaska North Slope crude oil prices for 1995 were lowest in January, peaked in May, then declined steadily until the end of the year (table 3). The average price of \$16.81 per barrel (West Coast) was 14 percent above the 1994 average price of \$14.77 per barrel (West Coast), the first such increase since 1990 (fig. 6). Alaska's treasury is especially vulnerable to crude oil prices because 80 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.

The oil industry and Federal and State agencies joined together to create the Alaska Energy InfoBank, a centralized repository for the nonproprietary oil and gas data shared by those entities. In addition to geologic information from well logs and seismic lines, the data base will also include production data and mandated regulatory materials such as permits and environmental assessments. The Energy InfoBank will promote standards for data storage, facilitate data retrieval, and help minimize storage costs for duplicate copies of permits, reports, and assessments. Initial projected savings are estimated at \$7 million annually. Participators include ARCO Alaska (ARCO-Ak), BP Exploration-Alaska (BPX-Ak), Exxon, Marathon, Unocal, Alyeska Pipeline Service Company, Alaska Department of Natural Resources (ADNR), Alaska Oil and Gas Conservation Commission (AOGCC), BLM, and MMS.

LEASING ACTIVITY

No Federal oil and gas lease sales were held on Alaska OCS lands in 1995, but the State of Alaska did hold five lease sales toward the end of the year: four were located in the Cook Inlet region and one on the North Slope. Cook Inlet sales 67A-W2, 74W, 76W, and 78W were held in November, and total high bids were \$978,349. The offerings consisted of 2,913 square kilometers in 158 tracts from the Matanuska-Susitna Valley to the central portion of the Kenai Peninsula. All tracts had been offered for lease within the previous 5 years but had received no bids. In the 1995 sales, bids were offered on 22 tracts, and 388 square kilometers were leased. Sale 80 was held in December, the first North Slope sale since 1993. The sale offered 202 tracts encompassing 3,850 square kilometers. High bids totaled \$3.34 million on 42 tracts covering 613.4 square kilometers.

Oil companies drop leases that do not have development potential; during 1994 and 1995, more than 2,428 square kilometers of leaseholdings were relinquished. This represents a loss to the State of more than \$1 million per year in lease payments.

The Alaska legislature passed a law in 1995 to allow adjustment of the 12.5-percent royalty rate from State oil lands. The law is designed to spur oil and gas production in marginal fields that might not otherwise be developed.

EXPLORATION AND DEVELOPMENT

PERMITS ISSUED

The Alaska Oil and Gas Conservation Commission issued 216 drilling permits in 1995 for 12 exploratory wells, 184 development wells, and 20 service wells. This was a 34-percent increase over the 161 permits issued in 1994. For the North Slope, 9 exploratory, 169 development, and 19 service wells were scheduled; 3 exploratory, 15 development, and 1 service well were planned for Cook Inlet.

EXPLORATION DRILLING

Nine exploratory wells were drilled on State lands in 1995, two more than the previous year: eight were located on the North Slope and one in the Cook Inlet region (fig. 7; table 4). Although most of the wells were plugged and abandoned,

Table 2. 1995 Alaskan oil and gas production statistics.

[Data from Alaska Oil and Gas Conservation Commission Bulletin, February 1996; BBL, barrels; NGL, natural gas liquids; MCM, thousand cubic meters; DNG, dry natural gas; CHG, casinghead gas; —, no production]

FIELD	BBL OIL	BBL NGL	MCM DNG	MCM CHG
NORTH SLOPE				
PRUDHOE BAY	327,062,577	27,748,741	—	79,513,521
KUPARUK RIVER	106,999,037	—	—	3,183,333
POINT MCINTYRE	50,153,692	679,125	—	1,320,608
ENDICOTT	33,232,734	1,204,436	—	3,605,703
MILNE POINT	8,691,067	—	—	144,649
WALAKPA	—	—	31,395	—
SOUTH BARROW	—	—	1,478	—
EAST BARROW	—	—	2,803	—
	<u>526,139,107</u>	<u>29,632,302</u>	<u>35,676</u>	<u>87,767,814</u>
COOK INLET				
MCCARTHER RIVER	6,621,820	—	1,430,306	124,668
MIDDLE GROUND SHOAL	2,823,234	—	35,022	25,505
GRANITE POINT	2,580,265	—	1,371	53,300
SWANSON RIVER	1,712,440	16,892	39,998	2,842,120
WEST MCCARTHER RIVER	922,073	—	—	6,546
TRADING BAY	722,377	—	—	15,308
BEAVER CREEK	132,189	—	53,220	1,003
NORTH COOK INLET	—	—	1,516,104	—
BELUGA RIVER	—	—	1,009,361	—
KENAI	—	162	623,505	—
IVAN RIVER	—	—	340,569	—
STUMP LAKE	—	—	8,159	—
PRETTY CREEK	—	—	7,257	—
STERLING	—	—	5,207	—
LEWIS RIVER	—	—	3,576	—
WEST FORK	—	—	453	—
	<u>15,514,398</u>	<u>17,054</u>	<u>5,074,108</u>	<u>3,068,450</u>
TOTALS	<u>541,653,505</u>	<u>29,649,356</u>	<u>5,109,784</u>	<u>90,836,264</u>

the Niakuk NK-27 well intercepted oil and became a production well after completion. No wells were drilled on Federal OCS lands.

GEOPHYSICAL SURVEYS

Approximately 194 square kilometers of three-dimensional seismic data was acquired by industry in exploration programs over State and Federal lands in the Beaufort Sea in 1995.

OIL FIELD DEVELOPMENT

North Slope.—BPX-Ak announced that it would defer development of its Badami oil field, located 60 kilometers east of the Endicott field, after recent drilling revealed the reservoir to be more complex than anticipated; BPX-Ak will examine ways to lower development costs at the field, which is estimated to contain as much as 100 million

barrels of oil and 2.8 billion cubic meters of gas. Drilling in the Colville Delta by Union Texas Petroleum, Anadarko Petroleum, and ARCO-Ak indicated a possible accumulation of 100 million barrels of recoverable oil; additional wells were planned for the area, as well as a production test of the Alpine well drilled in early 1995.

Beaufort Sea.—Two prospects in the Beaufort Sea were being evaluated for possible development. BPX-Ak acquired a 98-percent interest in the Northstar Unit, which was discovered in 1982 and is estimated to contain between 100 and 200 million barrels of recoverable oil. The field is located 13 kilometers offshore from Milne Point, north of the barrier islands, and under 9 to 12 meters of water; design of a pipeline that can withstand the hazardous conditions of winter sea ice is the most significant technical issue for development of the field. BPX-Ak has begun work on an EIS for review by the ACE. Union Texas Petroleum announced the size of its 1992 Kuvium discovery, estimating 325 million barrels of recoverable oil; this is notably less

Table 3. Fluctuation in price of Alaska North Slope crude oil, 1995.

[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
(12/1/94)	(16.65)	(16.81)
1/1/95	15.46	15.94
2/1/95	16.20	16.86
3/1/95	17.15	17.42
4/1/95	17.27	17.40
5/1/95	18.37	18.81
6/1/95	18.36	18.66
7/1/95	17.44	17.34
8/1/95	16.26	16.26
9/1/95	16.68	16.83
10/1/95	16.66	16.66
11/1/95	15.94	15.91
12/1/95	15.88	16.50
(1/1/96)	(17.01)	(17.59)
1995 average price	\$16.81	\$17.05

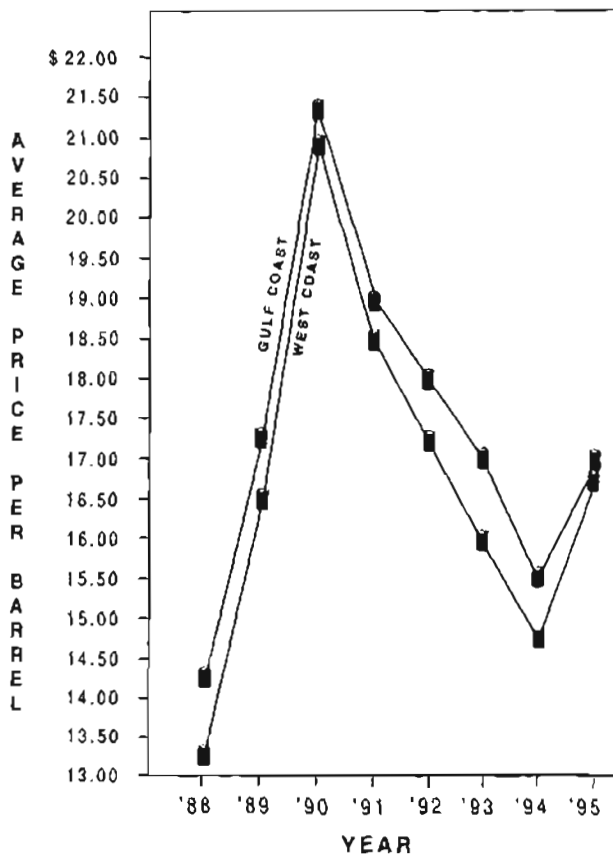


Figure 6. Fluctuation in annual average price of Alaska North Slope crude oil, 1988-1995. Averages calculated from data compiled from Alaska Report.

than the 1 billion barrels considered to be the threshold size for a commercial oil accumulation in the deep-water regions of the Beaufort Sea.

PRODUCTION

At year's end, there were 1,663 producing oil wells, 100 gas wells, 682 service wells, and 27 disposal wells active in Alaska (Alaska Oil and Gas Conservation Commission Bulletin, February 1996). Of these, 130 development and 16 service wells were drilled in 1995—16 oil wells in the Cook Inlet region, and the rest on the North Slope. Little information on these wells has been released to the public, but some data are made available through the AOGCC's monthly bulletins and the Petroleum Information Corporation's weekly Alaska Report. Production statistics for Alaska's oil and gas fields are listed in table 2.

NORTH SLOPE

North Slope oil fields produced 555.8 million barrels of oil and NGL's in 1995, 97.3 percent of the State's total. The Prudhoe Bay and Kuparuk River fields contributed 83 percent of North Slope production.

Prudhoe Bay oil field.—The Prudhoe Bay field, the Nation's largest oil producer, generated 62 percent of the State's oil and NGL's in 1995 while showing a 36-million-barrel decline in oil production, down 9.9 percent from 363 million barrels in 1994. In September, the field produced its 9-billionth barrel of oil. Originally estimated to have 9.6 billion barrels of recoverable oil, the field may ultimately yield 13 billion barrels. Reasons for increased production include improved directional drilling techniques, decreased costs for drilling production wells, and enhanced recovery methods.

Gas produced along with the oil is separated and reinjected into the reservoir to improve oil recovery. Prudhoe's GHX-1 gas-handling facility is the largest in the world, reinjecting 142 million cubic meters of gas each day. The GHX-2 gas facility became operational in 1994 and increased reinjection to 212 million cubic meters per day; this is equivalent to 55 percent of daily U.S. residential natural gas consumption.

NGL's are produced when some of the natural gas brought to the surface during field production condenses to light oil. A portion of this oil is reinjected to enhance oil extraction from the reservoir; about 74,000 bbl/d of Prudhoe Bay's NGL is routinely shipped through the TAPS for commercial sale. This amount was temporarily increased in 1995 to 94,000 bbl/d, but there is concern that decreased NGL reinjection will decrease overall oil recovery from the field.

The Niakuk pool of the Prudhoe Bay field was

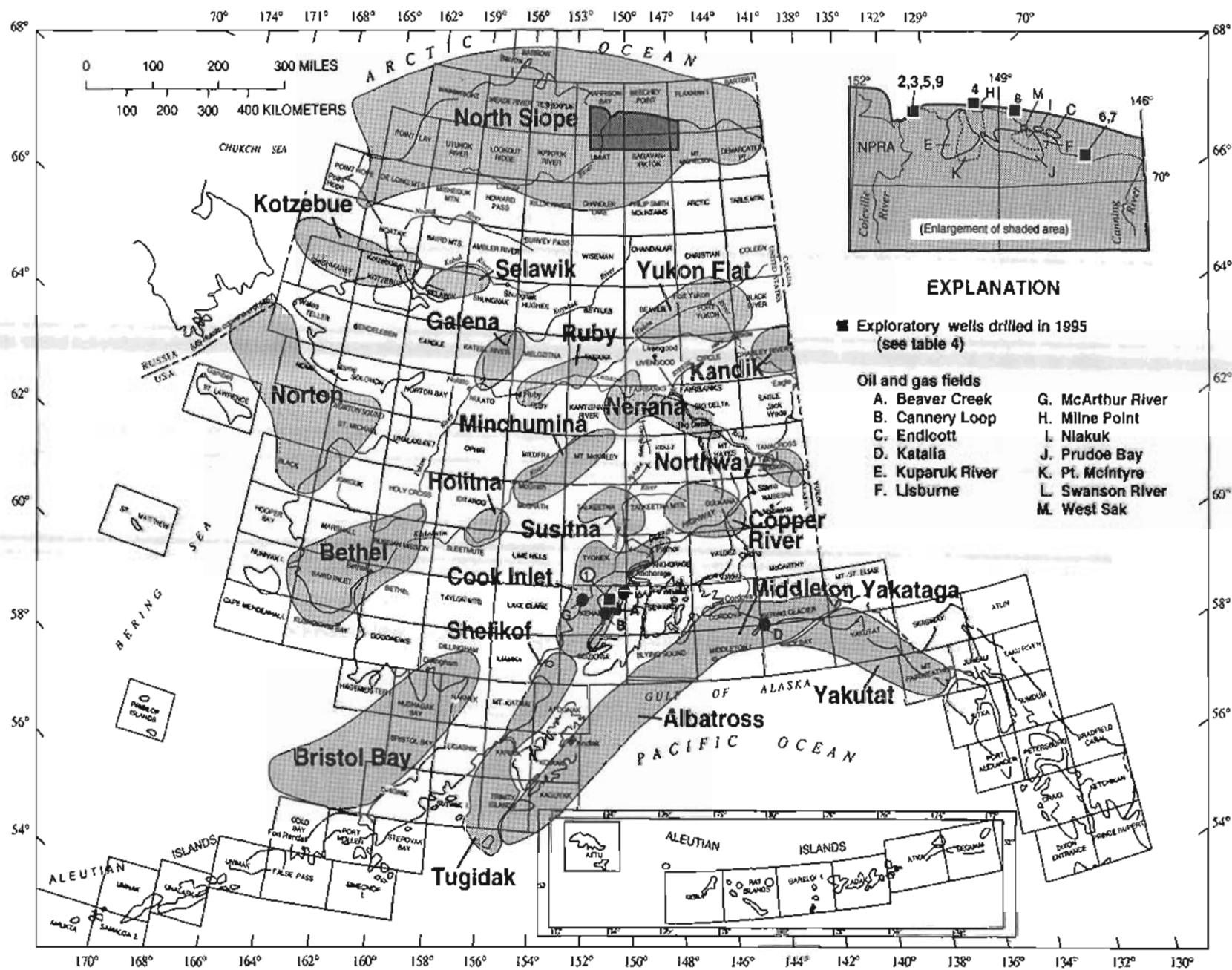


Figure 7. Locations of 1995 exploratory oil wells listed in table 4, known oil and gas fields, and possible petroleum-bearing sedimentary basins (outlined). Basins adapted from Kirschner (1988). 1:250,000-scale quadrangles are outlined and labeled.

Table 4. Alaska exploratory oil wells drilled on State lands in 1995.¹

[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). ARCO-Ak, ARCO Alaska; BPX-Ak, BP Exploration-Alaska; P&A, plugged and abandoned]

Well No.	Company	Well name	API No.	Location	Total depth (meter)	Date completed (1995)	Remarks
Cook Inlet							
1.	ARCO-Ak	Bufflehead I	50-883-20090-00	3-08N-09W, SM	3,674	12/16	suspended
North Slope							
2.	ARCO-Ak	Alpine I	50-103-20211-00	01-11N-04E, UM	2,286	2/16	P&A
3.	ARCO-Ak	Alpine 1A	50-103-20211-01	01-11N-04E, UM	3,030	3/01	P&A
4.	BPX-Ak	Milne Point E-13	50-029-22536-00	25-13N-10E, UM	4,135	3/15	P&A
5.	ARCO-Ak	Fiord 3	50-103-20210-00	25-12N-05E, UM	2,143	4/04	P&A
6.	BPX-Ak	Badami 5	50-629-22533-00	05-09N-20E, UM	3,520	4/07	P&A
7.	BPX-Ak	Badami 4	50-629-22532-00	03-09N-20E, UM	3,551	4/11	P&A
8.	ARCO-Ak	Niakuk NK-27	50-029-22547-00	36-12N-15E, UM	5,392	4/14	Oil discovery
9.	ARCO-Ak	Fiord 3A	50-103-20210-01	25-17N-05E, UM	2,788	4/15	P&A

¹ No exploratory wells were drilled on Federal lands in 1995

discovered by BPX-Ak in 1985 and put into production in 1994; daily oil and NGL production during 1995 averaged 19,482 barrels. The field, containing an estimated 54 million barrels of recoverable oil, is located entirely offshore in the eastern part of Prudhoe Bay and is being developed through extended-reach drilling from an onshore production facility at Heald Point. In 1995, BPX-Ak achieved a North Slope record for extended-reach drilling with a bottom-hole location nearly 5 kilometers from the drill rig. Waterflooding was implemented at Niakuk in 1995, injecting as much as 50,000 bbl/d of water into the reservoir; the project's goal is to increase daily oil production to 23,000 barrels. The areal limits of the pool were extended into the West Niakuk area in 1995 by the Niakuk NK-27 well, which hit a 35-meter-thick oil-bearing reservoir; this well is currently producing 5,700 bbl/d of oil.

Kuparuk River oil field.—The Kuparuk River field is the Nation's second largest oil producer, contributing 293,149 bbl/day in 1995 to Alaska's total oil production. Because production at the field peaked in 1992 at 322,000 bbl/d, new development wells will be drilled, and gas injection expanded from 5 to 15 drill sites, using NGL's from the Prudhoe Bay field. The goal of this project is to maintain daily production levels at 290,000 to 300,000 barrels over the next 5 years and ultimately recover an additional 200 million barrels of oil. This will be the first development in the field since 1994 when ARCO-Ak suspended drilling to cut costs when oil prices were low.

Point McIntyre oil field.—The Point McIntyre field produced 50.8 million barrels of oil and NGL's during 1995, 9 percent of Alaska's total production and a 33-percent increase from the previous year. The field was discovered in

1988 beneath the waters of Prudhoe Bay; initially expected to produce about 70,000 bbl/d, the field has consistently produced over 100,000 bbl/d since production began in October 1993. 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.

Endicott oil field.—The Endicott field was the first offshore Arctic oil field to be developed and produced 34.4 million barrels of oil and NGL's in 1995, a 4-percent decrease from the previous year; oil production at the field peaked in 1992 at 115,000 bbl/d. Endicott produced its 300-millionth barrel of oil in September 1995. Originally estimated at 350 million barrels of recoverable oil, the Endicott field may ultimately yield 600 million barrels as a result of enhanced recovery methods and development wells that target smaller pockets of oil.

Milne Point oil field.—BPX-Ak's expansion of the Milne Point production facilities boosted oil production from 18,300 bbl/d in 1994 to 23,800 bbl/d in 1995; continued expansion is expected to increase production to 60,000 bbl/d in 1996. The Milne Point field was discovered in 1969 and put into production in 1985. Original resource estimates were 100 million barrels of recoverable oil, but estimates have been revised to 200 million barrels since the discovery of a major offshore extension of the oil reservoir. During 1995, BPX-Ak began development of its 1993 Cascade discovery, located 5 kilometers southeast of the Milne Point field. A gravel production pad, road, and elevated pipeline connecting with the Milne Point infrastructure are planned. As many as 40 development wells may be drilled for peak oil production in the 10,000 bbl/d to 15,000 bbl/d range.

COOK INLET

The Cook Inlet region continued to be the main producer of dry natural gas in Alaska, producing 99.3 percent of the State's total in 1995. Five fields produced more than 90 percent of the region's 5.1 billion cubic meters. Oil and NGL production in 1995 was 15.5 million barrels, only slightly less than 1994's 15.6 million barrels, the result of new production from the West McArthur River field and increased efforts to stimulate, maintain, or revive production from aging fields.

West McArthur River oil field.—Stewart Petroleum's West McArthur River field is Cook Inlet's newest field and the first to be discovered by a small, independent oil company. Discovered in 1991, the field was confirmed by a second well in 1993; a third delineation well was completed in 1995. West McArthur River produced 922,073 barrels of oil in 1995, a slight increase over 1994. The company estimates resource recovery of 100 million barrels of oil and 991 million cubic meters of gas. Cumulative production at the end of 1995 was 1.9 million barrels of oil and 13.6 million cubic meters of gas.

TRANSPORTATION

Trans-Alaska oil pipeline.—More than 10 billion barrels of oil have been transported by the TAPS since 1977. Average throughput in 1995 was 1.5 million bbl/d, down from the peak of 2 million bbl/d in 1988. Overall North Slope production is falling and will eventually decline to the point when TAPS revenues will no longer pay for operation of the pipeline. To delay this event, and because less power is needed to move less oil along the 1,280-kilometer pipeline, cost-cutting efforts will result in closure of 3 of the line's 12 pump stations in 1996. State officials estimate that there is enough North Slope oil to keep the TAPS in operation through 2017.

Proposed natural gas pipeline.—Yukon Pacific Corporation has proposed construction of a \$14-billion 1,280-kilometer-long pipeline to bring North Slope natural gas to a tidewater LNG plant at Anderson Bay near Valdez. In 1995, the Federal Energy Regulatory Commission approved construction and operation of the liquefaction plant. Yukon Pacific has received all major government approvals for the project, but has yet to receive a specific commitment from major North Slope gas owners to sell their gas; ARCO-Ak, BPX-Ak, and Exxon, who control 98 percent of the Prudhoe Bay gas, currently reinject most of their gas to enhance oil recovery at the field. Shorter pipeline routes to the Chukchi or Bering Sea have also been considered in order to reach the Southeast Asia market, but overseas demand for North Slope gas may not materialize before 2005.

Whittier pipeline.—The Department of Defense decommissioned its Whittier-to-Anchorage jet fuel pipeline

and made it available for lease under competitive procedures in 1995. Alaska Pipeline, a subsidiary of Enstar Natural Gas, won the right to lease the pipeline for 33 years at a cost of \$76,000 per year. The 20-centimeter-diameter pipeline will be used to transport Cook Inlet natural gas to customers between Anchorage and Whittier.

ACTIVITY BY FEDERAL AGENCIES

MINERALS MANAGEMENT SERVICE

LEASING AND EXPLORATION ACTIVITY

Between 1976 and 1991, the DOI held 17 oil and gas lease sales on the Alaska OCS (fig. 8), offering over 546,330 square kilometers. The DOI leased 1,562 tracts covering 34,400 square kilometers and received \$6.5 billion in high bonus bids (tables 5 and 6). A total of 1,505 leases have been relinquished or have expired, leaving 57 leases still held by oil and gas companies as of December 31, 1995. No lease sales for oil and gas have been held on the Alaska OCS since 1991, but leasing is scheduled to begin again in 1996 (table 7).

Fourteen continental offshore stratigraphic test (COST) wells and 81 exploratory wells have been drilled on the Alaska OCS (table 5). COST wells were drilled to delineate the geologic framework and hydrocarbon potential of the basins penetrated; exploratory wells probe for oil and gas. For the second consecutive year, no exploratory wells were drilled in any of the Alaska OCS planning areas in 1995. All of the exploratory wells drilled on the Alaska OCS have been permanently plugged and abandoned.

Beaufort Sea planning area.—All 57 OCS leases still held by industry lie within the Beaufort Sea planning area. Nine leases have been classified as producible (table 8), but only five are active. The Hammerhead, Kuvlum, Northstar, and Sandpiper prospects, which cover a total of 22 leases, are being evaluated for development; Union Texas expects Kuvlum to yield 7 to 325 million barrels of oil, and BPX-Ak estimates that the Northstar unit contains between 100 and 200 million barrels of recoverable oil. OCS Sale 144 was scheduled for the Beaufort Sea planning area for September 1996 (Minerals Management Service, 1995a).

Chukchi Sea planning area.—The last eight active leases in the Chukchi Sea planning area were surrendered in 1995. OCS Sale 148, originally proposed for June 1997, has been deferred to the next 5-year (1997-2002) schedule due to low industry interest.

Cook Inlet planning area.—Two OCS lease sales scheduled for the Cook Inlet planning area were postponed—OCS Sale 88 in December 1984, due to lack of industry interest, and OCS Sale 114 in September 1990, pending results of the Exxon Valdez oil-spill studies. Industry interest in the Cook

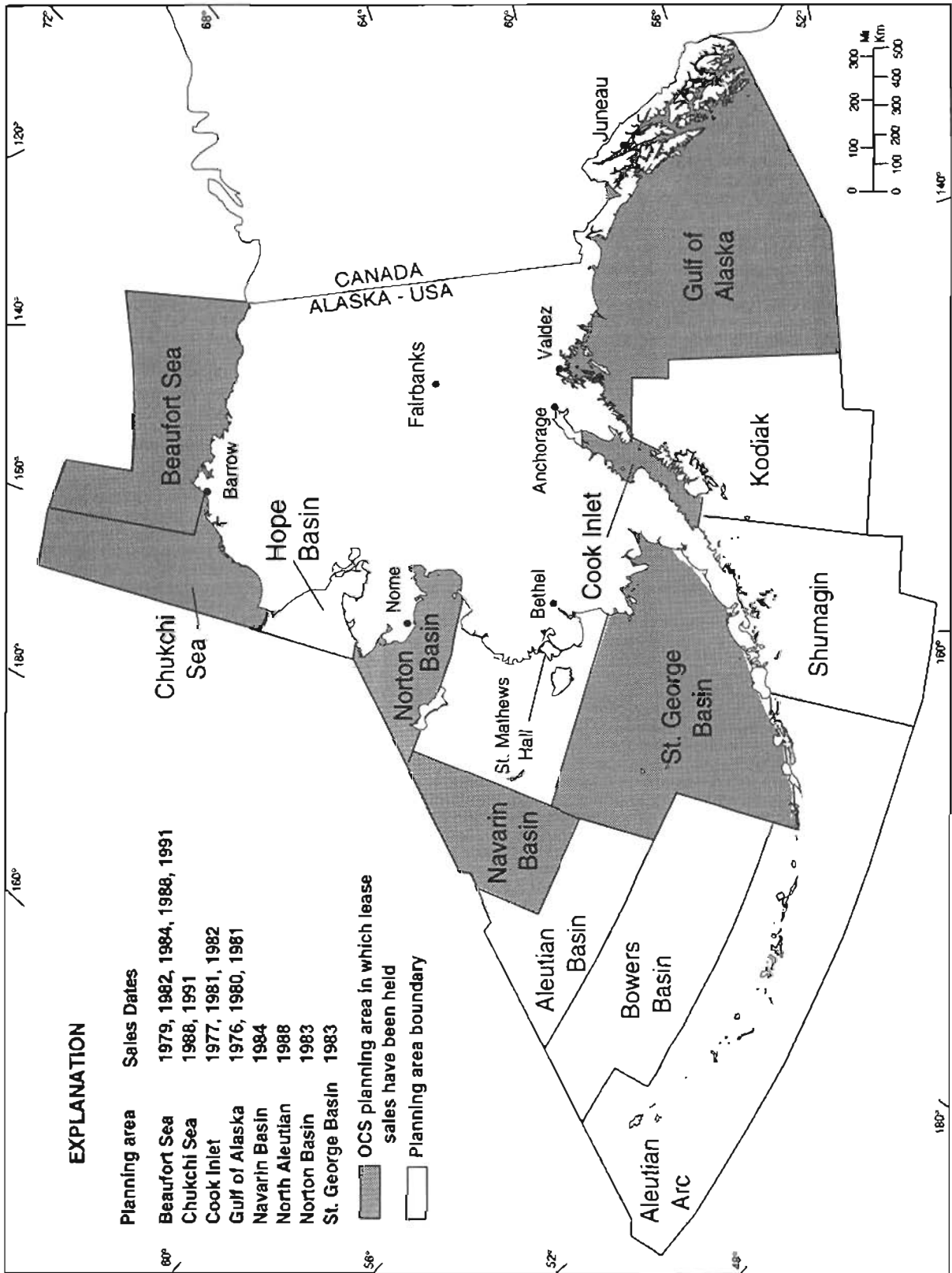


Figure 8. Alaska Outer Continental Shelf Region planning areas and lease sale history.

Table 5. Alaska Outer Continental Shelf leases and wells drilled, 1976-1995.
[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	57
Chukchi Sea (1988, 1991)	378	4	0
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)	0
North Aleutian Basin ³ (1988)	23	1 (1 COST)	0
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; all wells permanently plugged and abandoned.

² Includes Lower Cook Inlet and Shelikof Straits.

³ Exploratory drilling prohibited; all leases surrendered on July 28, 1995.

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

Planning area	Sale	Year	Proceeds (dollars)
Beaufort Sea	BF ¹	1979	488,691,138
	71	1982	2,055,632,336
	87	1984	866,860,327
	97	1988	115,261,636
	124	1991	16,807,025
Chukchi Sea	109	1988	478,032,631
	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	398,471,313
	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	426,458,830
Total			6,457,126,798

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

Inlet planning area has been renewed recently by ARCO-Ak's 1991 Sunfish discovery coupled with improved seismic technology and new geologic interpretations of the seismic data. Extended-reach and horizontal drilling technology, drilling platform modifications, and upgrades to production equipment have also been important in the revitalization of Cook Inlet's oil industry. In response to this renewed interest, the MMS was considering OCS Sale 149 for the Lower Cook Inlet area.

Gulf of Alaska planning area.—OCS Sale 114 was a joint Gulf of Alaska/Lower Cook Inlet lease sale originally scheduled for September 1990; it was postponed in May 1989 to allow additional time to assess the effects of the *Exxon Valdez* oil spill. OCS Sale 158 was tentatively scheduled for the Gulf of Alaska/Yakutat area for June 1997 (Minerals Management Service, 1995b), but it has been postponed until the 1997-2002 schedule.

Kodiak planning area.—Four lease sales have been scheduled for the Kodiak planning area since 1980 but have not been held due to low industry interest and administrative postponements; no lease sales are presently scheduled for the area. The MMS plans to conduct additional studies to gain a better understanding of the hydrocarbon resources of this area.

Navarin Basin planning area.—Seventeen of the blocks offered in the Navarin Basin planning area OCS Sale 83 in April 1984 lay in an area of disputed U.S.-Soviet jurisdiction, and the bid deposits were refunded with interest in December 1988; the last 2 of the 163 leases awarded in

Table 7. Proposed activity by Alaska OCS region and planning area, 1992-1997.

[see figure 8 for locations]

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

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

Table 8. Producible oil leases, Beaufort Sea planning area.

[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 costs of producing hydrocarbons at the wellhead]

Lease number	Prospect name	Number of wells drilled
¹ OCS-Y-0181	Seal	1
² OCS-Y-0191	Salmon	2
³ OCS-Y-0195	Tern	1
³ OCS-Y-0196	Tern	1
⁴ 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 Seal prospect is part of the Northstar unit.

² Relinquished 12/88.

³ Relinquished 7/90.

⁴ Relinquished 6/90.

that sale were surrendered in 1995. OCS Sale 107 was scheduled for 1991, and OCS Sale 130 was proposed for 1995, but neither were held due to low interest by the oil industry.

North Aleutian Basin planning area.—OCS Sale 92 in the North Aleutian Basin planning area was completed in October 1988, but six consecutive 1-year moratoria and suspensions of operations were enacted between 1989 and 1995 to assess the results of *Exxon Valdez* oil-spill studies and to evaluate possible environmental consequences of oil development on Bristol Bay fisheries. Consequently, owners of the 23 leases awarded in Sale 92 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. No leases remain in effect, and the moratoria precluded any exploratory drilling.

Norton Basin planning area.—OCS Sale 100 had been scheduled for March 1986 but was canceled due to lack of industry interest. OCS Sale 120 in 1992 was indefinitely postponed for the same reason.

Saint George Basin planning area.—The 1986 OCS Sale 89 was canceled, and the 1990 OCS Sale 101 postponed indefinitely, due to low industry interest. For the same reason, the 1996 OCS Sale 153 has been indefinitely postponed and is not part of the next 5-year (1997-2002) comprehensive program.

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 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 were considered in fewer areas.

Leasing is planned for two of the 15 Alaska OCS planning areas during the 1992-1997 program (table 7); studies planned for those and 3 additional areas will focus on hydrocarbon potential and environmental characteristics of the areas. Lease sales that had been considered in the *Chukchi Sea and Hope Basin planning areas* for the 1992-1997 program were delayed into the 1997-2002 program. Plans for simultaneous American and Russian lease sales in June 1997 for the Chukchi Sea region were dropped from the current Federal program because of low industry interest and significant environmental concerns.

The Alaskan Regional Stakeholders Task Force, which is composed of representatives from Federal and State agencies, municipalities, Native corporations, and environmental groups, identified five Alaska OCS planning areas for consideration in the next 5-year (1997-2002) program. The Draft EIS on the draft proposed 5-year program was released (Minerals Management Service, 1996d). Public hearings on the Draft EIS were completed in April 1996, and comments received will be analyzed and incorporated into the Final EIS scheduled for release in September 1996. The proposed final program proposes five lease sales, one in each program year: 1998, Beaufort Sea; 1999, Cook Inlet/Shelikof Strait; 2000, Beaufort Sea; 2001, Gulf of Alaska; and 2002, Chukchi Sea/Hope Basin (Minerals Management Service, 1996e).

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. Administered by the MMS, 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. Assessment information is provided to the AESP through cooperative Federal and State inter-agency 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 sub-Regions.

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 current mission of the AESP is 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).

OIL AND GAS RESOURCE ASSESSMENT

The MMS and USGS prepare estimates of the undiscovered, economically recoverable oil and gas resources on the OCS as part of a 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). Work on the next National Assessment was completed in 1995 (Minerals Management Service, 1996a, 1996c). Workshops were held to facilitate contact between MMS scientists and other Alaska OCS researchers in order to produce the best assessment possible. The new National Assessment will comprise two major components: a geologic evaluation of the undiscovered oil and gas resources and an economic appraisal of the undiscovered recoverable resources with regard to fluctuating market conditions.

DATA ACQUISITION ON THE ALASKA OCS

In 1995, geophysical operations were aimed primarily toward prospect and play definition on nearshore lands in the Beaufort Sea. Recent discoveries in the area continue to fuel industry interest, but the high cost of data acquisition and unfavorable economic conditions for small field development has kept exploration efforts at low levels.

Approximately 194 square kilometers of three-dimensional seismic data was acquired in programs over State and Federal lands in the Beaufort Sea in 1995.

U.S. GEOLOGICAL SURVEY

North Slope research, gas hydrates, petroleum systems, and the assessment of undiscovered oil and gas resources are the principal USGS activities directed at an improved understanding of onshore oil and gas resources in Alaska. In 1995, these projects were funded under the Onshore Oil and Gas Investigations, the Global Change and Climate History, and the Mineral Resource Surveys programs: USGS scientists conducted field work, analyzed field samples, and prepared several maps and reports. Results were published or presented at various technical meetings.

NORTH SLOPE

National Petroleum Reserve—Alaska.—Results of geologic, geophysical, and geochemical studies in the National Petroleum Reserve—Alaska (NPRA) (fig. 9) included the following: a new interpretation of the structural geology of the central Brooks Range and its implications for petroleum geology (Kelley and Brosge, 1995a); preliminary results on the sequence stratigraphy of Jurassic and Early Cretaceous strata in the western part of the NPRA (Grow and others, 1995a, 1995b); a revised digital version of the aeromagnetic map covering most of the NPRA and areas to the east (Grauch and Castellanos, 1995); and inorganic geochemical analyses of selected petroleum source-rock intervals in NPRA wells (Isaacs and others, 1995).

Brooks Range foothills.—USGS studies continued to evaluate the oil and gas potential of the Brooks Range foothills region. The second of five proposed transects across the belt was completed, and geologists prepared final reports on the tectonic evolution of the north-central Brooks Range (Cole, Bird, Howell, and others, 1995; Cole, Bird, Toro, and others, 1995; Cole, Roure, and others, 1995) and an evaluation of the foreland basin sandstones (Meier, 1995). This project involves scientists from the USGS, the Alaska Division of Geological and Geophysical Surveys (ADGGS), Adelaide University, Stanford University, the University of Missouri, Chengdu University, and the Institut Francais du Pétrole.

Arctic National Wildlife Refuge.—Helicopter-supported field work was conducted in and adjacent to the northern part of the Arctic National Wildlife Refuge (Arctic NWR) in 1995. Samples were collected for age dating by the apatite fission-track method, for analysis of both petroleum source rocks and reservoir strata, and for detailed sedimentologic observations. A new evaluation of the oil

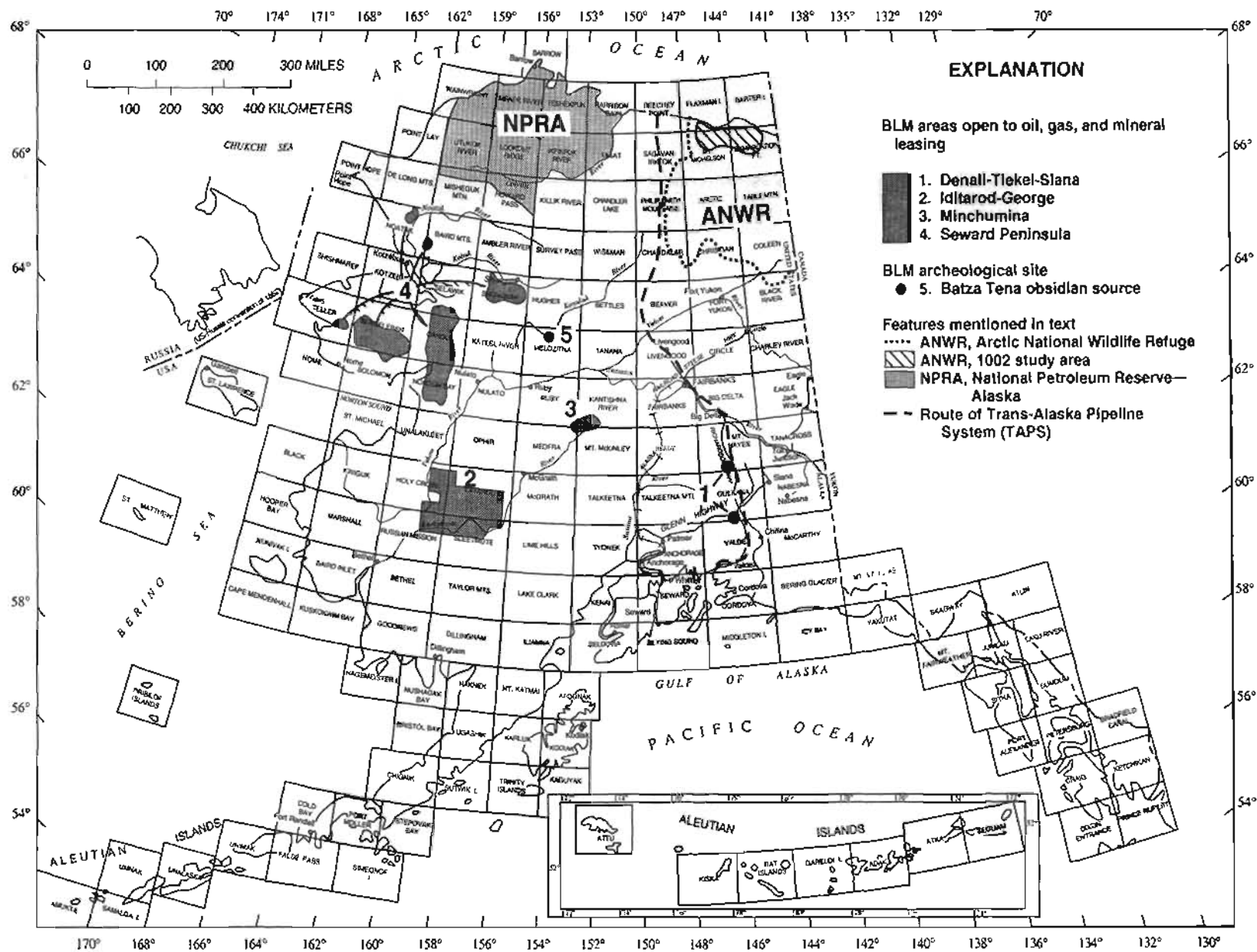


Figure 9. Selected Federal land units mentioned in text. 1:250,000-scale quadrangles are outlined and labeled.

and gas potential of the Arctic NWR Coastal Plain will be based on these studies.

GAS HYDRATES

The North Slope Gas Hydrate project is funded by the USGS Onshore Oil and Gas Investigations Program, USGS Global Change and Climate History Program, and the DOE. Gas hydrates are formed when methane gas is trapped in the ice matrix during crystallization of water. Much work has been done to identify and quantify gas hydrates in the Arctic (Collett, 1995a; Dallimore and Collett, 1995; Prenskey, 1995), as well as the climatic effects from decomposing hydrates (Collett, 1995c; Dillon and others, 1995). An assessment of the quantity of natural gas trapped as gas hydrates of onshore and offshore Alaska (Collett, 1995b) was part of the most recent national assessment of oil and gas resources.

OIL AND GAS ASSESSMENTS

The most recent assessment of United States oil and gas resources (Gautier and others, 1995; U.S. Geological Survey, 1995a) included estimates of undiscovered oil and gas resources of onshore and State offshore parts of Alaska. An overview of the assessment process (U.S. Geological Survey, 1995b) presented a review of oil and gas formation and shows how knowledge of formation processes is translated into quantitative estimates of undiscovered oil and gas resources. A separate summary of North Slope oil and gas resources was also compiled (Bird and others, 1995a, 1995b).

DRILLING WASTE SITE CLOSURES

Between 1974 and 1981, the Navy and USGS drilled 28 exploratory wells in northwestern Alaska in order to assess the oil and gas resources and geologic setting of the NPRA. In 1991, the Alaska Department of Environmental Conservation (ADEC) published guidelines for site assessment of inactive drilling waste sites. Because Federal lands are subject to State regulations, the USGS and BLM began a multiyear project in 1991 to request approval from the ADEC for official closure of the NPRA drilling waste facility sites. The USGS conducted a site analysis at each facility, and the BLM performed the risk assessments for possible contamination or leakage of drilling wastes from the pits. Formal application for closure was made to the ADEC in 1994. Based on site visits and the evidence submitted by the USGS and BLM, the ADEC gave closure approvals to 27 sites in early 1995; minor remedial actions and 5-year monitoring are required for one of the sites.

PETROLEUM SYSTEMS

In 1995, the American Association of Petroleum Geologists presented its award for best publication of 1994 to a USGS geologist and his co-editor for their book on petroleum systems (Magoon and Dow, 1994). This book was a collaboration between the USGS and private industry, presenting a compendium of world-wide petroleum systems and the factors that define such systems. Selected petroleum systems in Cook Inlet (Magoon, 1994) and on the North Slope (Bird, 1994) are detailed in the book.

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 of statutes governing mineral development. Evaluation of mineral potential is a required component of all BLM Resource Management Plans and Federal lands disposition. 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 systematically interpret geologic, geophysical, and mineral-resource data as they become available from Federal and State agencies and private industry. Proprietary information is held confidential in accordance with appropriate law, but nonproprietary data, interpretations, and assessment results are published as BLM-Alaska technical and open-file reports.

LEASE OPERATIONS

Oil and gas leases on the Kenai Peninsula and North Slope are managed under provisions of the National Petroleum Reserves Production Act and ANILCA. In 1995, the BLM administered 38 producing oil and gas leases on 272 square kilometers on the Kenai Peninsula. Minor production comes from an additional 0.65 square kilometers administered under a Compensatory Royalty Agreement in the West Fork field where two wells on private leases produce from neighboring Federal Estate.

The BLM's Inspection and Enforcement (I&E) program governs operations associated with exploration, development, and production of oil and gas from Federal onshore leases; active leases are located on the Kenai NWR in the onshore extension of the Cook Inlet petroleum province. Current I&E strategy evolves to reflect the changing economic climate. Operational factors affecting I&E strategy include reservoir volumes, ancillary resources, and legal requirements. Data pertaining to these factors are tracked by the Automated Inspection Records System. Royalty revenues from Federal

onshore oil and gas production in Alaska rank tenth in the United States.

During 1995, four Applications for Permit to Drill were issued for the Kenai Peninsula. North of the Swanson River Field, Arco-AK completed its Bufflehead exploratory well in late December, but results have not yet been made public. A second exploratory well was permitted in the Falls Creek area near Clam Gulch.

To fulfill the mandate of section 1008 of ANILCA, BLM Lease Operations has made four areas south of 68° N. available for noncompetitive oil and gas leases (fig. 9). These leases are in the Denali-Tiethyl-Stana area, the Iditarod-George area, the Minchumina area, and the Seward Peninsula. Of the 9,600 leases issued in the four areas, 330 remain active, encompassing 144 square kilometers. Potential exploration, development, and production activities will be managed under the Federal Onshore Oil and Gas Leasing Reform Act of 1987 and the Energy Policy Act of 1992.

RESOURCE EVALUATION

Arctic National Wildlife Refuge.—Ongoing BLM investigations in the Arctic NWR have started to quantify and compare petroleum system elements underlying the Coastal Plain. Petrography, geochemical analyses, seismic data, and stratigraphic interpretations show that two known oil-producing systems are present in the area and that one of them is actively generating oil. Further analysis of burial history and kinetic modelling will aid in the identification of system origins for the large seismically mapped prospects in the eastern Arctic NWR.

National Petroleum Reserve—Alaska.—In 1995, Arctic Slope Regional Corporation proposed an extensive land and mineral-resource exchange in northern Alaska involving the northern third of the NPRA and corporation-selected lands adjacent to the NPRA and along the northern flank of the Brooks Range. BLM geoscientists identified the quantity and distribution of available data and estimated the time necessary to update, interpret, and analyze the information in order to determine the economic and resource values needed to conduct an exchange.

Chukchi Sea.—BLM geologists analyzed recently available data from exploratory drilling on the Alaska OCS in order to better understand and describe onshore petroleum plays in the western NPRA (Mowatt and others, 1995); one new occurrence was identified. A comparative analysis of the Chukchi oils from northwestern Alaska and Prudhoe Bay oils in northeastern Alaska revealed major geochemical differences between the two, even though both were generated from the same source rocks (Banet, 1995a, 1995b). Alternatively, Chukchi oils exhibit a positive correlation to oils of the Sverdrup Basin of north-central Canada, and tectonic reconstruction of the Arctic places the two areas in

close proximity at the time of source rock formation.

PIPELINE MONITORING

The Joint Pipeline Office (JPO) consolidates diverse Federal and State regulatory requirements for the TAPS into a single entity. The JPO facilitates reviews of oil-spill contingency plans and promotes awareness of oil-spill effects and remedial activities. Major organizational sections of this interagency command team include Operations, Quality Assurance, Pipeline Surveillance, Engineering, Lands Administration, and a self-directed Oil Spill Team. The BLM is the Authorizing Officer of the 11 Federal and State agencies in the JPO.

The JPO maintains its pipeline monitoring program, under which each organizational section exercises its specific authority. Work continues on wetlands mapping and on the review and issuance of additional pipeline construction permits and rights of way. Possible seismic or unstable terrain hazards along the TAPS right-of-way are being re-evaluated. Geotechnical studies are gathering baseline information for proposed pipelines from the TAPS to Mikkelsen Bay and the Colville Delta.

NATIONAL PARK SERVICE

In 1995, the NPS commented on OCS oil and gas Lease Sale 149, proposed by the MMS for Cook Inlet and Shelikof Strait. Oil and gas development resulting from this sale could potentially affect NPS coastal resources and coastal wilderness values in Katmai and Lake Clark National Parks and Preserves.

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 1995 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. Most of the fuel appears to have been recovered, but remediation will continue until the ADEC grants closure approval.

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 ground water using recirculating and air-stripping technology were successful. While cleanup levels established by the

ADEC are being achieved, the procedure is time-consuming and costly, and the FWS continues to support the cleanup levels established by the State. A comprehensive review of remediation efforts at the yard was completed by the field operator in early 1995, and remediation was expected to continue through 1996. In 1991, an environmental audit was completed of chronic crude oil spills and leaks at tank settings and flare-pits throughout the Swanson River field. A remediation pilot project initiated in 1992 at one of the tank settings was expected to continue through 1996. Cleanup levels are being achieved, but a decision has not yet been made as to applicability for the remaining tank settings and flare pits. Unocal took over operation of the Swanson River field from ARCO Alaska in 1992.

ACTIVITIES UNDER SECTION 1008 OF ANILCA

Section 1008 of ANILCA provides for oil and gas studies on refuges in Alaska in order to gather information for use in future land-management decisions. In 1995, 21 special-use permits were issued for minerals activities on the following national wildlife refuges in Alaska (number of permits in parentheses): Arctic NWR—geologic mapping (4), helicopter operations (3), glacier research (1); Izembek NWR—volcano studies (1), gravel removal (8); Kenai NWR—geophysical gravimetric survey (1), surface gas analysis (1); Koyukuk NWR—government agency (1, permit not exercised); and Selawik NWR—geologic mapping with helicopter access (1, permit not exercised). 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 1995, the FWS reviewed for the ACE 20 Section 404 Clean Water Act Public Notices pertaining to oil and gas activities. These Public Notices included oil field activities at the Kuparuk, Lisburne, Milne Point, Point McIntyre, and Prudhoe Bay oil fields, as well as the TAPS.

Lease Sales.—The FWS reviewed and commented on the Federal draft OCS Leasing Program, 1997-2002. The FWS also commented on six proposed State offshore lease sales on the North Slope.

Monitoring.—The FWS continued its annual water-

quality monitoring of 16 ponds and lakes in the Prudhoe Bay and Kuparuk oil fields, the summer breeding habitat of numerous migratory birds. Contaminant specialists also continued sampling 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. In 1995, the FWS also published a technical report summarizing the data from a 4-year study of the breeding success of Steller's eiders near Barrow, Alaska (Quakenbush and others, 1995).

Reclamation.—FWS monitoring of the Kaktovik Inupiat Corporation's exploratory well in the Arctic NWR was minor in 1995, but data analysis and reporting continued. The FWS released its findings regarding the surface impacts created by private industry's seismic testing on the Coastal Plain in 1984 and 1985 (Emers and others, 1995).

ACTIVITIES UNDER SECTION 302 OF ANILCA

Section 302 of ANILCA stipulates that the FWS manage water quality and quantity in each refuge for the conservation of fish and wildlife and their habitats. Due to ongoing and possible oil and gas activities, 5-year water-resource inventories and assessments were initiated in two refuges. In the Kenai NWR (fig. 10), where oil and gas are produced from the Swanson River and Beaver Creek oil fields, 11 stream-gauging stations were installed in 1994, and 4 stations were added in 1995 (U.S. Fish and Wildlife Service, 1995c). In the Yukon Flats NWR (fig. 4), where the Doyon Limited Native regional corporation has proposed an exchange for oil and gas rights within the refuge, 11 stream-gauging stations were installed from 1993 to 1994; a progress report of preliminary data was released (Trawicki, 1995).

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 were in effect in Alaska in 1995. 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; this ruling was 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 requirement was met, and on August 14, 1995, the FWS modified and extended the Beaufort Sea ruling through December 15, 1998. In 1995, six LOA's were issued for the incidental take of polar bears and Pacific walrus in the Beaufort Sea.

Two FWS rulings for the intentional take (harassment only) of polar bears were issued in 1995. These rulings allow action to prevent bears from endangering human life during exploration for oil and gas in the Beaufort and Chukchi Seas.

EXXON VALDEZ OIL-SPILL RESTORATION PROJECT

Several *Exxon Valdez* oil-spill restoration projects issued their final reports in 1995. Reports discuss results of

surveys and monitoring of marine birds and mammals (Agler and others, 1995; Dragoo and others, 1995; Hayes, 1995; Kuletz and others, 1995; Roseneau, Kettle, and Byrd, 1995) and the removal of introduced predators from islands impacted by the oil spill (Schmidt, Bailey, and Byrd, 1995).

ARCTIC NATIONAL WILDLIFE REFUGE

Section 1002 of 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 strip is frequently referred to as the 1002 area (fig. 9). The FWS was designated as principal coordinator for a resource assessment required under ANILCA Section 1002 and subsequently conducted a baseline study of the area's fish, wildlife, and habitats. ANILCA also mandated a Report to Congress, which was prepared under the provisions of a 1983 interagency Memorandum of Understanding among the FWS, BLM, and USGS. The Report (Clough and others, 1987), which contained the Final Legislative EIS for the 1002 area, 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



Figure 10. FWS scientist uses Prick current meter to measure discharge of Little Black River in Yukon Flats NWR. Water flow is measured at intervals along tag line to produce a profile of total discharge at this point in river. Photograph from FWS files.

gas operations in the 1002 area, should they occur. Additional field studies were conducted from 1987 to 1995 (U.S. Fish and Wildlife Service, 1995a). ANILCA prohibits oil and gas activities on the 1002 area unless authorized by an act of Congress.

The FWS and National Biological Service continued to pursue biological studies on the Coastal Plain. The goal of these studies is to achieve a better understanding of the area's natural dynamics, the alteration of ecosystem dynamics that might result from activities, any associated adverse impacts, and the means to avoid, minimize, or rectify those adverse impacts. During 1995, studies relating to caribou productivity and habitat use, seismic impacts, musk oxen, polar bears, fisheries, weather data, and water resources were continued in order to address additional information objectives. The FWS issued its final report on the Coastal Plain fisheries based on investigations conducted from 1988 to 1991 (Underwood and others, 1995). In 1995, the FWS filed seven applications with the State of Alaska for water rights in the Coastal Plain on Sadlerochit Springs, Upper Sadlerochit River, Lower Sadlerochit River, Akutoktak River, Lower Itkilyariak River, Upper Itkilyariak River, and West Fork Itkilyariak River.

U.S. DEPARTMENT OF ENERGY

The DOE approved a 4-year cooperative research and development agreement with BP Exploration (BPX) in 1995 to develop a recovery process for the heavy-oil component of the Prudhoe Bay oil field. Project goals are two-fold: to chemically define and incorporate the natural gas, light oil, and heavy oil fractions of the field's hydrocarbon system into a single compositional model; and to characterize the heavy oil's physical properties for use in simulations of the proposed recovery methods. These goals are essential for the identification of a viable process and requisite equipment to implement the chosen recovery system. Laboratory research and development for the project will be conducted at the DOE's National Institute for Petroleum and Energy Research in Bartlesville, Oklahoma.

BPX will contribute approximately \$4.97 million to the \$6.36-million project. The physical target of this research is an estimated 1.54 billion barrels of heavy oil contained in a 9- to 24-meter-thick layer that underlies the main oil production zone in the southern part of the Prudhoe Bay field. Should the results of the laboratory research lead to an economically viable recovery process applicable to Prudhoe Bay's heavy-oil zone, BPX would then undertake a pilot study prior to initiating commercial operations.

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 1995 coal production, valued at \$41.3 million, increased 10 percent over 1994 levels to 1.49 million metric tons. This runs contrary to the 1-percent decline in overall estimated U.S. output for 1995 of 922 million metric tons (Weekly Coal Production, December 30, 1995). Approximately 43 percent of Alaska's coal production was burned in-state for power generation, and the remaining exported to South Korea from the Seward coal terminal. The Usibelli Mine near Healy produces all of Alaska's commercial coal; additional coal properties include the Kuchiak Research Mine on the western North Slope, the Beluga coal field west of Cook Inlet, and Wishbone Hill in the Matanuska Valley.

Construction began on the 50-megawatt Healy Clean Coal Project in May 1995 and shut down for the winter in October 1995; a similar schedule is anticipated for 1996, and construction should be completed by June 1997. Operations are scheduled to begin in January 1998. The DOE will contribute \$117.3 million, and the Alaska Industrial Development and Export Authority is providing \$150 million, for the \$267.3-million project, one of 45 projects nationwide sponsored by the DOE to demonstrate new, clean-burning coal technologies.

Cook Inlet Region Incorporated (CIRI), an Alaska Native regional corporation, purchased all rights to the 14.4-million-metric-ton Wishbone Hill coal deposit (fig. 12) near Palmer in August 1995; former owner Idemitsu Alaska had been developing the property for 10 years. CIRI plans to continue mine development and is negotiating for an experienced coal mining operator to begin open-pit production. In the same area, Nerox Power Systems is planning an underground mine on their coal leases to the east of the CIRI mine. Coal at Wishbone Hill is bituminous in rank, has both low sulfur and water contents, and has a higher heating value than the subbituminous Healy and Beluga coals.

The University of Alaska-Fairbanks (UAF) sought funding to test commercial production of a new coal-based heating fuel, developed at the DOE Energy and Environmental Research Center in Grand Forks, North Dakota (Alaska Journal of Commerce, January 9, 1995). The experimental procedure combines powdered coal and water under high pressure to yield a fuel that can be used in place of heavy oil

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 project is intended to illustrate the combined removal of particulate matter, nitrogen oxide compounds, and sulfur dioxide from stack emissions. The Alaska Public Utilities Commission gave its approval to the project in September 1992, and the ADEC issued the necessary air-quality permit in early 1993. The DOE published the project's Final EIS in December 1993 (U.S. Department of Energy, 1993) and signed the Record of Decision in March 1994 to approve Federal funds to begin construction and operation of the project.

DOE funds of \$117.3 million are being provided under the Clean Coal Technology Program in a 1991 cooperative agreement monitored by the DOE's Pittsburgh Energy Technology Center. A consortium headed by the Alaska Industrial Development and Export Authority will provide the remaining funds for the \$267-million project. The Healy Project, which is sited adjacent to the Golden Valley Electric Association's existing Healy Unit 1, will burn low-sulfur coal from the Usibelli Mine.

The DOE is funding a second Clean Coal Technology project in Alaska at UAF. The Coal Diesel Combined-Cycle Project is being designed to demonstrate an advanced, coal-fueled diesel engine combined-cycle



Figure 12. Geologists stand next to near-vertical 0.5-meter-thick coal seam at former Baxter Mine in south-central Alaska; the mine is located at western end of Wishbone Hill coal district. Orientation of coal beds in this district varies from horizontal to steeply dipping; this complex structure of the deposit will allow selective mining of some seams but require bulk mining of other layers. Photograph by T. Crafford, North Pacific Mining Corporation.

system for the generation of electricity. The DOE will contribute half of the project's \$38.3-million cost and plans to complete an Environmental Assessment of the project by the end of 1996.

URANIUM RESOURCES

No significant uranium exploration or development occurred in Alaska in 1995. In southeastern Alaska, exploration continued on claims at Bokan Mountain (fig. 11). Numerous uranium-thorium prospects there also hold potential for niobium and rare-earth-element production (Philpotts, Taylor, and Baedecker, 1996).

The USGS terminated its uranium/radon program on September 30, 1994. The new Energy Resources Program emphasizes the environmental aspects of energy minerals. The program includes 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; geothermally heated greenhouses are in operation at Circle Hot Springs and Manley Hot Springs. Widespread active volcanism in the Aleutian Islands and Alaska Peninsula sustains the potential for commercial geothermal energy production on a regional scale. A lease was active at the Makushin Valley geothermal area (fig. 11), but no development has occurred, although plans have been submitted to the Alaska Energy Authority for a 12-megawatt geothermal power plant; the plant would furnish electrical power for Dutch Harbor and Unalaska, centers of the fishing industry in the northwestern Pacific Ocean. No Federal research was funded for geothermal studies in Alaska in 1995.

— 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 data (table 9) and ore reserve statistics were derived from the State's preliminary report on Alaska's mining industry for 1995 (Bundtzen, Swainbank, and others, 1996). Federal mineral activity related to many of these mines and deposits is described under the appropriate agency heading following the industry review.

ECONOMIC OVERVIEW

The 1995 estimated value of Alaska's mining industry rose 23.6 percent from 1994 levels to \$721.3 million, encompassing production values (\$539.5 million), development costs (\$147.8 million), and exploration expenditures (\$34 million) (Bundtzen, Swainbank, and others, 1996). At \$440.9 million, metallic minerals represented 81.7 percent of mining production in Alaska; this 9.6-percent increase from 1994 is due mainly to increased production of zinc and lead from the Red Dog Mine in northwestern Alaska. Development outlays more than tripled from the \$44.9 million spent in 1994, mainly at the Red Dog and Greens Creek polymetallic mines and the Nixon Fork and Fort Knox gold mines. Exploration expenditures rose 9.3 percent from 1994, dominated by gold projects in interior, southwestern, and southeastern Alaska. The mining industry employed 3,405 people in 1995.

Zinc was the most valuable metallic mineral in Alaska at \$345.6 million; zinc and lead values combined were 86 percent of metallic production. The Red Dog Mine is the world's largest zinc producer, contributing more than half of domestic production and 8 percent of worldwide output in 1995. Gold production fell 25 percent due to the closure of Valdez Creek and several smaller placer mines; however, production at the Nixon Fork and Fort Knox lode gold mines will substantially increase gold output in the near future. Nixon Fork began production in October 1995 and became the first producing lode gold mine in Alaska since 1942.

Although the number of active placer mines decreased 22 percent from 185 in 1994 to 145 in 1995, the bulk of Alaska's gold continues to be produced from these mines. The Valdez Creek Mine produced 1 million grams

of gold, and another 8 mines produced 1.7 million grams of gold, totaling 63 percent of 1995 production. Many of these larger mines utilize open-pit or underground mining techniques to reach buried placer deposits, but most placer mines remain small surface operations employing two or three people. Placer mines occur throughout Alaska, from the Canadian Border to the Seward Peninsula and from the Brooks Range to the Kenai Peninsula.

Land ownership in Alaska is divided between the Federal government (60 percent), the State and private entities (28 percent), and Alaska Native regional corporations (12 percent). National parks, wildlife refuges, and wilderness areas are closed to new mineral entry, but mineral activities are permitted in national forests, BLM planning areas, and grandfathered parcels. Federal agencies not only oversee and manage permitted mining activities on their respective lands, but also deal with issues of access to, and environmental impacts from, adjacent, non-Federal lands. Over 90 percent of State land is open to mineral entry. To encourage exploration, the legislature enacted a financial incentives bill in 1995 that provides full credit for qualifying exploration costs, corporate taxes, and production royalties; the Alaska Division of Geological and Geophysical Surveys (ADGGS) also published results of its airborne geophysical surveys in the Fairbanks, Richardson, and Rampart-Manley Mining Districts and southeastern Bethel Basin (Alaska Division of Geological and Geophysical Surveys, 1995a, 1995b, 1995c, 1996). The Alaska Native Claims Settlement Act in 1971 mandated conveyance of 161,875 square kilometers of land to 13 Alaska Native regional corporations; mineral values are one of the factors influencing final land decisions for some corporations. Many Native corporations are also actively conducting or promoting mineral exploration and development on their lands. The most successful Native mineral venture is the Red Dog Mine, owned by the NANA Native regional corporation and operated by Cominco Alaska.

MINES AND PROSPECTS

The following section describes major mineral activities by the mining industry in Alaska in 1995; additionally, there is considerable regional and site-specific exploration that is undocumented by published sources. The annual mining industry report published by the ADGGS (Swainbank and others, 1995) is a good source of information on mineral companies, mines, and production statistics.

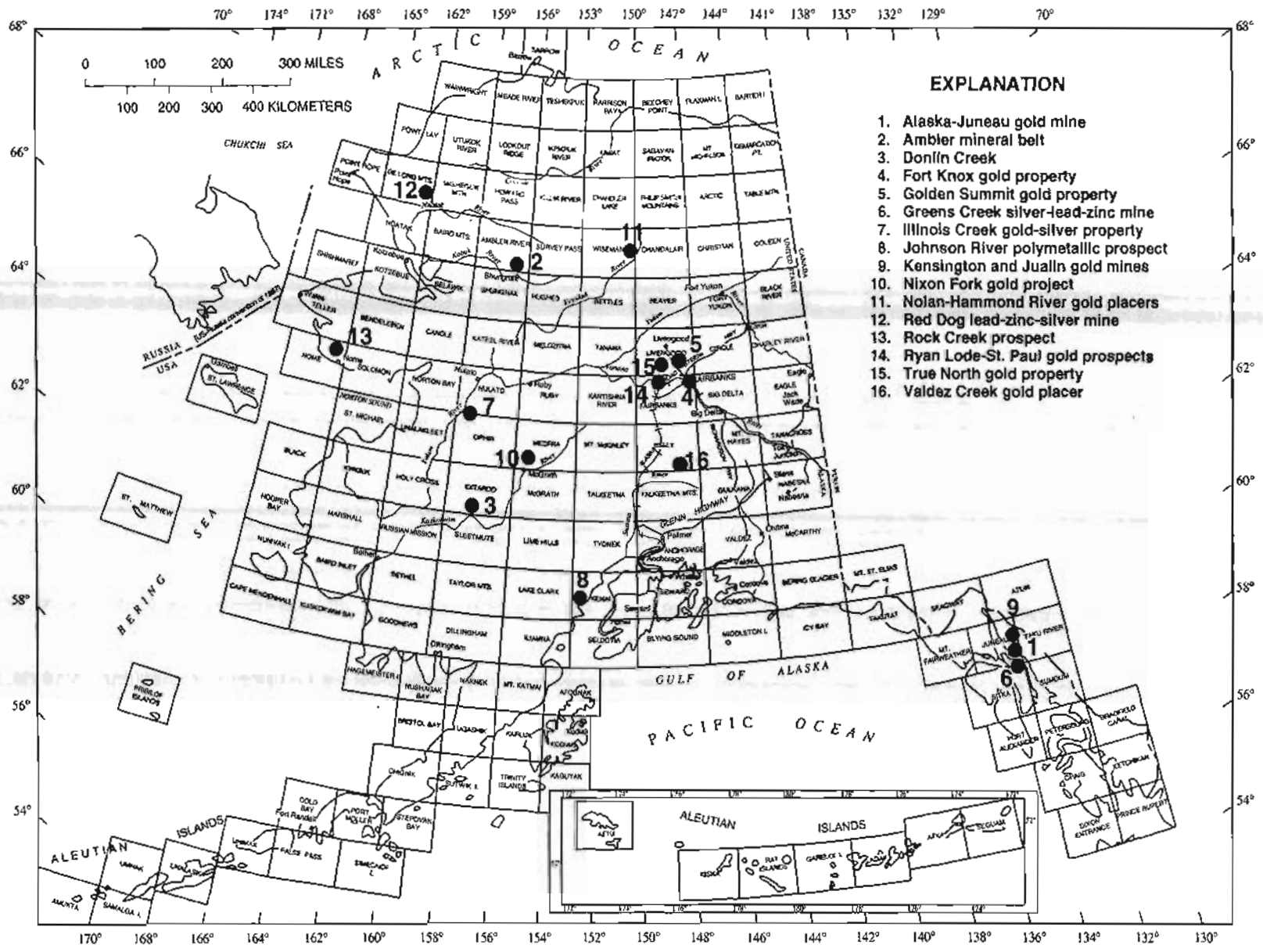


Figure 13. Areas of significant industry activity involving metallic minerals (excluding uranium) in 1995, and mine and deposit locations mentioned in text. 1:250,000-scale quadrangles are outlined and labeled.

NORTHERN ALASKA

Red Dog polymetallic mine.—The Red Dog Mine began producing in 1990 and was the world's largest zinc producer by 1994. In 1995, a new ore body was discovered just north of the existing pit that doubled the reserve estimates for the mine. This newly found Aqqaluk deposit contains at least 76 million metric tons of ore, averaging 13.7 percent zinc, 3.6 percent lead, and 65.2 grams of silver per metric ton; substantial tonnage of lower grade ore also exists. At current prices, the gross value of Aqqaluk metal reserves is roughly equal to the value of all known gold ever produced in Alaska. The new reserves will allow production to be expanded by 30 percent. Even with increased production, current reserves at Red Dog are sufficient to support mining into the middle of the next century.

Ambler Mineral Belt.—The Ambler mineral belt is a massive-sulfide district that contains the Bornite, Arctic, and Sun copper-zinc-lead deposits. Both Kennecott and Teck Exploration conducted field work in the area in 1995.

Wiseman area.—Silverado Mines continued exploration for placer and lode gold in the Wiseman district, drilling 65 holes totaling more than 1,500 meters. The Nolan Creek placer deposit contains proven and probable reserves of 1.56 million grams of gold and inferred reserves of 2.7 million grams. The Hammond River placer deposit, discovered in 1995, has an inferred potential of 2 million to 6 million grams of gold.

WESTERN AND SOUTHWESTERN ALASKA

Seward Peninsula.—Kennecott Exploration conducted field work to evaluate lands belonging to the Bering Straits Native regional corporation and the Sitnasuak Native village corporation. Kennecott also drilled exploratory holes in the Snake River lowlands and at the Rock Creek deposit. Alaska Gold Company abandoned the use of placer dredges and mined 591,000 grams of gold from an open-pit operation.

Illinois Creek.—In 1995, USMX Incorporated signed a formal agreement with CIRI to explore and develop the Illinois Creek gold-silver property (fig. 14) and subsequently met with State and Federal agencies to review the mining and reclamation plans and initiate the permitting process. Exploratory drilling in 1995 totaled 7,318 meters; one 11-meter intercept contained 30 grams of gold per metric ton of ore. Current reserves are estimated at 10.7 million grams of gold and 206 million grams of silver. Production start-up is scheduled for late 1996; ore will be mined from an open pit, and a zero-discharge, heap-leach operation will be used to recover the gold. After mine closure, the leach heap will be rinsed, and both heap and waste dumps will be contoured, topsoiled, and vegetated. USMX hopes to recover 1.9 million grams of gold annually.

Nixon Fork.—Consolidated Nevada Goldfields Corporation operates the Nixon Fork Mine near McGrath, which poured its first gold in October 1995 to become the first lode gold mine to go into production in Alaska since 1942; 193,000 grams of gold were produced by December. The deposit is small but high grade, showing an average grade of about 52 grams of gold per metric ton of ore and 2.2 percent copper. Reserves are currently estimated at 4.8 million grams of gold, sufficient for only 3 years production, but exploration to identify additional reserves continues. In 1995, the company leased 186 square kilometers of land adjacent to the mine from the Doyon Limited Native regional corporation.

Donlin Creek.—Placer Dome reached an agreement with the Calista Native regional and Kuskokwim Native village corporations for exploration rights to 85 square kilometers in the vicinity of Donlin Creek, spending \$1 million there in 1995. Prior exploration in the area had defined a resource of 12.4 million grams of gold, with potential for 31 million grams of bulk-minable gold.

FAIRBANKS MINING DISTRICT

Exploration and mining companies have begun to find lode sources of the placer gold that has been mined in the Fairbanks Mining District since 1902. Aided by an ADGGS geophysical survey published in 1994, exploration efforts blanketed the district in 1995. Several lode properties were being developed for production, and various placer mines were also active in the area.

Fort Knox Mine.—Construction of the mill and mining facilities at Amax Gold's Fort Knox Mine began in early 1995; total construction costs were estimated at \$256 million. When production begins in October 1996, Fort Knox will become the largest gold mine in Alaska, doubling Alaska's annual gold production. Ore reserves total 127.5 million grams of gold, sufficient for 12 years of production at projected rates; exploration for more reserves continues. Amax Gold worked with State and Federal agencies and environmental groups to ensure low environmental risk from mining operations, complete mine closure when reserves have been exhausted, and land reclamation that includes recreational facilities and wildlife habitat. Fort Knox is recognized as the prototype of a previously unknown type of mineral deposit, now called porphyry gold.

True North prospect.—La Teko Resources acquired the True North prospect from Amax Gold in early 1994 and conducted an aggressive exploration program on the property. In mid-1995, Newmont Mining joined La Teko in exploration efforts under an agreement that will allow Newmont to acquire up to 65 percent interest in the property. Drilling and trenching have defined ore reserves of 31 million grams of gold and an inferred resource of 77.8 million grams, but the extent of mineralization has not yet been delineated.

Development of the ore body will be facilitated by its spatial geometry, high-grade ore, and amenable metallurgy for gold recovery.

Ester Dome.—Two deposits on Ester Dome have potential for gold production. Exploration at the Ryan Lode property had defined an ore body containing estimated reserves of 25.6 million grams of gold, and La Teko was soliciting development capital to build the mine. The main undertaking in 1995 was the neutralization of several heap-leach pads left by a former operator of the property. Silverado Mines conducted exploration drilling at the St. Paul prospect and anticipated start-up of open-pit mining there in the near future.

Cleary mineral belt.—Considerable exploration

took place along the Cleary mineral belt, previously known for its small high-grade mines, but now targeted for larger, lower grade deposits. International FreeGold's Golden Summit project covers 93 square kilometers of claims along 18 kilometers of the Chatanika Fault, where lode mineralization occurs in fractures and shears. Exploration drilling by Avalon Development on property adjacent to Golden Summit had intercepts showing 2 grams of gold per ton of ore. Placer Dome drilled 1,500 meters of core and conducted an airborne geophysical survey on their claims. Northwest of the belt, La Teko Resources staked the Juniper Creek prospect on the basis of geophysical evidence, then subsequently discovered gold anomalies in the stream-sediment and soil samples collected.

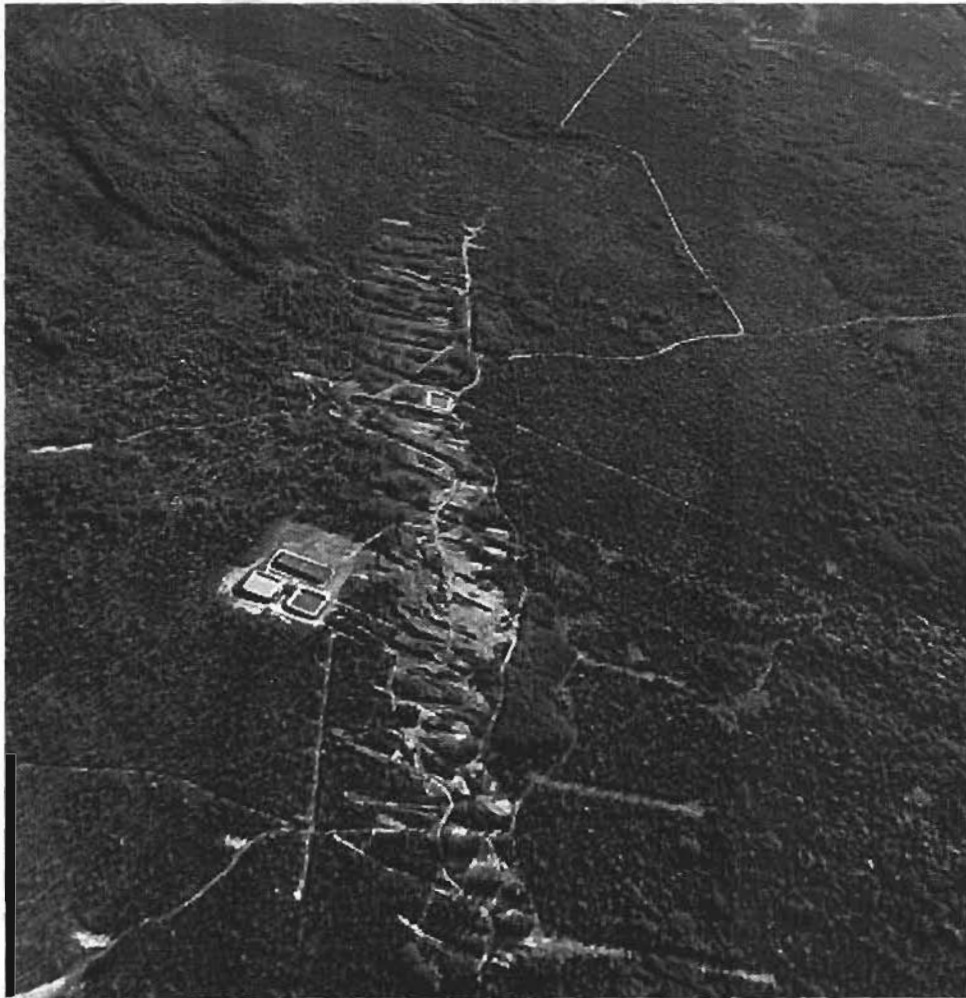


Figure 14. Aerial view looking east-northeast along strike of Illinois Creek gold-silver property in western Alaska; exploration workings extend over 3 kilometers along top of deposit. Camp, leach heap, and gold-extraction plant are being constructed north of deposit, to left of photograph. Photograph from North Pacific Mining Corporation files.

Placer mining.—Polar Mining operated several large open-pit placer mines in the Fairbanks area, one on Goldstream Creek and the other on Fish Creek. The Little Eldorado Group operated an underground drift mine on Little Eldorado Creek, sinking a decline more than 305 meters through permafrost to mine gravels too deep to reach from a surface operation.

EAST-CENTRAL ALASKA

The Valdez Creek Mine produced 1.02 million grams of gold in 1995 but was closed in September when reserves were exhausted; the mine had been the largest placer operation in Alaska for the previous 5 years. Reclamation work at the mine earned a 1995 Governor's Award for the mine's owner, Cambior Alaska.

SOUTHEASTERN ALASKA

Berners Bay Consortium.—In November 1994, a business alliance was formed by Coeur Alaska and the Berners Bay Native Business Consortium to promote mining development and to increase Consortium shareholder employment in the Berners Bay region, 64 kilometers north of Juneau on Lynn Canal. As of January 1996, the Consortium comprised three Native village corporations: Goldbelt Incorporated, Kake Tribal Corporation, and Klukwan Incorporated. Terms of the alliance call for Coeur Alaska to employ a minimum 25-percent-Native workforce in its mining operations and to accord the Consortium preferential treatment in contract negotiations for mine construction and support activities. In return, Coeur will receive public relations assistance, support facilities for mining operations, and possible mining leases on Native lands.

Kensington gold project.—The Kensington property is located in the Berners Bay Mining District at the northern end of the Juneau Gold Belt; calculated gold reserves total 62 million grams. During 1995, Coeur Alaska acquired full ownership of the property from its former partner, Echo Bay Alaska, and submitted to the FS an amendment to its Plan of Operations. In June, the EPA conditionally approved the company's mining Plan but required changes in the proposed water-treatment facilities. In December, the EPA discovered flaws in the data provided for the waste-water permit; Coeur Alaska was working to rectify this situation. The ACE permit was also pending at year's end. As of December 1995, over \$85 million had been spent on the Kensington project, and an additional \$115 million in capital costs was expected to be expended to get the Kensington Mine on-line after the necessary environmental permitting is in place.

Jualin gold prospect.—Coeur Alaska's Jualin mining property is located 4 kilometers southeast of the Kensington property. Coeur Alaska acquired 100 percent interest from

International Curator in June 1994. Exploration activities during 1995 on the Jualin property were minimal, and gold reserve estimations remain at 12.4 million grams.

Alaska-Juneau Mine.—Echo Bay Alaska announced that the latest phase of drilling at the Alaska-Juneau (A-J) gold mine in the State's capital city had completed their exploration efforts. The \$15-million program took 18 months and was expected to increase the mine's proven, probable, and inferred reserves of 91 million metric tons of ore containing 162 million grams of gold. In response to a 1994 EPA report, Echo Bay dropped plans to use cyanide in the gold-recovery process and also re-examined its strategy for tailings disposal; submarine disposal in Taku Inlet south of Juneau was one of the options being considered. Underground production facilities will be developed after all permitting is completed. Echo Bay anticipated that 20,400 metric tons of ore will be mined daily and expects to employ 450 people to operate the mine during its minimum estimated lifespan of 13 years.

Greens Creek Mine.—In the spring of 1995, the Kennecott Greens Creek Mining Company announced that they would reopen the nation's largest silver producer by the beginning of 1997; the Greens Creek Mine had been closed since April 1993 due to low metal prices. During the shutdown, development work and exploration drilling continued underground; new and higher grade ore reserves were discovered. A review of the surface management and treatment of waste rock and its effluent was completed. Other activities included refinement of the environmental monitoring program and revision of the General Plan of Operations to address proposed changes to mine operations upon reopening. The mill will be refurbished to accommodate a production level of 1,225 metric tons per day, and a new gravity circuit for precious-metal recovery will be added. A new water-treatment plant will also be built as part of the \$8-million environmental upgrade. The company's objective is to provide active treatment of all effluents, increasing discharge into Hawk Inlet by 57 percent to 4,160 liters per minute; settling ponds will be kept for passive effluent treatment only as necessary. Loading facilities will be modernized, and the concentrate warehouse expanded 50 percent to 27,215 metric tons. The reopening project was projected to involve a capital cost of \$90 million, most of which will be spent during the first three quarters of 1996. The company was to begin production in the fourth quarter of 1996 and intended to be at full production by January 1997. Current employment of 130 people would expand to 250 by July 1996. Using current ore-reserve estimates, a mine life of 17 years was expected at the proposed production rate. Kennecott completed negotiations with the Federal government to gain underground access to additional lands adjacent to the mine within Admiralty Island National Monument.

ACTIVITY BY FEDERAL AGENCIES

U.S. GEOLOGICAL SURVEY

MINERAL-RESOURCE ASSESSMENTS

Much of the USGS Alaska program was conducted to implement the Alaska Mineral Resource Assessment Program (AMRAP) defined in Section 1010 of ANILCA, which requires the assessment of "mineral potential on all public lands in the State of Alaska." Assessments done under AMRAP employ field mapping, geochemical analyses, geophysical studies, and mineral-deposit modeling to define districts of potential mineral resources. The scope of AMRAP studies varies from Statewide projects to investigations of individual mineral deposits. Geologic and mineral-resource activities in Alaska at the regional, quadrangle-scale, and topical levels are shown on figures 15 and 16 and table 10.

Statewide.—The Statewide Alaska Mineral Resource Assessment project (SAMRAP) was initiated in 1993 to (1) compile the Alaska Resource Data File (ARDF), a 4,428-record data base of information on the lode and placer deposits of Alaska; (2) prepare maps, accompanied by tables of important deposits, showing permissive mineral-resource assessment tracts; and (3) prepare quantitative estimates of the undiscovered resources of copper, lead, zinc, gold, and silver in selected mineral-deposit types. Preliminary results were released (Light and others, 1995); final maps will be published at a scale of 1:2,500,000.

A digital bibliography with index maps of geologic mapping in Alaska was published (Galloway and Laney, 1994). A summary of the porphyry copper, porphyry molybdenum, and granitoid-hosted gold deposits of Alaska was also published (Nokleberg, Bundtzen, Brew, and Plafker, 1995).

Regional.—Regional studies address large areas of the State, and resultant maps are generally published at a scale of 1:500,000 to 1:1,000,000. In 1995, assessment studies were underway for the western Brooks Range, eastern Alaska Range, Alaska Peninsula, and Aleutian Islands. As part of the west-central Alaska project, a geologic map of the Unakaleet quadrangle was published (Patton and Moll-Stalcup, 1996), and a similar map for the adjacent Norton Bay quadrangle was finalized. In addition to SAMRAP, a new project will produce 1:1,000,000-scale regional geologic maps and mineral-resource assessments for the entire State; these assessments will be incorporated into the National mineral-resource assessment.

A cooperative project between the USGS and the Alaska Division of Oil and Gas resulted in the compilation of aeromagnetic and gravity data for 25 quadrangles in Interior Alaska (Meyer and Saltus, 1995; Meyer and others, 1996; Saltus and others, 1995). Resultant maps are being published at a scale of 1:500,000 and will be used in regional

Table 10. Regional and topical studies of USGS AMRAP and related projects active in 1995.

[Projects marked by asterisk are of statewide scope; other locations shown on figure 16]

Areal mineral-resource assessments
Alaska Peninsula, geology and mineral resources
Aleutian Islands, geology and mineral resources
Chugach National Forest Special Study Area, geology and mineral resources
Colville Mining District, geology and mineral resources
Eastern Alaska Range, metallogenesis
Fortymile Mining District, placer gold deposits
Juneau Gold Belt, lode gold deposits
Norton Bay-Unalakleet area, geology and mineral resources
* Placer gold deposit studies
Western Brooks Range, mineral deposits
Framework or process studies
* Alaska mafic and ultramafic rocks
* Alaska metamorphic-facies map
Geophysical data, interior Alaska
Greens Creek lead-zinc-silver massive-sulfide deposit
Jualin and Kensington low sulfide gold-quartz-vein deposits
Northwestern Alaska crustal study
* Paleomagnetism of accreted terranes
Exploration geochemical studies
Western Brooks Range, stratabound base-metal deposits
Southwestern Alaska, epithermal mercury deposits
Admiralty Island geochemistry
Environmental geochemical studies
Southwestern Alaska mercury deposits
Brooks Range exhalative Zn-Pb-Ag deposits

mineral- and energy-resource evaluations. The digital data from these compilations are being released to the public through the National Geophysical Data Center in Boulder, Colorado.

Quadrangles.—Mineral-resource assessments of 1:250,000-scale quadrangles (fig. 15) have been the core of AMRAP for many years, complementing and supporting both regional and site-specific studies. These multidisciplinary projects have produced geologic, geochemical, and geophysical maps; mineral deposit and mineral-resource assessment maps; a table of mineral deposit descriptions; and a summary publication. By the end of 1995, 34 AMRAP quadrangles had been completed. In 1995, reports and maps were published for the Chandler Lake quadrangle (Church, Kelley, and Bohn, 1995); Craig and Dixon Entrance quadrangles (Brew, 1995); Gulkana quadrangle (Folger and others, 1995); Healy quadrangle (Tripp, King, and Light, 1995); and Killik River

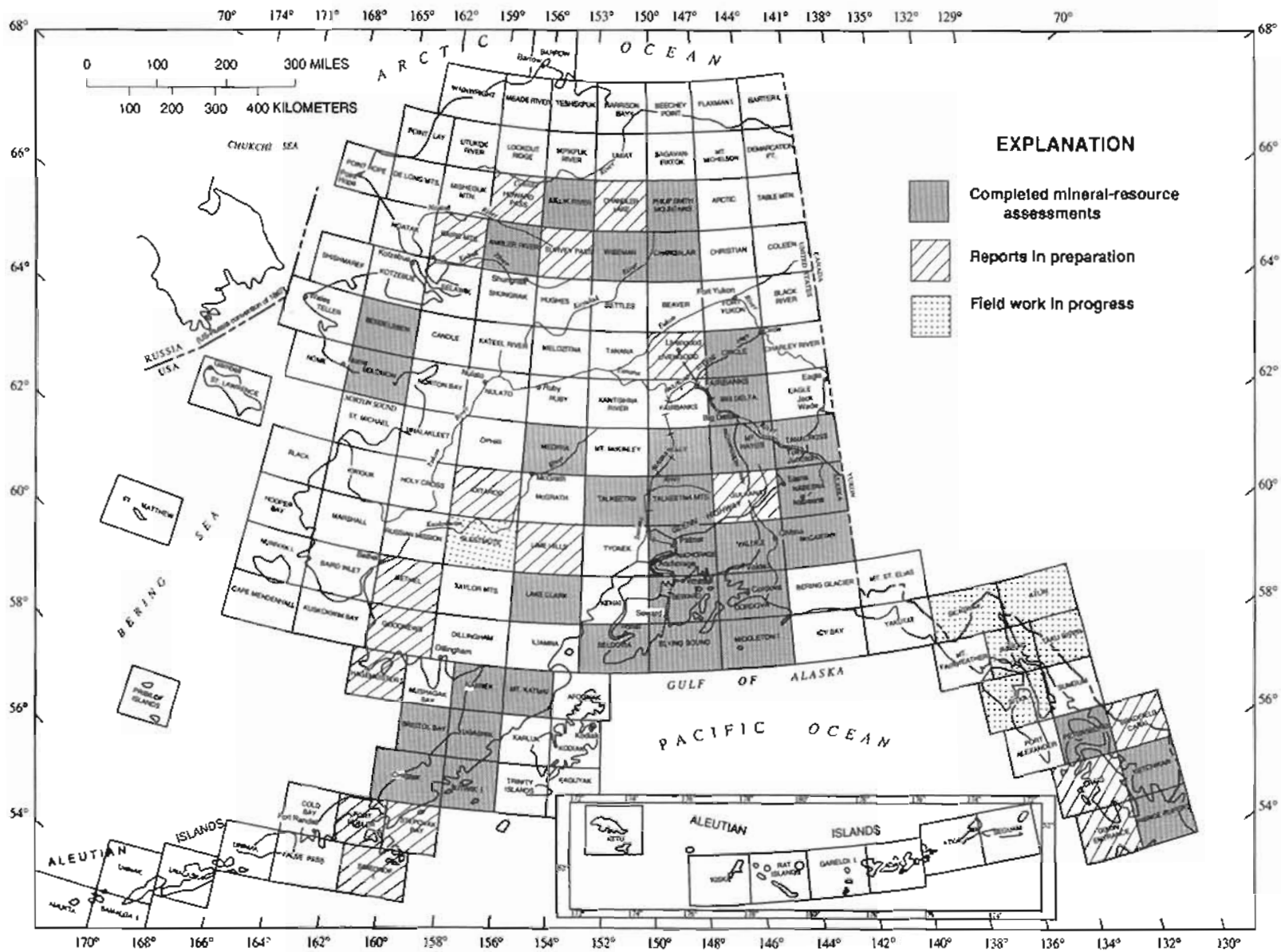


Figure 15. Status of USGS AMRAP quadrangle studies as of January 1996. 1:250,000-scale quadrangles are outlined and labeled.

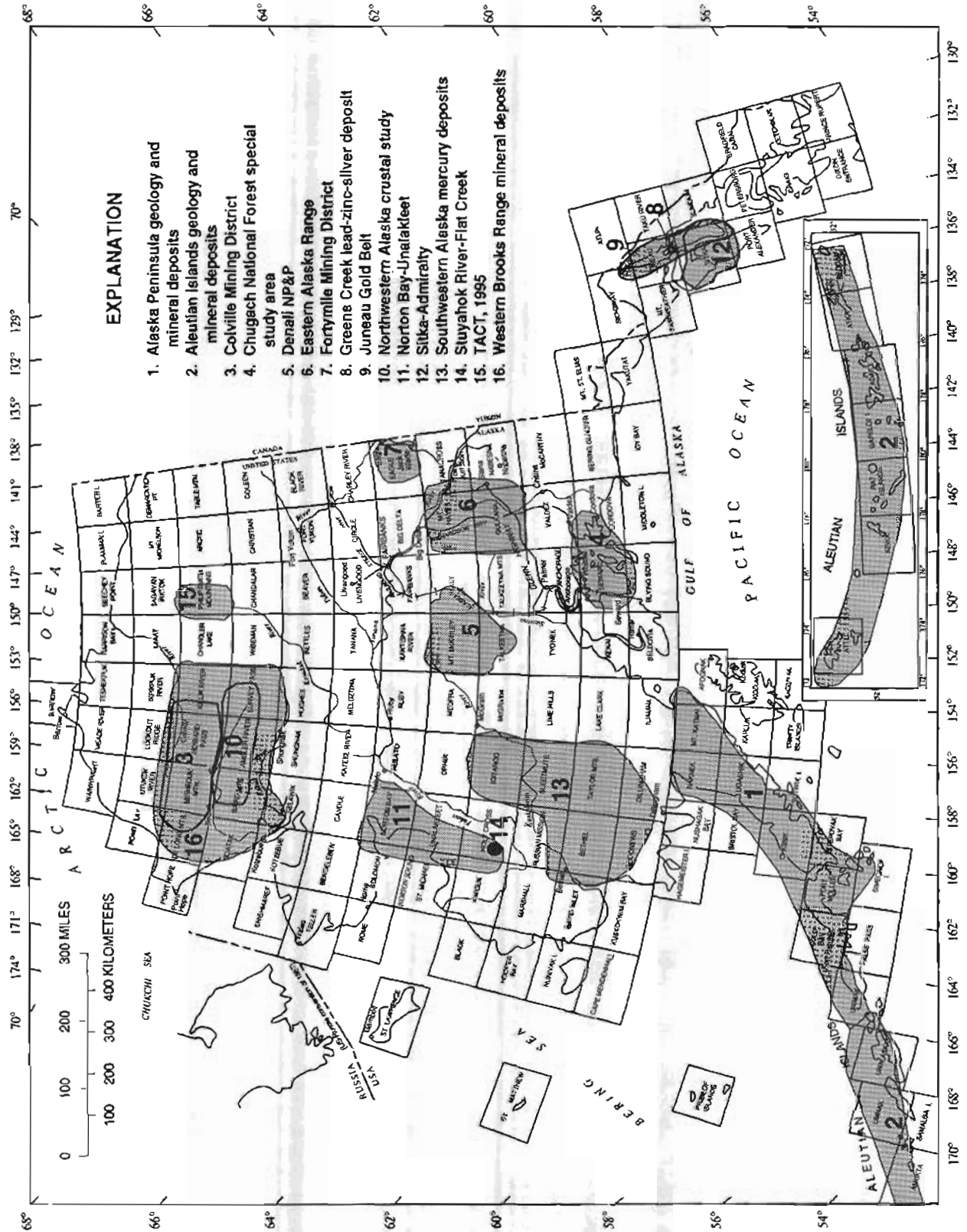


Figure 16. Locations of USGS regional and topical AMRAP and TACT studies in 1995. 1:250,000-scale quadrangles are outlined and labeled.

quadrangle (Kelley and Mull, 1995a, 1995b, 1995c; Kelley, Mull, and Barton, 1995a, 1995b).

Topical studies.—A comprehensive study of the Fortymile Mining District included bedrock geology; geology, mineralogy, and genesis of the placer gold deposits; current mining operations; and a history of mining in the district (Yeend, 1996). The annual research report on current USGS studies in Alaska was compiled for 1994 (Moore and Dumoulin, 1996); mineral-resource studies in this publication covered organic matter in rocks near Nixon Fork (Jacobson, Blodgett, and Babcock, 1996), the Bokan Mountain rare-earth deposit (Philpotts, Taylor, and Baedeker, 1996), environmental geochemistry of three mining districts (Kelley and Taylor, 1996; Gray and others, 1996; Trainor and others, 1996), and acid mine drainage in Prince William Sound (Goldfarb and others, 1996).

COOPERATIVE WORK WITH FEDERAL AGENCIES

National Park Service.—The USGS and NPS have cooperative projects in two national parks in Alaska. USGS and NPS personnel worked together on topical studies in Denali National Park and Preserve (Denali NP&P); preliminary results were published (Cooper, 1995; Csejty and others, 1994, 1995a, 1995b, 1996; Till and Harris, 1995). The USGS also published a guide to the volcanoes of Wrangell-St. Elias NP&P (Richter, Rosenkrans, and Steigerwald, 1995) to increase awareness of geology and geologic hazards in the area.

Forest Service.—USGS personnel were working in both Chugach and Tongass National Forests on various projects. A geologic map for the Chugach National Forest Special Study Area was being prepared, and acid mine drainage on Latouche and Knight Islands and in the Port Fidalgo area was studied. In the Tongass National Forest, the USGS developed an Interagency Agreement with the FS to provide geologic expertise in several areas: a geologic base map for the FS ecosystem study of the Northeast Chichagof area; an assessment of limestone resources as construction material and for use in mitigation of acid mine drainage; and a study of the surficial and glacial geology of southeastern Alaska to help the FS deal more effectively with landslides in their road-building operations. In addition, the FS will publish a USGS-produced pamphlet on the Mount Edgecumbe volcanic field near Sitka.

COOPERATIVE WORK WITH ALASKA NATIVE CORPORATIONS

Stuyahok project.—The USGS has a cooperative research and development agreement with the Calista Native regional corporation to perform geologic mapping and geochemical sampling in the Stuyahok River-Flat Creek area

of the Holy Cross quadrangle in southwestern Alaska, for the purpose of assessing the mineral resources in the area. Rocks favorable for gold, tungsten, and mercury deposits are present, and some gold has been mined from placers. USGS and Calista personnel conducted field work in 1995 (fig. 17), and Calista provided proprietary geochemical data. The USGS will publish a geologic map, geochemical data, and a summary mineral-resource assessment. The work will also be integrated into the AMRAP study of the Holy Cross quadrangle.

Inter-Tribal Youth Practicum.—The Practicum is a multiagency program designed to expose 16- to 19-year-old Native youths to problems and issues related to land use, resource development, environmental concerns, and the preservation of cultural traditions on Native lands in Alaska. The Practicum was organized by the FS, with participation from the NPS, FWS, USGS, and Bureau of Indian Affairs. In 1995, USGS personnel constructed a set of earth-science and natural-resource data bases and maps using the computerized Geographic Information System (GIS) and guided Practicum participants in the interpretation of the data.

COOPERATIVE WORK WITH FOREIGN SCIENTIFIC AGENCIES

Northern Alaskan-Canadian border.—The Alaska-Yukon border mapping project is a cooperative effort with the Geological Survey of Canada (GSC) to produce an integrated geologic map of northeastern Alaska and northwestern Yukon Territory. This work will provide a better understanding of the rocks underlying the Arctic coastal plain (Kelley, Wrucke, and Lane, 1995; Kelley, Wrucke, and others, 1995; Lane and others, 1995) and provide a geologic base map for regional mineral-resource assessments in the northeastern Brooks Range. In 1995, the project's third year, field work was conducted in an area 150 kilometers west of the border to determine the continuity of rocks and structures to the east.

Circum-North Pacific Terrane.—The USGS has been involved since 1988 in a collaborative project to evaluate the mineral resources of the Russian Far East and to develop an integrated metallogenic model for the Russian Far East, Alaska, and western Canada; in addition to maps and tables, digital data bases of mineral deposits and mining districts in the three areas are being compiled. The Circum-North Pacific Terrane map has been published (Nokleberg, Parfenov, and others, 1994; Nokleberg, Monger, and Parfenov, 1995), and the metallogenic model is being developed (Nokleberg, Bundtzen, Shpikerman, and others, 1995). These studies involve scientists from the USGS, ADGGS, GSC, Russian Academy of Sciences, Russian Committee on Geology, and Russian Committee on the Earth.

ENVIRONMENTAL STUDIES

In recent years, the USGS initiated a program to study the environmental effects of elements and metals associated with mineral deposits, especially where these elements or metals may be toxic to man or wildlife. In some cases, the halo of elevated elemental abundances surrounding a mineral deposit can be regional in scale. For instance, a

natural mercury province occurs in southwestern Alaska where cinnabar deposits have caused high background levels of mercury in water, soils, rocks, vegetation, and some species of wildlife (Bailey and others, 1995; Gray, 1994; Gray, Bailey, and Miller, 1995; Gray, Meier, and others, 1996). In northern Alaska, massive-sulfide deposits in the Brooks Range have also caused regional elevation of copper, lead, and zinc levels (Kelley, 1995; Kelley and Taylor, 1996). Knowing the



Figure 17. Using gas-powered auger, Calista Native corporation personnel sample soils in Stuyahok River-Flat Creek area of southwestern Alaska. The USGS and Calista are working together to assess the mineral resources of the area. Photograph by E.A. Bailey, USGS.

baseline geochemistry of a mineralized area not only allows for better planning of mining and mitigation activities, but also for the assessment of undiscovered mineral deposits (Plumlee, Kelley, and others, 1995). Geoenvironmental models have been described for several mineral-deposit types in Alaska (Goldfarb and others, 1995; Kelley, Seal, and others, 1995; Plumlee, Montour, and others, 1995; Taylor, Zierenberg, and others, 1995), and a summary of environmental case studies of selected mineral deposits in Alaska has been published (Gray and Sanzolone, 1996).

TRANS-ALASKA CRUSTAL TRANSECT

The Trans-Alaska Crustal Transect is an integrated, multidisciplinary study of the Earth's crust along a corridor from the Gulf of Alaska to the Arctic Ocean. Field work was completed, and preliminary results for the northernmost section were published (Aleinikoff and others, 1995; Dumoulin, Watts, and Harris, 1995; Fuis and others, 1995a, 1995b; Moore, Wallace, and Fuis, 1995; Mull and others, 1995; Nokleberg, Foster, and Aleinikoff, 1995; Till, 1995). Although mainly a study of deep crustal structures, results from the TACT program are used for mineral-resource assessments and metallogenic models.

U.S. BUREAU OF MINES

The USBM's Alaska Field Operations Center was 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.

POLICY ANALYSIS

Mine permitting in Alaska and British Columbia.—The United States has a well-developed regulatory process for permitting mine development while evaluating the potential environmental impact of a proposed operation. Case studies of mines in Alaska and three other western States evaluated 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, 1995b).

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 developed an analytical framework for evaluating the mining-related implications of proposed policies and regulations and created a GIS-based ecosystem model for evaluating the impacts of mine development on wildlife habitat. A third study was undertaken to better understand how principles of ecosystem

management could be incorporated into public land policies and their impact on permitting of mining operations in the western United States (McDonald and Martin, 1995a).

MINERAL LAND ASSESSMENT

USBM mining district studies (fig. 18, table 11) were designed to determine the mineral-development potential of the districts by inventorying known mineral resources and reserves, evaluating the probability that more resources exist, and determining the feasibility of mining certain deposit types. Site-specific evaluations were undertaken when the presence of significant minerals is noted. The studies were done in cooperation with other Federal and State agencies. In 1995, the USBM completed reports for the Colville and Ketchikan Mining Districts, the Gulf of Alaska, and two BLM planning units. Investigations continued in the Sitka and Hoonah ranger districts. The USBM also assessed abandoned mine hazards for the BLM, NPS, and FS.

Colville Mining District.—The Colville Mining District is located in northern Alaska and includes the southern part of the NPRA. From 1990 to 1995, the USBM, USGS, and BLM 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 (Meyer, 1994), but mining feasibility studies of lead-zinc-silver, barite, and coal resources found no economically viable deposits (Coldwell and Gensler, 1995a). Areas in the central and eastern parts of the district have the highest potential for future mineral discoveries (Kurtak, 1995; Kurtak and others, 1995; Meyer and others, 1995).

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; investigations assessed both metallic and nonmetallic mineral deposits. Final reports for the study covered resource descriptions and evaluations, beneficiation techniques, economic feasibility studies, and a discussion of ecosystem issues relevant to mineral development activities (Coldwell and Gensler, 1995b; 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 areal geology is favorable for a variety of mineral deposit types, and mineralization has been identified at 211 localities. During the 1995 field season, USBM geologists investigated 50 mines, prospects, or occurrences (fig. 19); mapped a kilometer of mine workings; and collected 400 rock, placer,

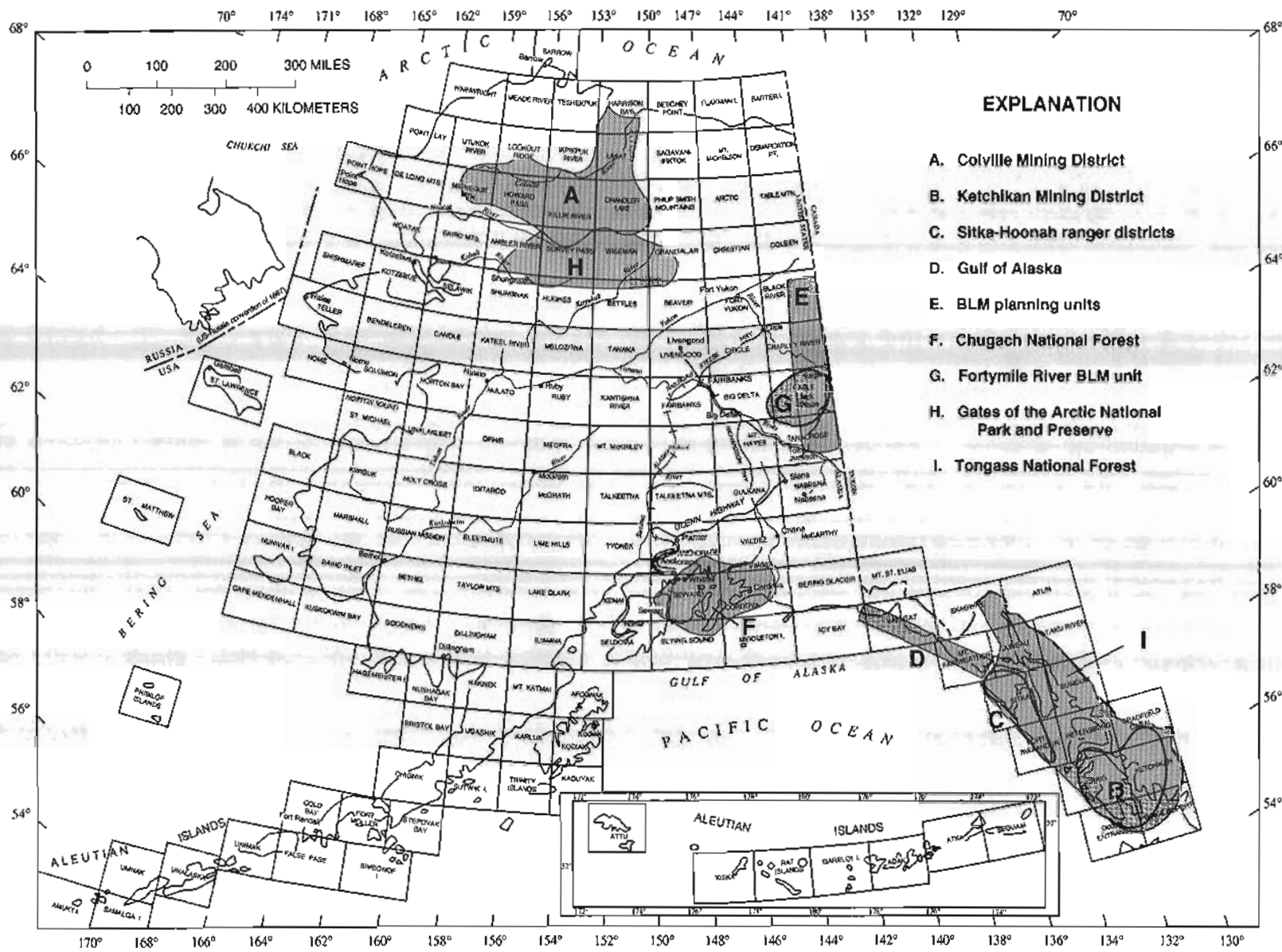


Figure 18. Locations of 1995 USBM study areas listed in table 11. 1:250,000-scale quadrangles are outlined and labeled.

Table 11. USBM study areas in 1995.

[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
Areal Investigations	
E. BLM Fortymile River/Black River planning units	
F. Chugach National Forest Mining claim GIS	
Industrial minerals	
Abandoned-Mine Land Hazards	
G. BLM Fortymile River planning unit	
H. Gates of the Arctic National Park & Preserve	
I. Tongass National Forest	

and sediment samples.

Gulf of Alaska.—The USBM completed its investigation of the titanium-resource potential in the coastal beach sands along the eastern Gulf of Alaska (Foley and others, 1995). Identified resources in modern shoreline deposits in the Cape Yakataga, Yakutat, and Mt. Fairweather areas were calculated 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 exist both inland and offshore of the areas investigated in this study.

BLM planning units.—The BLM asked the USBM for 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 USBM performed fieldwork in 1993 and 1994 to refine the areal geology and delineate the known mineral resources in the units; the final report has been published (Alaska Field Operations Center, 1995).

Abandoned-mine land inventory.—In 1995, the USBM evaluated abandoned mine sites for the FS, BLM, and NPS; hazards included explosives, underground workings, collapsed structures, and process chemicals. At 50 sites in the northern Tongass National Forest, physical and environmental hazards were assessed, and water quality

was analyzed (fig. 2). A summary of the physical and environmental hazards at abandoned mines in the Fortymile River planning unit was completed and delivered to the BLM. Site visits were made to 10 abandoned mines in Gates of the Arctic NP&P in 1994, and the USBM presented its findings to the NPS in 1995.

Chugach National Forest mining claims.—To facilitate FS planning efforts in the Chugach National Forest, the USBM and the FS entered into an Interagency Agreement to identify and digitize all active mining claims in the forest. A total of 830 active claims on the forest or within 5 kilometers of the boundary were digitized and imported into a GIS data base. Results indicate that there is considerable overlap of active mining claims on the Chugach National Forest.

MINERALS RESEARCH

Subaqueous disposal of mining wastes.—Subaqueous disposal of mining wastes is not permitted in Alaska at this time. However, because onshore tailings disposal is causing increased environmental concern, the USBM, in consultation with Federal and State regulatory agencies, is exploring the feasibility of offshore disposal as a potentially safer alternative in specific areas. USBM 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. On this basis, the USBM obtained permits for a site demonstration in Auke Bay in southeastern Alaska. In 1994, approximately 1.4 metric tons of inert tailings were placed in several containers on the bottom of Auke Bay; these were to 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.

Maritime archaeological project.—An experimental ground-penetrating radar, developed at the USBM Pittsburgh 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 to configure three-dimensional images of the sites. Archaeological investigations can be directed to identified sites, avoiding costly excavation efforts at inappropriate localities. The project is jointly funded by Federal, Native, academic, and private agencies.

MINERALS AVAILABILITY PROGRAM

Submarine tailings disposal.—In some coastal mining localities, deep marine disposal of mill tailings may be the environmentally preferred method of tailings disposal. Since 1991, the USBM has conducted studies to assess the technology, environmental aspects, and current regulations

relating to this method of tailings disposal, and to assess the availability of minerals from domestic sources if this disposal technique were permissible in the United States. Alaska-specific reports identified seven known mineral deposits along Alaska's southern coast that could benefit economically from the use of submarine disposal (Coldwell and Gensler, 1993) and documented the 14-year attempt to obtain operating permits for submarine tailings disposal at the proposed Quartz Hill Mine (Hesse and Reim, 1993). In 1995, the USBM joined the EPA's Technical Review Team to evaluate the use of submarine tailings disposal for Echo Bay's proposed reopening of the A-J Mine.

Public minerals information.—The USBM published a report detailing GIS coverage of mineral terranes and files of known mineral-deposit areas of hardrock mineral resources in Alaska (Resource Data, 1995); the document provided current and accurate mineral-resource data for land-use planners and other interested parties. The MAS data base was updated with new information on major mineral deposits and active mining properties. Deposit reports, map

overlays, and digital formats were used to provide mineral data to the State of Alaska, Native corporations, the FS, mineral consultants, and private individuals.

BUREAU OF LAND MANAGEMENT

MINING CLAIM ACTIVITIES

Recorded claims.—The number of Federal mining claims in Alaska has declined annually since 1993. Only 162 new claims were recorded in 1995, and total recorded claims were 9,705, down from 1994 levels of 538 new claims and 12,280 total claims. No new mineral patents were issued, and no applications were rejected.

Mining operations.—Production began at the Nixon Fork Mine in southwestern Alaska, the largest gold mine in Alaska and the first to come into production from a Federal mining claim since the 1930's. Because the mine is on Federal land, the BLM is responsible for operator



Figure 19. USBM geologist examines gold-bearing quartz vein at Stewart Mine near Sitka, Alaska. The Stewart Mine was the first lode-gold mine in Alaska. The USBM was evaluating mineral resources of the Sitka and Hoonah ranger districts in the Tongass National Forest for the FS. Photograph from USBM files.

compliance to the permitted Plan of Operations. To fulfill this obligation, the BLM conducted two on-site inspections in 1995 and used aerial photography to document the surface impact of the operation. The BLM also processed 67 Plans of Operations and 128 Notices of Operations for mining activities and completed an additional 326 surface compliance inspections. The BLM completed a mining scenario for the Squirrel River Legislative EIS; Squirrel River is under review for listing as a national Wild and Scenic River.

Mineral examinations.—The BLM has adjudication and review authority for all mineral validity and patent exams on Federal lands (fig. 20). In 1995, field examinations were conducted for seven mineral patent applications. The BLM reviewed 2 BLM mineral reports, 6 NPS mineral reports, and 1 FS mineral report. The BLM also completed 38 mineral reports in support of Land Use Plans such as land conveyances or Recreation and Public Purpose leases.

Reclamation.—Mining operations are bonded to ensure mine reclamation according to the permitted Plan or Notice. The BLM administers this bonding requirement on Federal mining claims on BLM-managed lands. The BLM also formed a Reclamation Standards working group in 1995. Over the next 2 years, this group will produce two publications for the mining community: a reclamation handbook and a brochure on recommended reclamation procedures and how to plan mining methods to minimize land disturbance. This group is also designing pilot projects to demonstrate suitable stream-bed reclamation.

Claim occupancy.—The BLM started to formalize procedures to deal with unauthorized occupancy of Federal mining claims. New occupancy regulations were to be published in mid-1996.

Abandoned mine lands.—The BLM began to inventory abandoned mine lands on BLM-managed estate, using procedures similar to those used by the USBM. An Abandoned Mine Land (AML) strategy was formulated for Alaska, and this will be submitted for inclusion in the national AML strategy.

OTHER ACTIVITIES

The BLM worked on a geologic guide to the Taylor Highway and Fortymile Wild and Scenic River area, completing its second season of field work in 1995. In addition to rock types and mineral occurrences seen in roadside and riverside outcrops, the guide will describe the general geologic history of the area and relate the history of the Fortymile Mining District from early gold mining days to present status and land disposition. Target date for publication is the Klondike Centennial in 1997.

Public outreach remains an important component of the BLM minerals program. Geologists staffed information centers and taught gold-panning at the annual Outdoor Week programs of the Anchorage and Fairbanks

school districts and also gave classroom presentations on rocks, minerals, and fossils throughout the year. Under a grant from the Department of Education and National Science Foundation, BLM geoscientists worked with the Anchorage School District to develop an improved earth science curriculum involving teacher education, ongoing technical and scientific support from the BLM, and development of student projects. Construction began on an Environmental Education Center at the BLM's Campbell Tract in Anchorage; proposed curriculum will balance minerals activities and an environmentally aware scope of ecosystem management. The center is jointly funded by the Federal government and the Anchorage School District.

NATIONAL PARK SERVICE

MINERAL LANDS MANAGEMENT

Mining Plans of Operations.—Although one mining Plan of Operations was approved for Bering Land Bridge National Preserve in 1994, no mining occurred during 1995. In Denali NP&P, a Plan for additional validity sampling was received, reviewed, and approved. Three additional Plans of Operations were received by Denali NP&P late in the year and were being evaluated for completeness. One miner completed work under an approved Plan of Operations in Kenai Fjords National Park, and the bond was released to the claimant following satisfactory reclamation of the site. In Wrangell-St. Elias NP&P, one Plan of Operations was reviewed and approved, and another was reviewed and rejected. The only mining within Alaska park units in 1995 occurred in Wrangell-St. Elias NP&P, where one operation conducted small-scale placer mining under an existing Plan of Operations that was approved in 1994.

Mineral validity examinations.—After the August 31, 1995, rental fee deadline, there were 792 administratively valid, unpatented Federal mining claims in Alaska park units. Determination of the mineral-resource validity of these mining claims is a necessary component of mining plan review or claim acquisition. NPS mineral examiners are certified by the BLM, and the BLM has final approval authority for NPS mineral validity examinations. In 1995, NPS mineral examiners investigated 22 mineral claims in Denali NP&P, 2 in Kenai Fjords National Park, and 13 in Wrangell-St. Elias NP&P; mineral reports for these examinations should be completed within 2 years. In 1995, the BLM approved six NPS mineral reports and was reviewing one other. Several additional reports are in preparation by NPS staff.

Mining claim acquisition.—Since 1991, Congress has appropriated \$11.8 million for the purchase of mining claims in the Kantishna area of Denali NP&P. Of this, \$6.8

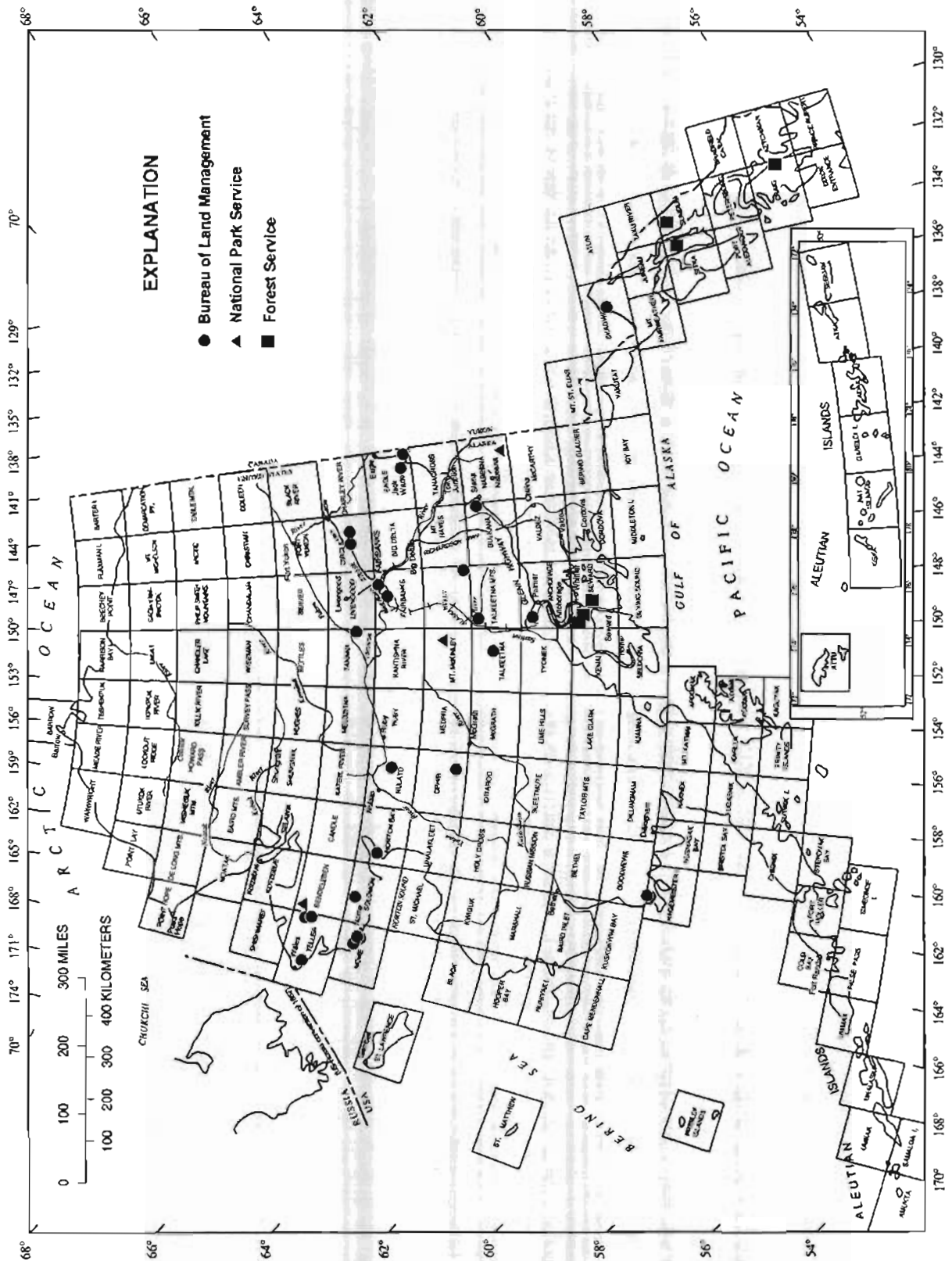


Figure 20. Locations of 1995 active Federal mineral patent case files. 1:250,000-scale quadrangles are outlined and labeled.

million has been spent: \$4.2 million for acquisition and \$2.6 million for hazardous materials surveys, real estate appraisals, title reports, relocation, and other pre- and post-acquisition activities. The NPS has acquired 28 patented claims encompassing 2.27 square kilometers and 8 unpatented claims encompassing 1.1 square kilometers. The unpatented claims were acquired in 1995 through the purchase of one claim and the settlement of an inverse condemnation case for seven claims. Relocation of mining equipment and other personal property from six claim groups was funded by the NPS. Fair market value appraisals and other acquisition work continued, with the objective of purchasing all mining claims in Denali NP&P; however, in July 1995, Congress rescinded most of the remaining funds from the Denali acquisition account and will have to appropriate additional funds to complete the acquisition of claims. In Kenai Fjords National Park, a block of unpatented mining claims was donated to the Federal government, and the owner's personal property was relocated at NPS expense.

Cultural resources mining inventory.—The Cultural Resources Mining Inventory and Monitoring Program ensures that all mining-related activities in Alaska's national parks are in full compliance with Federal historic and cultural resource protection laws and regulations. In 1995, field and research activities were carried out in Wrangell-St. Elias NP&P, Denali NP&P, and Lake Clark NP&P. The focus of activity in Wrangell-St. Elias NP&P is the Gold Hill-Chisana Historic Mining District, where a team of archaeologists, historians, and architects continue to compile a Cultural Landscape Inventory for the district. The inventory includes many historic remains of both camps and operations that exemplify past placer mining in the area. Efforts were also made to map the cabin and house foundations and depressions in the old town of Chisana. In Denali NP&P, research continued for the nomination of the Stampede Mine, the State's premier historic antimony mine, to the National Register of Historic Places. In Lake Clark NP&P, archaeologists conducted a field survey on Magnetic Island and recorded one mining site.

Land Surveys.—The NPS conducts cartographic surveys to determine the location and boundary lines of both unpatented and patented mining claims within park units. The NPS also performs photogrammetric control surveys and topographic ground surveys for the production of digital topographic maps at typical scales of 1:1,200 or 1:2,400. The maps are produced either on contract or by the NPS and are used to facilitate minerals and resource management projects, including claim acquisition, validity examinations, mining plan reviews, hazardous waste surveys, relocation projects, and property appraisals. In 1995, the NPS produced over 4,500 computer-generated cartographic, graphic, and engineering products in support of its management programs. Roughly 25 percent of those products was supplied to mining claimants, consultants, concessionaires, and other interested parties.

In 1995, a photogrammetric control survey and claim corner search was completed on 124 unpatented claims and 15 patented claims in Yukon-Charley Rivers National Preserve. In Wrangell-St. Elias NP&P, the NPS set final corners on six unpatented claims. An ongoing patented claim corner search-and-survey program was conducted on an additional 70 claims; these claim groups were originally surveyed 50 to 100 years ago and, in most cases, had not been accurately plotted until this program was initiated. Also in Wrangell-St. Elias NP&P, several mapping contracts were completed for the creation of digital topographic maps from an NPS survey.

ABANDONED MINERAL LANDS RECLAMATION

Restoration program.—Within the NPS, abandoned mineral lands are managed under a multiphase Mineral Land Restoration program with eight major components: inventory, explosives removal, hazard signing and mitigation, 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 1995, restoration program activities took place in four park units: (1) in Gates of the Arctic NP&P, 157 large fuel drums were removed from the former Mascot Creek mining property (fig. 21); (2) in Glacier Bay National Park, one mine adit was surveyed, and design plans were completed for closing the adit with expanding poly-urethane foam; (3) in Kenai Fjords National Park, four hazardous mine adits were surveyed and posted with hazard signs; design work for sealing these adits was completed, and closure was to be effected with poly-urethane foam or explosives during the summer of 1996; (4) in Wrangell-St. Elias NP&P, 10 former mining properties and 6 support sites were cleared of debris; 321 large fuel drums, 175 smaller containers, 11 batteries, 757 liters of miscellaneous contaminants, and 680 kilograms of solid waste were removed from the park. Old explosives were mitigated on 19 sites on NPS lands and on an additional 5 sites on patented and unpatented mining claims. AML hazards were inventoried on 22 sites; these include unstable buildings, hazardous wastes, old explosives, unsafe adits, and unstable ground. Working with the EPA, NPS personnel compiled an AML database of abandoned or inactive mineral properties for 275 sites within the boundaries of Wrangell-St. Elias NP&P.

The NPS continued its Comprehensive Environmental Response, Compensation, and Liability Act response activities at several sites in Alaskan park units. Projects included initiation of the removal of arsenic-laden mine tailings from a site in Kenai Fjords National Park,

preparation of the risk assessment for a site in Yukon-Charley Rivers National Preserve, three site investigations in Denali NP&P, a site characterization in Sitka National Historic Park, and ongoing sampling and monitoring of several other smaller sites to assess the presence of hazardous substances.

Reclamation research.—The NPS completed its seventh 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. Permanent cross-section transects were resurveyed in 1995 to evaluate the success of rebuilt stream channels and flood plains in the placer-mined stream. Field work for a cooperative agreement with the University of

Alaska-Anchorage to monitor aquatic macroinvertebrates in Glen (mined and restored) and Spruce (unmined reaches) Creeks to assess the long-term effects of reclamation work was completed in 1995. Qualitative observations of floodplain stabilization and upland revegetation were made. Major quantitative measurements of the revegetation plots are scheduled for the tenth year post-planting.

Eureka Creek is the second targeted reclamation project in the Kantishna Hills of Denali NP&P. The preliminary planning and project proposal was generated to begin the design for rebuilding the Eureka Creek flood plain and for shaping and revegetating the placer tailings. The Eureka Creek watershed was cleaned of debris and hazardous waste in 1993 by NPS crews.



Figure 21. Abandoned Mineral Lands Reclamation crew members process fuel drums from Mascot Creek mining property during 1995 field season. Approximately 8,600 kilograms of empty drums, 11 lead-acid batteries, and 12,000 liters of waste fuels were removed from 17 sites in Gates of the Arctic and Wrangell-St. Elias NP&P's and delivered to recycling companies by the project team. Photograph from NPS files.

AMRAP AUTHORIZATIONS

As mandated in Section 1010(b) of ANILCA the NPS has regulations to authorize AMRAP activities within park units. During 1995, one AMRAP project was approved for the USGS in Wrangell-St. Elias NP&P.

U.S. FISH AND WILDLIFE SERVICE

Valid mining claims on lands established as national wildlife refuges by ANILCA in 1980 remain valid if they are kept active. In 1995, there were 68 claims on 5 of the 16 refuges in Alaska: 16 claims on the Alaska Peninsula NWR, 2 on the Arctic NWR, 2 on the Innoko NWR, 35 on the Togiak NWR, and 13 on the Yukon Delta NWR. This represents a significant reduction from the 127 active claims in 1994, due mainly to the BLM's reclassification of many claims as abandoned and void; some other claims proceeded to patent.

In 1995, the FWS released a technical report of contaminant monitoring on the Kanuti NWR, where placer mining occurs upstream of the refuge (Mueller, Snyder-Conn, and Scannell, 1995). The FWS responded to 77 ACE permit applications or permit modifications for mining-related activities, including gold mining and gravel removal. The FWS also reviewed task reports provided to EPA by contractors preparing supplemental EIS's for the proposed A-J and Kensington gold mines in southeastern Alaska.

The FWS coordinated with USMX and reviewed their plans for the Illinois Creek heap-leach open-pit gold mine. Although the mine is north of the Innoko Refuge boundary, it lies within the Innoko River drainage, and the 1995 failure of two heap-leach dams outside the United States heightened FWS concerns about possible contaminants entering refuge waters from the mine's operation. The FWS prepared a baseline monitoring plan for its own field activities, which will include a water-resource inventory and assessment (U.S. Fish and Wildlife Service, 1995b). The FWS also reviewed new mining plans for the Red Dog Mine in northwestern Alaska.

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 System (NFS) lands requires FS authorization via approved Notices of Intent or approved Plans of Operation. The number of actions filed with the FS decreased from 41 Notices and 74 Plans in 1994 to 15 Notices and 71 Plans in 1995.

MINERALS DEVELOPMENT ON FOREST SERVICE LANDS

Admiralty Island National Monument.—The Kennecott Greens Creek Mine was scheduled to reopen and return to full production by January 1997. During the mine's closure, engineering projects were completed to upgrade production and water-treatment facilities. Kennecott worked with Federal agencies to ensure that its upgraded mining plan was in compliance with the terms of its various permits. A modified Plan of Operations that addressed the project changes was approved by the FS at the end of 1995. In addition, an exchange agreement between the Kennecott Corporation and the Federal government was drafted for Congressional approval. The agreement would grant Kennecott the right to explore, from its underground developments at the Greens Creek Mine, the subsurface of 30 square kilometers of NFS lands surrounding the company's patented claims within the Admiralty Island National Monument non-wilderness area. The company would make royalty payments to the U.S. Treasury on any ore removed from the 30 square kilometers, and, when mining is completed, the subsurface estate would revert to the Federal government. In return for exploration rights, Kennecott would make available to the FS \$1.1 million to be used for the purchase of key private inholdings from willing sellers within Admiralty Island National Monument wilderness lands and other wilderness lands within Conservation System Units established by ANILCA in the Tongass National Forest. The Greens Creek Exchange Act was passed by Congress and signed by the President on April 1, 1996.

Juneau Ranger District.—In 1995, Coeur Alaska purchased its partner's interest in the Kensington gold project and submitted an amendment to the mine's Plan of Operations. Proposed modifications include (1) relocation of the treated tailings effluent discharge point from Lynn Canal to Sherman Creek; (2) advanced water treatment of flotation cell tailings; (3) underground backfill disposal of cyanide-treated tailings; (4) improved avalanche control and management techniques; (5) relocation of the proposed staging area, helicopter pad, and temporary construction camp areas; and (6) use of diesel fuel for power generation rather than liquefied natural gas. The EPA and ACE are cooperating with the FS to prepare a Supplemental EIS to address these changes; the Supplemental EIS and Records of Decision were expected to be completed during the summer of 1996. Coeur Alaska is also conducting exploration at the Jualin project, where gold was originally discovered in 1895.

The FS cooperated with the BLM in preparing the original 1992 EIS for Echo Bay's A-J project, in which Sheep Creek was identified as the preferred alternative for

tailings disposal. However, as the result of a 1994 EPA Technical Assistance Report, Echo Bay rewrote its project proposal, and the EPA initiated a Supplemental EIS to address new options for tailings disposal. Alternatives included upland sites on FS lands considered in the original EIS and deep water submarine disposal. The FS would become a cooperating agency in the preparation of the Supplemental EIS if NFS lands were considered for tailings disposal, and the FS would also have to approve any tailings disposal alternative on NFS lands before disposal could occur. Such approval would be extended through a Plan of Operations or a Special-Use permit.

MINERAL PATENT AND VALIDITY EXAMINATIONS

Admiralty Island National Monument.—The Pyrola Partnership filed patent application on 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 was expected in early Fiscal 1997.

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, originally completed in 1994, was re-evaluated in 1995 using new information submitted by the applicants. The FS revision was completed and sent to the BLM for technical review in March 1996.

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. The 1993 FS mineral report, amended to incorporate a re-evaluation and review requested by the BLM, was technically reviewed and approved by the BLM in September 1995; patent approval was recommended for only three of the lode claims. Further action currently resides with the BLM's adjudicative process for patent applications.

Wrangell Ranger District.—Dave's Dream claim block consists of four placer claims within the Le Conte Wilderness Area. A validity examination on these claims was performed in September 1995 to confirm whether or not a discovery existed on each claim at the time specified in the Wilderness Act. A report was expected to be completed by late 1996.

Chugach National Forest.—A patent exam for the BBK #2 placer claim on Falls Creek was underway; the claim supports a suction dredging operation for placer gold. An FS mineral examiner-in-training assisted the BLM mineral examiner in completing the field portion of the examination, and the report was expected to be completed in early Fiscal 1997.

EXPLORATION ON NATIONAL FOREST LANDS

Craig Ranger District.—Exploration continued 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 in the Nutka area.

Hoonah Ranger District.—Assessment work on the Apex-El Nido gold property across Lisianski Inlet from Pelican consisted of boundary surveys and access road alignment. Project proponents were revising their Plan of Operations to conform with the 1993 FS decision on the project's Environmental Assessment.

Juneau Ranger District.—Echo Bay performed helicopter-supported surface drilling in the Gold Fork area south of Juneau. On Admiralty Island's Mansfield Peninsula, Kennecott drilled two holes and conducted a geochemical survey on the Alaska Empire property, while Alaska Dano claimants performed a limited sampling program.

Ketchikan Mining District.—The USBM published the results of its 5-year study on the Ketchikan Mining District, which covers the four FS ranger districts in the Ketchikan Area of southeastern Alaska. Mineral data provided to the FS were used in the revision of the Tongass Land Management Plan.

ABANDONED MINE HAZARDS

In early 1995, the FS and the USBM entered into a cooperative agreement to inventory abandoned and inactive mines on the Tongass National Forest and to evaluate them for potential physical and chemical hazards (fig. 22). The mines were to be visited by both FS and USBM personnel, and the USBM would provide site documentation reports. The project was organized as a 2-year effort, and preliminary analysis of data records for over 1,200 sites within the Tongass indicated that about 108 mining localities would need field examinations. Final reports for the 52 sites examined in 1995 were to be ready by February 1996.

INDUSTRIAL MINERALS

OVERVIEW OF INDUSTRY ACTIVITY

Sand, gravel, building stone, jade, and soapstone comprise Alaska's industrial minerals; their combined value was 11 percent of mining production in 1995. The value of sand, gravel, and building stone fell 16 percent from 1994 to

\$57.1 million; 10.7 million metric tons of sand and gravel production was valued at \$35.6 million, and 2.7 million metric tons of building stone was valued at \$21.5 million (table 9). The quantity of jade and soapstone fell slightly, but the value increased 25 percent from 1994; this was due to the varying quantities of raw and processed materials sold.

ACTIVITY BY FEDERAL AGENCIES

U.S. GEOLOGICAL SURVEY

In the Tongass National Forest, the USGS developed an Interagency Agreement with the FS to provide geologic

expertise for an assessment of limestone resources on Chichagof Island. Limestone is used for construction and for mitigation of acid mine drainage.

U.S. BUREAU OF MINES

In 1995, the USBM and FS entered into an agreement to conduct a survey to determine the location, accessibility, quantity, and quality of industrial minerals on the Chugach National Forest. Materials of interest include sand and gravel, shot rock, building stone, limestone, marl, and shales. Because the survey was targeting construction materials, field work would concentrate on areas easily accessible from the existing



Figure 22. USBM geologist sketches ruins of 10-stamp mill at Lucky Chance Mine at headwaters of Salmon Creek, 21 kilometers south of Sitka. The USBM was evaluating the mine as part of the FS program on abandoned mine hazards in the Tongass National Forest. Photograph from USBM files.

transportation system. Economic analysis of significant resources was planned once reserve estimates were formulated. Field work on the project was to begin in 1996.

BUREAU OF LAND MANAGEMENT

The BLM recorded 49 sand and gravel sales to Alyeska Pipeline Service Company in 1995, up from 38 sales the previous year; production was approximately 128,000 metric tons. A rock material sale for Anvik in southwestern Alaska yielded approximately 34,000 metric tons. There were no village permits issued for sand and gravel extraction, but there remains in place a single, ongoing Free-Use Permit for local government entities to extract 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. The FWS made eight gravel sales on the Izembek NWR in 1995. The Koyukuk NWR issued a special-use permit to the BLM to continue studies of the Batza Tena obsidian source (fig. 9), but the permit was not exercised.

FOREST SERVICE

The FS annually conducts material sales and issues Free-Use permits for the removal of sand, gravel, and stone from NFS lands. This material is commonly used by State and local governments for the construction and maintenance of roads, airports, and breakwaters. In 1995, 96,410 cubic meters of shot rock, sand, and gravel were extracted from the Tongass National Forest; most of this material was utilized for Native corporation timber-road construction. On the Chugach National Forest, 331,280 cubic meters was extracted; the majority of this was utilized for State public road construction and realignment. FS in-service use for the construction of Federal timber-sale roads on both Chugach and Tongass National Forests totalled 1.87 million cubic meters.

— SELECTED REFERENCES —

The following publications contain pertinent information about energy resources and other minerals in Alaska. Reports by Federal or State agencies can generally be obtained from the agency offices in Alaska (see "Contacts for Further Information") or are available at the BLM Alaska Resources Library, Federal Building, 701 C Street, Anchorage, AK 99513-7599. Many reports are also available from the U.S. Government Printing Office in Washington, DC, or from the National Technical Information Service (NTIS) in Springfield, VA 22161.

- Agler, B.A., Seiser, P.E., Kendall, S.J., and Irons, D.B., 1995, Winter marine bird and sea otter abundance of Prince William Sound, Alaska—Trends following the *T/V Exxon Valdez* oil spill from 1990-94: Anchorage, Alaska, U.S. Fish and Wildlife Service, Migratory Bird Management, *Exxon Valdez Oil Spill Restoration Project Number 94159, Final Report*, 55 p.
- Alaska Division of Geological and Geophysical Surveys, 1995a, Total field magnetism and electromagnetic anomalies of the Fairbanks Mining District: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-4, 2 sheets, scale 1:63,360.
- 1995b, Total field magnetism and electromagnetic anomalies of the Richardson Mining District: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-9, 1 sheet, scale 1:63,360.
- 1995c, Total field magnetism of the southeastern Bethel Basin, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-1, 2 sheets, scale 1:125,000.
- 1996, Total field magnetism and electromagnetic anomalies of the Rampart-Manley Mining District, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 96-1, 2 sheets, scale 1:63,360.
- Alaska Field Operations Center, 1995, Final report of the mineral resource evaluation of the Bureau of Land Management Black River and Fortymile River subunits: U.S. Bureau of Mines Open-File Report 79-95, 209 p.
- Alaska Journal of Commerce [published weekly by OCA Publishing, 3710 Woodland Drive, Suite 2100, Anchorage, AK 99517]
- Alaska Oil and Gas Conservation Commission Bulletin [published monthly by the State of Alaska, Alaska Oil and Gas Conservation Commission, 3001 Porcupine Drive, Anchorage AK 99501].
- Alaska Report [published weekly by Petroleum Information Corporation, P.O. Box 2612, Denver, CO, 80201-2612].
- Alaska Volcano Observatory, 1995, Volcanoes of Alaska: Alaska Division of Geological and Geophysical Surveys Information Circular 38, 1 sheet, scale 1:4,000,000.
- Aleinikoff, J. N., Moore, T. E., Nokleberg, W. J., and Koch, R. D., 1995, Preliminary U-Pb ages from detrital zircons from the Arctic Alaska and Yukon-Tanana terranes, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 2.
- American Society for Testing and Materials, 1980, Standard for metric practice: Philadelphia, Pennsylvania, American Society for Testing and Materials Publication E380-79, 42 p.
- Bailey, E.A., Gray, J.E., Miller, M.L., and Balen, M.D., 1995, Mercury accumulation in vegetation from the Red Devil and Cinnabar Creek mercury mines in southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 3.
- Bajusz, A.M., and Gall, M.A., 1995, Offshore scientific & technical publications, 1990-1993: Minerals Management Service OCS Report, MMS 95-0008, 73 p.
- Banet, A.C., Jr., 1995a, Chemical correlations among Arctic oils—Will the circle be unbroken? [abs.]: Geological Society of America Abstracts with Programs, vol. 27, no. 5, p. 4.
- 1995b, So what is the source of the Alaskan Chukchi oils? [abs.]: American Association of Petroleum Geologists Bulletin, vol. 79, no. 4, p. 578-579.
- Bird, K.J., 1994, The Ellesmerian(!) petroleum system, North Slope of Alaska, USA, in Magoon, L.B., and Dow, W., eds., The petroleum system—From source to trap: American Association of Petroleum Geologists Memoir 60, p. 339-358.
- Bird, K.J., Cole, F., Howell, D.G., and Magoon, L.B., 1995a, The future of oil and gas in northern Alaska: U.S. Geological Survey Circular 1108, p. 45-47.
- 1995b, The future of oil and gas in northern Alaska [abs.]: American Association of Petroleum Geologists Bulletin, v. 79, no. 4, p. 579.
- Bradley, D.C., Hacussler, P., Nelson, S.W., Kusky, T., Donley, D.T., and Goldfarb, 1995, Geologic effects of Paleogene ridge subduction, Kenai Peninsula [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 7.
- Brew, D.A. (compiler), 1995, Geologic map of the Craig, Dixon Entrance, and parts of the Ketchikan and Prince Rupert

- quadrangles, southeastern Alaska: U.S. Geological Survey Open-File Report 95-215, 1 sheet, scale 1:250,000.
- Brew, D.A., Drinkwater, J.L., Ford, A.B., and Himmelberg, G.R., 1995, The Taku transect across the Coast Mountains Complex and its granitic rocks, southeastern Alaska [abs.]: U.S. Geological Survey Circular 1129, p. 29-30.
- Brew, D.A., Ford, A.B., Himmelberg, G.R., and Drinkwater, J.L., 1995, The Coast Mountains Complex of southeastern Alaska and adjacent regions: U.S. Geological Survey Bulletin 2135, p. 21-28.
- Brew, D.A., Horner, R.B., and Barnes, D.F., 1995, Bedrock-geologic and geophysical research in Glacier Bay National Park and Preserve—Unique opportunities of local to global significance, in Engstrom, D.R., ed., 1995, Proceedings of the Third Glacier Bay Science Symposium, 1993: Anchorage, Alaska, National Park Service, p. 5-14.
- Bundtzen, T.K., Laird, G.M., Clautice, K.H., and Harris, E.E., 1995, Metamorphic stratigraphy and economic geology of the Nome Group, Nome Mining District, western Alaska [abs.]: Geological Society of America Abstracts with Program, v. 27, no. 5, p. 7.
- Bundtzen, T.K., Nokleberg, W.J., and Plafker, G., 1995, Metallogenic belts of mainland Alaska [abs.]: Geological Association of Nevada Program with Abstracts, v. 27, p. A-12.
- Bundtzen, T.K., Swainbank, R.C., Clough, A.H., Henning, M.W., and Charlie, K.M., 1996, Alaska mineral industry 1995—A Summary: Alaska Division of Geological and Geophysical Surveys Information Circular 41, 12 p.
- Bundtzen, T.K., and Wiltse, M.W., 1995, The role of geology in the selection of Alaska's statehood land entitlement [abs.]: Geological Society of America Abstracts with Program, v. 27, no. 5, p. 8.
- Bureau of Land Management, 1990, Federal lands in Alaska: Bureau of Land Management Land Status Map BLM-AK-GI-90-030-112-924, 1 sheet, scale 1:2,500,000.
- Carter, L.M.H., ed., 1995, Energy and the environment—Application of geosciences to decision-making—Tenth V.E. McKelvey Forum on mineral and energy resources: U.S. Geological Survey Circular 1108, 134 p.
- Church, S.W., Kelley, J.S., and Bohn, D., 1996, Mineral resources of the Chandler Lake quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Investigations Map MF-2144-E, 44 p., 1 sheet, scale 1:250,000.
- Clough, J.C., 1995, Summary report on coal resource potential assessment of the Jarvis Creek coal field: Alaska Division of Geological and Geophysical Surveys Public Data File 95-22, 23 p., 1 sheet, scale 1:63,360.
- Clough, N.K., Patton, P.C., and Christiansen, A.C., eds., 1987, Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment—Report and recommendation to the Congress of the United States and Final Legislative Environmental Impact Statement: Washington, DC, U.S. Fish and Wildlife Service, U.S. Geological Survey, and Bureau of Land Management, 2 volumes, 208 p.
- Coldwell, J.R., and Gensler, E.C., 1993, Potential for submarine tailings disposal to affect the availability of minerals from United States coastal areas: U.S. Bureau of Mines Open-File Report 101-93, 50 p.
- 1995a, Economic feasibility of mining in the Colville Mining District, Alaska: U.S. Bureau of Mines Open-File Report 49-95, 26 p.
- 1995b, Economic feasibility of mining in the Ketchikan Mining District, Alaska: U.S. Bureau of Mines Open-File Report 06-95, 26 p.
- Cole, F., Bird, K.J., Howell, D.G., Roure, F., Valin, Z.C., Pawlewicz, M.J., Robbins, S.L., and Toro, J., 1995, Deformation and foreland basin sedimentation in the north-central Brooks Range, Alaska [abs.]: American Association of Petroleum Geologists Bulletin, v. 79, no. 4, p. 581-582.
- Cole, F., Bird, K.J., Toro, J., Roure, F., and Howell, D.G., 1995, Kinematic and subsidence modeling of the north-central Brooks Range and North Slope of Alaska: U.S. Geological Survey Open-File Report 95-823, 4 p., 3 sheets, scale 1:250,000.
- Cole, F., Roure, F., Bird, K.J., Howell, D.G., and Toro, J., 1995, Kinematic models for the north-central Brooks Range fold and thrust belt, Killik River quadrangle, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 10.
- Collett, T.S., 1995a, Distribution of permafrost-associated natural gas hydrate accumulations within the circumarctic of the northern hemisphere: International Gas Research Conference and Exhibition, Nice, France, September 10-13, 1995, Proceedings, p. 9-20.
- 1995b, Gas hydrate resources of the United States, in Gautier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.L., eds., 1995 National assessment of United States oil and gas resources—Results, methodology, and supporting data: U.S. Geological Survey Digital Data Series DDS-30, 1 CD-ROM.
- 1995c, Possible resources and climatic effects of gas hydrate in the Arctic: American Association for the Advancement of Science Annual Meeting, Atlanta, Georgia, February 16-21, 1995, Proceedings, p. 102-103.
- Cooke, L.W., 1991, Estimates of undiscovered, economically recoverable oil and gas resources for the Outer Continental Shelf, revised as of January 1990: Minerals Management Service OCS Report, MMS 91-0051, 30 p.
- Cooper, K.M., 1995, Structural and metamorphic history of the southwestern Kantishna Hills, Denali National Park, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 12.
- Csejtey, Bela, Jr., Brease, P.F., Ford, A., and Nelson, W.H., 1994, Possible occurrence of middle Paleozoic rocks south of

- the Denali fault, Denali National Park, Alaska, and implications for Denali fault displacements: U.S. Geological Survey Bulletin 2107, p. 157-160.
- Csejtey, Bela, Jr., Ford, A.B., Wrucke, C.T., Dutro, T.J., Jr., Harris, A.G., and Brease, P.F., 1995a, Geologic correlations across the Denali fault in south-central Alaska—Implications for Cenozoic fault displacement [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 12.
- 1995b, Differences in Mesozoic and Late Cenozoic tectonics of the central Alaska Range, Alaska—Overthrusting versus high-angle faulting [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 13.
- Csejtey, Bela, Jr., Wrucke, C.T., Ford, A.B., Mullen, M.W., Dutro, T.J., Jr., Harris, A.G., and Brease, P.F., 1996, Correlation of rock sequences across the Denali Fault in south-central Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Dallimore, S.R., and Collett, T.S., 1995, Intrapermafrost gas hydrates from a deep corehole in the Mackenzie Delta, Northwest Territory: Journal of Geology, v. 23, no. 6, p. 527-530.
- Decker, J., Reifensuhl, R.R., Robinson, M.S., Waythomas, C.F., and Clough, J.S., 1995, Geology of the Sleetmute A-5, A-6, B-5, and B-6 quadrangles, southwestern Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 99, 16 p., 2 sheets, scale 1:63,360.
- Dillon, J.T., and Reifensuhl, R.R., 1995, Geologic map of the Chandalar B-6 quadrangle, southeastern Brooks Range, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 103, 1 sheet, scale 1:63,360.
- 1995, Geologic map of the Chandalar C-6 quadrangle, southeastern Brooks Range, Alaska: Alaska Division of Geological and Geophysical Surveys Professional Report 105, 1 sheet, scale 1:63,360.
- Dillon, W.P., Booth, J.S., Collett, T.S., Kvenvolden, K.A., Colman, D.F., Lee, M.W., Winters, W.J., and Fehlhaber, K., 1995, Resource and climate implications of natural gas hydrates: U.S. Geological Survey Circular 1108, p. 68-70.
- Donley, D.T., Kusky, T., and Bradley, D.C., 1995, Emplacement of Tertiary Nuka, Aialik, and related near-trench plutons, Chugach accretionary wedge, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 15.
- Dragoo, D.E., Byrd, G.V., Roseneau, D.G., Dewhurst, D.A., Cooper, J.A., and McCarthy, J.H., 1995, Population levels and reproductive performance of murrelets based on observations at breeding colonies 4 years after the *TV Exxon Valdez* oil spill: Homer, Alaska, U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, Exxon Valdez Oil Spill Restoration Project Number 11, Final Report, 41 p.
- Drinkwater, J.L., Brew, D.A., and Ford, A.B., 1995, Geology, petrography, and geochemistry of granitic rocks from the Coast Mountains Complex near Juneau, southeastern Alaska: U.S. Geological Survey Open-File Report 95-638, 119 p.
- duBray, E.A., ed., 1995, Preliminary compilation of descriptive geoenvironmental mineral deposit models: U.S. Geological Survey Open-File Report 95-831, 272 p.
- Dumoulin, J.A., Watts, K.F., and Harris, A.G., 1995, Lithofacies, conodont biostratigraphy, and regional correlation of the Lisburne Group at Shainin Lake and Atigun Gorge, central Brooks Range, northern Alaska [abs.]: Geological Society of America Abstracts with Program, v. 27, no. 5, p. 16.
- Dusel-Bacon, C., Lanphere, M.A., Hansen, J.L., and Ajeinkoff, J.N., 1995, Thermochronometric constraints on Mesozoic contraction and expansion in the eastern Yukon-Tanana upland, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 16.
- Dusel-Bacon, C., Hansen, L.L., and Scala, J.A., 1995, High-pressure amphibolite facies dynamic metamorphism and the Mesozoic tectonic evolution of an ancient continental margin, east-central Alaska: Journal of Metamorphic Geology, v. 13, no. 1, p. 9-24.
- Emers, M., Jorgenson, J.C., and Reynolds, M.K., 1995, Response of arctic tundra plant communities to winter vehicle disturbance: Canadian Journal of Botany, v. 73, no. 6, p. 905-917.
- Environment and Natural Resources Institute, University of Alaska Anchorage, 1995, Current water quality in Cook Inlet, Alaska, study: Minerals Management Service OCS Study, MMS 95-0009, 124 p. + appendix
- Fall, J.A., and Utermohle, C.J., editors, 1995, Introduction, v.1 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management Service OCS Study, MMS 95-010, 315 p. [available only in compressed digital format].
- 1995, Prince William Sound, v.2 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management Service OCS Study, MMS 95-011, 450 p. [available only in compressed digital format].
- 1995, Lower Cook Inlet, v.3 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management Service OCS Study, MMS 95-012, 1,112 p. [available only in compressed digital format].
- 1995, Kodiak Island, v.4 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management Service OCS Study, MMS 95-013, 400 p. [available only in compressed digital format].
- 1995, Alaska Peninsula and Arctic, v.5 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management

- Service OCS Study, MMS 95-014, 530 p. [available only in compressed digital format].
- 1995, Discussion and Conclusions, v.6 of An investigation of the sociocultural consequences of Outer Continental Shelf development in Alaska: Minerals Management Service OCS Study, MMS 95-015, 240 p. [available only in compressed digital format].
- Foley, J.Y., LaBerge, R.D., Grosz, A.E., and Oliver, F.S., 1995, Onshore titanium and related heavy-mineral investigations in the eastern Gulf of Alaska region, southern Alaska: U.S. Bureau of Mines Open-File Report 10-95, 126 p.
- Folger, H.A., Koch, R.D., Hopkins, R.T., Cieutat, B.A., Goldfarb, R.J., Nokleberg, W.J., and Hoffman, J.D., 1995, Analytical results and sample locality maps of stream-sediment, heavy-metal concentrate, and rock samples from the Gulkana quadrangle, south-central Alaska: U.S. Geological Survey Open-File Report 95-509, 105 p., 2 sheets, scale 1:250,000.
- Fuis, G.S., Moore, T.E., Brocher, T.M., Plafker, G., Fisher, M.E., Levander, A. R., and Wissinger, E.S., 1995a, Deep structure and evolution of the north and south margins of Alaska through time and space [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 19.
- 1995b, Seismic images of the Brooks Range, Arctic Alaska, reveal crustal-scale duplexing: *Geology*, v. 23, no. 1, p. 65-68.
- Galloway, J.P., and Laney, J., 1994, Status of geologic mapping in Alaska—A digital bibliography: U.S. Geological Survey Open-File Report 94-675-A, 96 p., 4 sheets, scale 1:10,000,000 (paper); 94-675-B (3.5-inch PC diskette); and 94-675-C (3.5 Mac diskette).
- Gautier, D.L., Dolton, G.L., Takahashi, K.I., and Varnes, K.L., eds., 1995, 1995 National assessment of United States oil and gas resources—Results, methodology, and supporting data: U.S. Geological Survey Digital Data Series DDS-30, 1 CD-ROM.
- Goldfarb, R.J., Berger, B.R., Klein, T.L., Pickthorn, W.J., and Klein, D.P., 1995, Low sulfide Au-quartz veins: U.S. Geological Survey Open-file Report 95-831, p. 261-267.
- Goldfarb, R.J., Nelson, S.W., Taylor, C.D., d'Angelo, W.M., and Meier, A.L., 1996, Acid mine drainage associated with volcanogenic massive sulfide deposits, Prince William Sound, Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Grauch, V.J.S. and Castellanos, E., 1995, Revised digital aeromagnetic data for areas in and adjacent to the National Petroleum Reserve area (NPR), North Slope, Alaska: U.S. Geological Survey Open-File Report 95-835, 105 p.
- Gray, J.E., 1994, Environmental geochemistry of mercury deposits in Alaska: U.S. Geological Survey Fact Sheet 94-072.
- Gray, J.E., Bailey, E.A., and Miller, 1995, Downstream environmental effects of mercury mines and deposits, southwestern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 22.
- Gray, J.E., Meier, A.L., O'Leary, R.M., Outwater, C., and Theodorakos, P.M., 1996, Environmental geochemistry of mercury deposits in southwestern Alaska—Mercury contents in fish, stream-sediment, and stream-water samples: U.S. Geological Survey Bulletin 2152 [in press].
- Gray, J.E., and Sanzalone, R.F., 1996, Environmental studies of mineral deposits in Alaska: U.S. Geological Survey Bulletin 2156, 40 p.
- Grow, J.A., Miller, J.J., Mull, C.G., and Bird, K.J., 1995a, Seismic stratigraphy near the Tunalik well, North Slope, Alaska [abs.]: American Association of Petroleum Geologists Bulletin, v. 79, no. 4, p. 586.
- 1995b, Seismic stratigraphy near the Tunalik well, North Slope, Alaska [abs.]: Geological Society of America Abstracts with Program, v. 27, no. 5, p. 23.
- Grybeck, D.J., 1995, A retrospective view of the role of earth sciences in the ANILCA decision [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 23.
- Haeussler, P.J., Bradley, D.C., Goldfarb, R.J., and Snec, L.W., 1995, A link between ridge subduction and turbidite-hosted gold mineralization in southern Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 23.
- Haeussler, P., Bradley, D., Goldfarb, R., Snec, L., and Taylor, C., 1995, Link between ridge subduction and gold mineralization in southern Alaska: *Geology*, v. 23, p. 995-998.
- Hayes, D.L., 1995, Recovery monitoring of pigeon guillemot populations in Prince William Sound, Alaska: Anchorage, Alaska, U.S. Fish and Wildlife Service, Migratory Bird Management, Exxon Valdez Oil Spill Restoration Project Number 94173, Final Report, 71 p.
- Hedstrom, K.S., 1994, Coupled sea-ice/ocean circulation model, technical manual, version 1: Minerals Management Service OCS Study, MMS 94-0020, 117 p.
- Hesse, C.A., and Reim, K.M., 1993, Regulatory aspects of submarine tailings disposal—The Quartz Hill history: U.S. Bureau of Mines Open-File Report 66-93, 85 p.
- Himmelberg, G.R., Brew, D.A., and Ford, A.B., 1995, Low-grade metamorphism of the Douglas Island Volcanics, western metamorphic belt, Juneau, Alaska: Geological Society of America Special Paper 296, p. 51-66.
- Isaacs, C.M., Bird, K.J., Medrano, M., Keller, M.A., Piper, D.Z., and Gautier, D.L., 1995, Preliminary report on major and minor elements in cores from the Triassic Shublik Formation, Jurassic and Cretaceous Kingak Shale, and Cretaceous Pebble Shale Unit, Hue Shale, and Torok Formation: U.S. Geological Survey Open-File Report 95-236, 30 p.

- Jacobson, S.R., Blodgett, R.B., and Babcock, L.E., 1996, Organic matter and thermal maturation of lower Paleozoic rocks from the Nixon Fork Subterrane of the Farewell Terrane, west-central and southwestern Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Kelley, J.S., and Brosge, W.P., 1995a, Geologic framework of a transect of the central Brooks Range—Regional relations and an alternative to the Endicott Mountains allochthon: *American Association of Petroleum Geologists Bulletin*, v. 79, no. 8, p. 1087-1116.
- 1995b, Paleozoic basins and shelf deposits of the central Brooks Range—Possible analogs in basins under the Arctic coastal plain, northern Alaska [abs.]: *Abstracts with Program, Annual Convention of the American Association of Petroleum Geologists*, Houston, Texas, March 5-8, p. 49A.
- Kelley, J.S., Wrucke, C.T., and Lane, L.S., 1995, Stratigraphy of pre-Mississippian rocks in the Clarence River area, northeastern Alaska and northwestern Yukon Territory [abs.]: *Geological Society of America Abstracts with Programs*, v. 27, no. 5, p. 57.
- Kelley, J.S., Wrucke, C.T., Lane, L.S., and Foland, R.L., 1995, Franklinian rocks along the Alaska-Yukon border in the northeastern Brooks Range—Implications for reflection seismic imaging under the Arctic coastal plain of the Arctic National Wildlife Refuge, Alaska: *American Association of Petroleum Geologists*, v. 79, no. 4, p. 590.
- Kelley, K.D., 1995, Natural environmental effects of silver-lead-zinc deposits in the Brooks Range, Alaska: U.S. Geological Survey Fact Sheet FS-092-95.
- Kelley, K.D., and Mull, C.G., 1995a, Maps showing areas of potential for mineral resources in the Killik River 1° X 3° quadrangle, Brooks Range, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-2225-A, 1 sheet, scale 1:250,000.
- 1995b, Maps showing the distribution of selected elements in minus-100 mesh and minus-80 mesh sediment samples from the Killik River quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-2225-B, 1 sheet, scale 1:250,000.
- 1995c, *The Alaska Mineral Resource Assessment Program—Background information to accompany geologic and mineral resource maps of the Killik River quadrangle, northern Alaska*: U.S. Geological Survey Circular 1117, 30 p.
- Kelley, K.D., Mull, C.G., and Barton, H.N., 1995a, Maps showing the distribution of selected elements in minus-30-mesh stream-sediment samples from the southern part of the Killik River quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-2225-C, 2 sheets, scale 1:250,000.
- 1995b, Maps showing the distribution of selected elements and mineralogy of nonmagnetic heavy-mineral-concentrate samples from the southern part of the Killik River quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-2225-D, 2 sheets, scale 1:250,000.
- Kelley, K.D., Seal, R.R., II, Schmidt, J.M., Hoover, D.B., and Klein, D.P., 1995, Sedimentary exhalative Zn-Pb-Ag deposits: U.S. Geological Survey Open-File Report 95-831, p. 225-233.
- Kelley, K.D., and Taylor, C.D., 1996, Natural environmental effects associated with the Drenchwater zinc-lead-silver massive sulfide deposit with comparisons to the Red Dog and Lik deposits, west-central Brooks Range, Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Kirschner, C.E., 1988, Map showing sedimentary basis of onshore and continental shelf areas, Alaska: U.S. Geological Survey Miscellaneous Investigations Series Map I-1873, 1 sheet, scale 1:2,500,000.
- Kline, J.T., and Pinney, D.S., Preliminary map of selected occurrences of industrial minerals in Alaska: Alaska Division of Geological and Geophysical Surveys Public Data File 95-24, 3 sheets, scale 1:2,500,000.
- Kornbrath, R.W., 1995, Analysis of historical oil and gas lease sale and exploration data for Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-11, 22 p.
- Kuletz, K.J., Marks, D.K., Flint D., Burns, R., and Prestash, L., 1995, Marbled murrelet foraging patterns in Prince William Sound, Alaska: Anchorage, Alaska, U.S. Fish and Wildlife Service, Migratory Bird Management, *Exxon Valdez Oil Spill Restoration Project Number 94102*, Final Report, 53 p.
- Kurtak, J.M., 1995, Bureau of Mines evaluates Alaskan phosphate deposits: *Mining Engineering*, v.47, no. 8, p. 717.
- Kurak, J.M., Meyer, M.P., Hicks, R.W., Weldon, M.B., and Mull, C.G., 1995, Mineral investigations in the Colville Mining District and southern National Petroleum Reserve in Alaska: U.S. Bureau of Mines Open-File Report 08-95, 217 p.
- Lane, L.S., Cecile, M.P., Kelley, J.S., Wrucke, C.T., and Hoffman, H.J., 1995, Paleogeographic implications of early Paleozoic shelf to basin transitions, northern Yukon and Alaska [abs.]: *Geological Society of America Abstracts with Program*, vol. 27, no. 5, p. 59.
- Leonard, K.R. and Huber, D.F., 1987, Status of Alaska Mineral Resources Data System: U.S. Geological Survey Circular 998, p. 15-18.
- Light, T.D., Schmidt, J.M., Peterson, D.P., Gamble, B.M., Grybeck, D., Miller, M.L., Wilson, F.H., Brew, D.A., and Nokleberg, W.J., 1995, Statewide assessment of undiscovered mineral resources in Alaska [abs.]: *Geological Society of America Abstracts with Programs*, v. 27, no. 5, p. 61.

- Maas, K.M., Bittenbender, P.E., and Still, J.C., 1995, Mineral investigations in the Ketchikan Mining District, southeastern Alaska: U.S. Bureau of Mines Open-File Report 11-95, 606 p.
- Magoon, L.B., 1994, The Tuxedni-Hemlock (!) petroleum system in Cook Inlet, Alaska, USA, in Magoon, L.B., and Dow, W., eds., *The petroleum system—From source to trap*: American Association of Petroleum Geologists Memoir 60, p. 359-370.
- Magoon, L.B., and Dow, W., eds., 1994, *The petroleum system—From source to trap*: American Association of Petroleum Geologists Memoir 60, 655 p.
- Martin, W.E., and McDonald, L.A., 1995, Environmental compliance in the mine permitting process—case studies from Alaska, Colorado, Montana, and Nevada: U.S. Bureau of Mines Open-File Report 51-95, 66 p.
- Mast, R.F., Dolton, G.L., Crowelli, R.A., Root, D.H., and Attanasi, E.D., U.S. Geological Survey; Martin, P.E., Cooke, L.W., Carpenter, G.B., Pecora, W.C., and Rose, M.B., Minerals Management Service; 1989, *Estimates of undiscovered conventional oil and gas resources in the United States—A part of the Nation's energy endowment*: U.S. Department of the Interior, 44 p.
- Mate, B.R., and Krutzikowsky, G.K., 1995, Application of remote methods of large cetacean tracking—Bowhead whales: Minerals Management Service OCS Study, MMS 95-0053, 174 p. + appendices.
- McConnell, D.L., 1995, Project report of the Fairbanks and Richardson mining districts: Alaska Division of Geological and Geophysical Surveys Public Data File 95-12, 178 p., 3 sheets, scale 1:63,360.
- McDonald, L.A., and Martin, W.E., 1995a, Ecosystem management and mine permitting on public lands: U.S. Bureau of Mines Open-File Report 78-95, 35 p.
- 1995b, Regulatory efficiency of environmental compliance in the mine permitting process—analysis of Alaska, Colorado, Montana, and Nevada: U.S. Bureau of Mines Open-File Report 50-95, 68 p.
- Meier, J.M., 1995, Petrographic evaluation of foreland basin sandstones, Brooks Range, north-central Alaska: Columbia, Missouri, University of Missouri, Masters thesis, 253 p.
- Meyer, J.F., Jr., and Saltus, R.W., 1995, Merged aeromagnetic map of Interior Alaska: U.S. Geological Survey Geophysical Map GP-1014, 2 sheets, scale 1:500,000.
- Meyer, J.F., Jr., Saltus, R.W., Barnes, D.F., and Morin, R.L., 1996, Bouguer gravity maps of Interior Alaska: U.S. Geological Survey Geophysical Map GP-1016, 2 sheets, scale 1:500,000 [in press].
- Meyer, M.P., 1994, Analytical results from U.S. Bureau of Mines investigations in the Colville Mining District, Alaska: U.S. Bureau of Mines Open File Report 34-94, 130 p.
- Meyer, M.P., and others, 1995, Executive summary of the U.S. Bureau of Mines investigations in the Colville Mining District, Alaska: U.S. Bureau of Mines Open-File Report 07-95, 56 p.
- Miller, L.D., Goldfarb, R.J., Snee, L.W., Gent, C.A., and Kirkham, R.A., 1995, Structural geology, age, and mechanisms of gold vein formation at the Kensington and Jualin deposits, Berners Bay district, southeast Alaska: *Economic Geology*, v. 90, no. 2, p. 343-368.
- Minerals Management Service, 1992, *Comprehensive program 1992-1997—Summary and decision*: Minerals Management Service, 38 p. + appendices.
- 1994, *Alaska environmental studies strategic plan—Fiscal years 1996-1997*: Anchorage, Alaska, U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region, 88 p.
- 1995a, Beaufort Sea planning area oil and gas Lease Sale 144, draft Environmental Impact Statement: Minerals Management Service OCS EIS/EA, MMS 95-0043, variously paged.
- 1995b, Gulf of Alaska/Yakutat planning area oil and gas Lease Sale 158, draft Environmental Impact Statement: Minerals Management Service OCS EIS/EA, MMS 95-0054, variously paged.
- 1995c, Outer Continental Shelf draft proposed leasing program, 1997 to 2002: Minerals Management Service, 168 p.
- 1996a, An assessment of the undiscovered hydrocarbon potential of the Nation's Outer Continental Shelf: Minerals Management Service OCS Report, MMS 96-0034, 53 p.
- 1996b, Cook Inlet planning area oil and gas Lease Sale 149, final Environmental Impact Statement: Minerals Management Service OCS EIS/EA, MMS 95-0066, 2 volumes, variously paged.
- 1996c, Endowments of undiscovered conventionally recoverable and economically recoverable oil and gas in the Alaska Federal offshore: Minerals Management Service OCS Report, MMS 96-0033, 17 p.
- 1996d, Outer Continental Shelf oil and gas leasing program, 1997-2002—Draft Environmental Impact Statement: Minerals Management Service OCS EIS/EA, MMS 95-0006, 2 volumes, variously paged.
- 1996e, Proposed final Outer Continental Shelf oil and gas leasing program, 1997 to 2002: Minerals Management Service, 160 p.
- Monger, J.W.H., and Nokleberg, W.J., 1995, Evolution of the northern North American Cordillera: A "single arc" model [abs], in *Geology and ore deposits of the American Cordillera*: Geological Society of Nevada Program with Abstracts, p. 56.
- Moore, T.E., and Dumoulin, J.D., eds., 1996, *Geologic studies in Alaska by the U.S. Geological Survey, 1994*: U.S. Geological Survey Bulletin 2152, 217p.

- Moore, T.E., Wallace, W.K., and Fuis, G.S., 1995, Northward-tapering orogenic wedge, central Brooks Range, Alaska [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 65.
- Motyka, R.J., 1995, *Photointerpretive surficial geology of areas surrounding Alatna and Allakaket*, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-3, 8 p., 1 sheet, scale 1:6,000.
- Mowat, T.C., Mull, C.G., Banet, A.C., Wilson, M.D., and Reeder, J.W., 1995, Petrography of Neocomian sandstones in western Brooks Range, and Tunalik, Klondike, and Burger Wells, northwestern Arctic Slope-Chukchi Sea [abs.]: American Association of Petroleum Geologists Bulletin, vol. 79, no. 4, p. 594.
- Mueller, K.A., Snyder-Conn, E., and Scannell, P.O., 1995, Metal and metalloid contaminants in water, sediments, fish, and mammals of Kanuti National Wildlife Refuge, Alaska, 1985-1990: Anchorage, Alaska, U.S. Fish and Wildlife Service, Technical Report NAES-TR-95-02, 125 p.
- Mull, C.G., Moore, T.E., Weldon, M.B., and Crowder, R.K., 1995, How the central Brooks Range mountain-front and foothills came to be: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 66.
- Newberry, R.J., 1995, An update on skarn deposits in Alaska: Alaska Division of Geological and Geophysical Surveys Public Data File 95-20, 72 p.
- Newberry, R.J., and Solie, D.N., 1995, Data for plutonic rocks and associated gold deposits in Interior Alaska: Alaska Division of Geological and Geophysical Surveys Public Data File 95-25, 62 p.
- Nokleberg, W.J., Bundtzen, T.K., Brew, D.A., and Plafker, G., 1995, Metallogenesis and tectonics of porphyry Cu and Mo (Au, Ag), and granitoid-hosted Au deposits of Alaska: Canadian Institute of Mining, Metallurgy, and Petroleum Special Volume 46, p. 103-141.
- Nokleberg, W.J., Bundtzen, T.K., Shpikerman, V.I., Eremin, R.A., Goryachev, N.I., and Parfenov, L.M., 1995, Metallogenic and tectonic model for the Russian Northeast and mainland Alaska [abs.]: Geology and Ore Deposits of the American Cordillera: Geological Society of Nevada Program with Abstracts, p. 58-59.
- Nokleberg, W.J., Foster, H.L., and Aleinikoff, J.N., 1995, Tectonic model for the Yukon-Tanana, Seventymile, Stikinia, and Wrangellia terranes along the Trans-Alaska Crustal Transect (TACT) [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 69.
- Nokleberg, W.J., Monger, J.W.H., and Parfenov, L.M., 1995a, Circum-North Pacific tectono-stratigraphic terrane map [abs.]: Eos (Transactions of the American Geophysical Union), v. 76, no. 46/Supplement, p. F588.
- 1995b, Mesozoic and Cenozoic tectonics of the Circum-North Pacific [abs.]: Eos (Transactions of the American Geophysical Union), v. 76, no. 46/Supplement, p. F592.
- 1995c, Mesozoic and Cenozoic tectonics of the Circum-North Pacific [abs.]: Geological Association of Canada Program with Abstracts, v. 27, p. A-76.
- 1995d, Mesozoic and Cenozoic tectonics of the Circum-North Pacific [abs.]: Geological Society of America Abstracts with Programs, v. 27, no. 5, p. 68-69.
- Nokleberg, W.J., Parfenov, L.M., Monger, J.W.H., Baranov, B.V., Byalobzhessky, S.G., Bundtzen, T.K., Feeney, T.D., Fujita, K., Gordon, S.P., Grantz, A., Khanchuk, A.I., Natal'in, B.A., Natapov, L.M., Norton, I.O., Patton, W.W., Jr., Plafker, G., Scholl, D.W., Sokolov, S.D., Sosunov, G.W., Stone, D.B., Tabor, R.W., Tsulkanov, N.V., Vallier, N.V., and Wakita, K., 1994, Circum-North Pacific tectono-stratigraphic terrane map: U.S. Geological Survey Open-File Report 94-714, 2 sheets, scale 1:5,000,000; 2 sheets, scale 1:10,000,000, 221 p.
- Patton, W.W., Jr., 1995, Crustal composition and magmatic history of the central part of the Yukon-Koyukuk basin, Alaska: Geological Society of America Abstracts with Program, v. 27, no. 5, p. 71.
- Patton, W.W. Jr., and Moll-Stalcup, E.J., 1996, Geologic map of the Unalakleet quadrangle, west-central Alaska: U.S. Geological Survey Miscellaneous Investigations Map I-2559, 1 sheet, scale 1:250,000.
- Philpotts, J.A., Taylor, C.D., and Baedeker, P.A., 1996, Rare-earth enrichment at Bokan Mountain, southeast Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Plumlee, G.S., Kelley, K.D., Goldfarb, R.J., Gray, J., Taylor, C.D., and Eppinger, R.G., 1995, The environmental geology and geochemistry of mineral deposits, with applications to Alaska: Conference Juneau 1995, p. 49-51.
- Plumlee, G.S., Montour, M., Taylor, C.D., Wallace, A.R., and Klein, D.P., 1995, Polymetallic vein and replacement deposits: U.S. Geological Survey Open File Report OFR 95-831, pp. 121-129.
- Prensky, S., 1995, A review of gas hydrates and formation evaluation of hydrate-bearing reservoirs: Society of Petroleum Well Log Analysts, 36th Annual Logging Symposium, June 26-29, 1995, Proceedings, Paper GGG, 12 p.
- Quakenbush, L.T., Suydam, R.S., Fluetsch, K.M., and Donaldson, C.L., 1995, Breeding biology of Steller's eiders nesting near Barrow, Alaska, 1991-1994: U. S. Fish and Wildlife Service and North Slope Borough Department of Wildlife Management, Technical Report NAES-TR-95-03, 53 p.
- Reger, R.D., and Pinney, D.S., 1995, Surficial geologic map of the Circle Mining District, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-2C, 1 sheet, scale 1:63,360.
- Resource Data, 1995, Mineral terranes and known mineral deposit areas of Alaska—Digital map documentation: U.S. Bureau of Mines Open-File Report, 27 p.

- Richardson, W.J., Greene, C.R., Jr., Hanna, J.S., Koski, W.R., Miller, G.W., Patenaude, N.J., and Smultea, M.A., 1995, Acoustic effects of oil production activities on bowhead and white whales visible during spring migration near Pt. Barrow, Alaska—1991 and 1994 phases—Sound propagation and whale responses to playbacks of icebreaker noise: Minerals Management Service OCS Study, MMS 95-0051, 539 p.
- Richter, D.H., Rosenkrans, D.S., and Steigerwald, M.J., 1995, Guide to the volcanoes of the western Wrangell Mountains, Alaska—St. Elias National Park and Preserve: U.S. Geological Survey Bulletin 2072, 31 p.
- Roeske, S.M., Dusel-Bacon, C., Aleinikoff, J.N., Snee, L.W., and Lanphere, M.A., 1995, Metamorphic and structural history of continental crust at a Mesozoic collision margin—The Ruby terrane, central Alaska: *Journal of Metamorphic Geology*, v. 13, no. 1, p. 25-41.
- Roseneau, D.G., Kettle, A.B., and Byrd, G.V., 1995, Common murre restoration monitoring in the Barren Islands, Alaska: Homer, Alaska, U.S. Fish and Wildlife Service, Alaska Maritime National Wildlife Refuge, *Exxon Valdez Oil Spill Restoration Project Number 93049*, 71 p.
- Saltus, R.W., Meyer, J.F., Barnes, D.F., and Morin, R.L., 1995, New gravity and aeromagnetic data compilations for Central Alaska—Implications for basin and fault structure: *Eos (Transactions of the American Geophysical Union)*, v. 76, n. 46 (Supplement), p. F575-F576.
- Schmidt, K., Bailey, E.P., and Byrd, G.V., 1995, Introduced predator removal from islands: Anchorage, Alaska, U.S. Fish and Wildlife Service, *Exxon Valdez Oil Spill Restoration Project Number 94041, Final Report*, 13 p.
- Swainbank, R.C., and Bundtzen, T.K., 1995, Alaska's mineral industry 1994—A summary: Alaska Division of Geological and Geophysical Surveys Information Circular 40, 11 p.
- Swainbank, R.C., Bundtzen, T.K., Clough, A.H., Henning, M.W., and Hansen, E.W., 1995, Alaska's mineral industry 1994: Alaska Division of Geological and Geophysical Surveys Special Report 49, 77 p.
- Taylor, C.D., Philpotts, J., Hall, T.E., Wakeman, B.W., and Snee, L.W., 1995, New information on the geochemistry, age, and tectonic history of late Triassic volcanic host rocks and associated volcanogenic massive sulfide occurrences of the Alexander terrane, southeast Alaska. [abs.]: Conference Juneau, p. 31-32.
- Taylor, C.D., Philpotts, J., Sutley, S., Gent, C., Harlan, S., Premo, W., Tatsumoto, M., Emsbo, P., and Meier, A., 1995, Geochemistry of late Triassic volcanic host rocks and age of alteration associated with volcanogenic massive sulfide occurrences, Alexander terrane, southeast Alaska [abs.]: in *Geology and ore deposits of the American Cordillera*, April 10-13, 1995, Reno, NV.
- Taylor, C.D., Zierenberg, R.A., Goldfarb, R.J., Kilburn, J.E., Seal, R.R., II, and Kleinkopf, M.D., 1995, Volcanic-associated massive sulfide deposits: U.S. Geological Survey Open-File Report 95-831, p. 137-144.
- Till, A.B., 1995, Multiple pulses of deformation in the metamorphic core of the the Brooks Range—Implications for tectonic evolution of the orogen: *Geological Society of America Abstracts with Programs*, v. 27, no. 5., p. 81.
- Till, A.B., and Harris, A.G., 1995, Evidence for post-Triassic emplacement of metamorphic rocks in the Kantishna Hills, central Alaska Range, Alaska [abs.]: *Geological Society of America Abstracts with Programs*, v. 27, no. 5, p. 81.
- Trainor, T.P., Fleisher, S., Wildeman, T.R., Goldfarb, R.J., and Huber, C.S., 1996, Environmental geochemistry of the McKinley Lake gold mining district, Chugach National Forest, Alaska: U.S. Geological Survey Bulletin 2152 [in press].
- Trawicki, J., 1995, Progress report—Water resources inventory and assessment, Yukon Flats National Wildlife Refuge—Preliminary data (1993-94): Anchorage, Alaska, U.S. Fish and Wildlife Service, Water Resources Branch, WRB 96-1, 17 p.
- Treacy, S.D., 1995, Aerial surveys of endangered whales in the Beaufort Sea, Fall 1994: Minerals Management Service OCS Study, MMS 95-0033, 116 p.
- Tripp, R.B., King, H.D., and Light, T.D., 1995, Mineralogical maps showing the distribution of ore-related minerals in the minus-30 mesh, nonmagnetic heavy-mineral fraction of stream sediment, Healy quadrangle: U.S. Geological Survey Miscellaneous Field Investigations Study MF-2058D, 2 sheets, 1:250,000 scale.
- Tyson, Ray, 1995, Cutting costs with coalbed gas: *Alaska Business Monthly*, vol. 11, no. 9, p. 10-13.
- Underwood, T., Gordon, J.A., Millard, M.J., Thorpe, L.A., and Osborne, B.M., 1995, Characteristics of selected fish populations of Arctic National Wildlife Refuge coastal waters—Final report, 1988-1991: Anchorage, Alaska, U.S. Fish and Wildlife Service, Fishery Resources Office, 590 p.
- U.S. Department of Energy, 1993, Final Environmental Impact Statement for the proposed Healy Clean Coal Project: Pittsburgh Energy Technology Center, DOE/EIS-0186, 1,100 p.
- U.S. Fish and Wildlife Service, 1995a, A preliminary review of the Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment—Report and recommendations to the Congress of the United States and Final Legislative Environmental Impact Statement: Washington, D.C., U.S. Fish and Wildlife Service, 20 p.
- 1995b, Plan of study, water resources inventory and assessment, Innoko National Wildlife Refuge: Anchorage, Alaska, U.S. Fish and Wildlife Service,

- Water Resources Branch, WRB 96-3, 13 p.
- 1995c, Plan of study, water resources inventory and assessment, Kenai National Wildlife Refuge: Anchorage, Alaska, U.S. Fish and Wildlife Service, Water Resources Branch, WRB 96-2, 13 p.
- U.S. Geological Survey, 1995a, 1995 National assessment of United States oil and gas resources: U.S. Geological Survey Circular 1118, 20 p.
- 1995b, Wrestling with uncertainty—The 1995 National assessment of United States oil and gas resources: U.S. Geological Survey video.
- Weast, R.C., ed., 1974, Handbook of chemistry and physics, 55th edition: Cleveland, Ohio, CRC Press, 2,279 p.
- Weekly Coal Production [published weekly by Energy Information Administration, U.S. Department of Energy, EI-231, Washington DC 25085].
- Wiltse, M.A., 1995, Short Notes on Alaska Geology 1995: Alaska Division of Geological and Geophysical Surveys Professional Report 117, 116 p.
- Wiltse, M.A., Reger, R.D., Newberry, R.J., Pessel, G.H., Pinney, D.S., Robinson, M.S., and Solie, D.N., 1995, Geologic map of the Circle Mining District, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-2A, 1 sheet, scale 1:63,360.
- 1995, Bedrock geologic map of the Circle Mining District, Alaska: Alaska Division of Geological and Geophysical Surveys Report of Investigations 95-2B, 1 sheet, scale 1:63,360.
- Yeend, Warren, 1996, Gold placers of the Fortymile River region, Alaska, a historic mining area: U.S. Geological Survey Bulletin 2125 [in press].

— APPENDIX 1. —

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, metalliferous, and industrial 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 recently reorganized Geologic Division, the Alaska Section is the primary USGS office studying mineral resources in Alaska. The Alaska Section is part of the Western Mineral Resource Surveys Team, one of three regional minerals teams that assist the national program coordinator in Reston, Virginia, to prioritize and carry out the objectives of the USGS minerals program. The section is headquartered in Anchorage, and additional Alaska Section geoscientists are stationed in Menlo Park, California, and Denver, Colorado. In this report, specific information on 1995 USGS programs, projects, and data bases is given under the USGS heading in the "Activity by Federal Agencies" sections of the chapters on "Oil and Gas Resources", "Coal and Peat Resources", "Metallic Minerals", and "Industrial 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 1995, the USBM's Alaska Field Operations Center (AFOC) had headquarters in Anchorage and an office in Juneau. In 1995, the

Center carried out its mission through four programs:

1. *Policy analysis.*—This program emphasized the analysis of newly developed and existing mineral data to interpret their significance in the context of local and national mineral issues. Assessment of technical, institutional, political, social, and economic factors that affect the supply of, and demand for, domestic and international minerals is the fundamental analysis required for land-management agencies to resolve mineral issues.

2. *Mineral land assessment.*—This was 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 DOI Secretary's mandate to assess the mineral potential of public lands in Alaska, the USBM initiated a program in 1985 to evaluate the mineral resources of known mining districts in the State. The program sought to identify the type, amount, and distribution of mineral deposits; related studies determined their economic feasibility, which included potential for development and reclamation requirements. Legislative effects on mineral development were also addressed. The USBM completed its studies of the Colville, Juneau, Ketchikan, and Valdez Creek mining districts. The USBM also provided minerals data in support of BLM and FS land-management activities in Alaska and assisted the BLM, NPS, and FS in the identification of mine hazards on their respective lands.

3. *Minerals research.*—The USBM attempts to provide solutions to mining safety, mineral recovery, and environmental problems in Alaska through a number of research efforts and technology transfer. USBM and university research centers cooperate to address mineral-related research.

4. *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 information about the identification and location of known mineral deposits. MAS is more extensive, containing information about reserve estimates, mineral extraction and beneficiation methodologies, environmental constraints to mining, and cost analyses for selected major mineral deposits. A computer and communication system allow the information to be stored, manipulated, and retrieved as computer-plotted map overlays and printouts of MAS/MILS data, enabling rapid and uniform development of cost data for MAS mineral-deposit evaluations. MAS and MILS mineral-deposit data are cross-indexed to several other minerals-information data bases.

Through Congressional and administrative actions, the USBM was defunded in Fiscal 1996. Most of the environmental

assessment and research program activities were abolished, and the AFOC's functions were transferred to the BLM-Alaska State Office on January 19, 1996.

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 derived primarily 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 geological 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

Since the agency's creation in 1946, the BLM has had a role in the administration of mineral activities on Federal lands. In 1976, under the Federal Land Policy and Management Act, the BLM became responsible for the management of mining claims on BLM-administered land and for the recording of mining claims on all Federal lands. Under Secretarial Order 3087, the BLM also

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

Management decisions concerning all mineral estate of the 372,312 square kilometers of land currently managed by the BLM in Alaska (fig. 1) are made through the Resource Management Planning process. Through this process, the BLM identifies and defines planning units, and the mineral potential of each unit is analyzed. Effects of potential minerals exploration, development, production, and reclamation are determined and compared to analyses of coexisting cultural and biological resources. The BLM then develops land-management options to minimize adverse or competing land-use proposals involving mineral extraction activities. Active field monitoring of all phases of mineral activities ensures that unnecessary or undue degradation does not occur. The BLM provides similar resource management information to other agencies for leasable Federal mineral estates on an additional 404,673 square kilometers.

NATIONAL PARK SERVICE

In 1916, Congress established the National Park Service 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 ANILCA in 1980 increased NPS involvement with minerals management issues. ANILCA expanded the National Park System in Alaska (fig. 3) 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. ANILCA identified specific minerals management directives for some park units and directed 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 Environmental Impact Statements (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 continuing 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 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

The mission of the FS in relation to minerals management is to encourage, facilitate, and administer the orderly exploration, development, and production of mineral and energy resources on National Forest System lands in order to help meet present and future needs of the Nation. It is the responsibility of the FS to encourage and support environmentally sound mineral enterprises on the 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 postmining reclamation. In implementing this policy, the FS Chief has directed that minerals management professionals—

1. Process applications and other use authorizations efficiently and timely.
2. Ensure the integration of mineral-resource programs into the planning process, recognizing that mineral development can occur concurrently or sequentially with other resource uses.
3. Plan and provide for access to all NFS lands open to mineral entry; eliminate or prevent occupancy that is not reasonably incident to, and required for, the mineral operation; and ensure that valid existing rights have been established before allowing mineral or energy activities on NFS lands withdrawn from mineral entry.
4. Ensure that the mineral character or potential of lands considered for administrative withdrawal from mineral entry are thoroughly evaluated for the value of the resource foregone, and ensure that only certified mineral examiners perform site visits and prepare reports which address the mineral or geologic character of the subject lands.
5. Coordinate with all Federal, State, and local agencies having authority and expertise in minerals-related activities.
6. Maintain a professional administrative, technical, and managerial work force that is knowledgeable in FS minerals-management responsibilities and activities.
7. Ensure the uniform application of exploration, development, reclamation, and monitoring standards, and require, for all minerals activities involving significant surface disturbance, a reclamation bond and plan to return the land to other productive uses consistent with FS minerals-management and land-use planning goals.

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, resources currently being addressed by the DOE are the fossil fuels (petroleum and coal) and geothermal energy.

The strategy for responding to petroleum-supply interruptions is to rely on the free market, supplemented as necessary and appropriate with other measures, such as the Strategic Petroleum Reserve. The DOE's Fossil Energy Research and Development Programs are aimed at careful consideration of the alternatives available and the relative chances for success in fostering an adequate supply of energy at a reasonable cost through

long-term, high-risk research and development. Alternatives for increasing domestic petroleum supplies include (1) the DOE's Natural Gas Technology Program, which emphasizes the development of advanced technologies for the extraction of natural gas from resources that are classified as nonconventional due to unique geologic settings and production mechanisms that are not now well understood, and (2) various DOE programs for developing tertiary oil recovery, tar sands, and heavy-oil deposits. The DOE's cooperative research and development agreement with BPX for heavy-oil recovery on Alaska's North Slope is hoped to be the first of a series of industrial partnerships dealing with oil production concerns.

The Clean Coal Technology Program is a partnership between the DOE and industry that has as its primary goal the successful demonstration of a new generation of advanced coal-

based technologies and the resultant movement of the most promising technologies into the domestic and international marketplace. The demonstrations are at a scale large enough to generate the data needed to enable potential domestic and international users to make judgments about the commercial viability of a particular process. These technologies will improve the global environment and enhance global energy security through the use of technologies and services provided by United States' industry.

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.

— APPENDIX 2. —

LISTING OF USGS CIRCULARS IN ANILCA ANNUAL MINERAL REPORT SERIES

- Schneider, J.L., ed., 1997. 1996 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1142, 70 p.
- 1995, 1995 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1127, 67 p.
- 1994, 1994 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1113, 69 p.
- 1993, 1993 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1102, 70 p.
- Bohn, D., and Schneider, J.L., eds., 1992, 1992 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1091, 65 p.
- Schneider, J.L., ed., 1991. 1991 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1072, 69 p.
- 1990, 1990 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1056, 67 p.
- 1989, 1989 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1040, 70 p.
- Bohn, Diedra, ed., 1988. 1988 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1023, 57 p.
- 1987, 1987 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 1012, 59 p.
- U.S. Geological Survey, 1986. 1986 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 983, 47 p.
- 1985, 1985 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 970, 58 p.
- 1984, 1984 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 940, 54 p.
- 1983, 1983 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 908, 48 p.
- 1982, 1982 Annual Report on Alaska's Mineral Resources: U.S. Geological Survey Circular 884, 59 p.