2/04/11
OVERVIEW:
DNR - DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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Alaska Department of Natural Resources
Division of Geological & Geophysical Surveys

DGGS Overview

Robert Swenson
State Geologist & Director
Division of Geological & Geophysical Surveys

http://www.dggs.alaska.gov
http://akgeology.info

Alaska Department of Natural Resources

Division of Geological & Geophysical Surveys

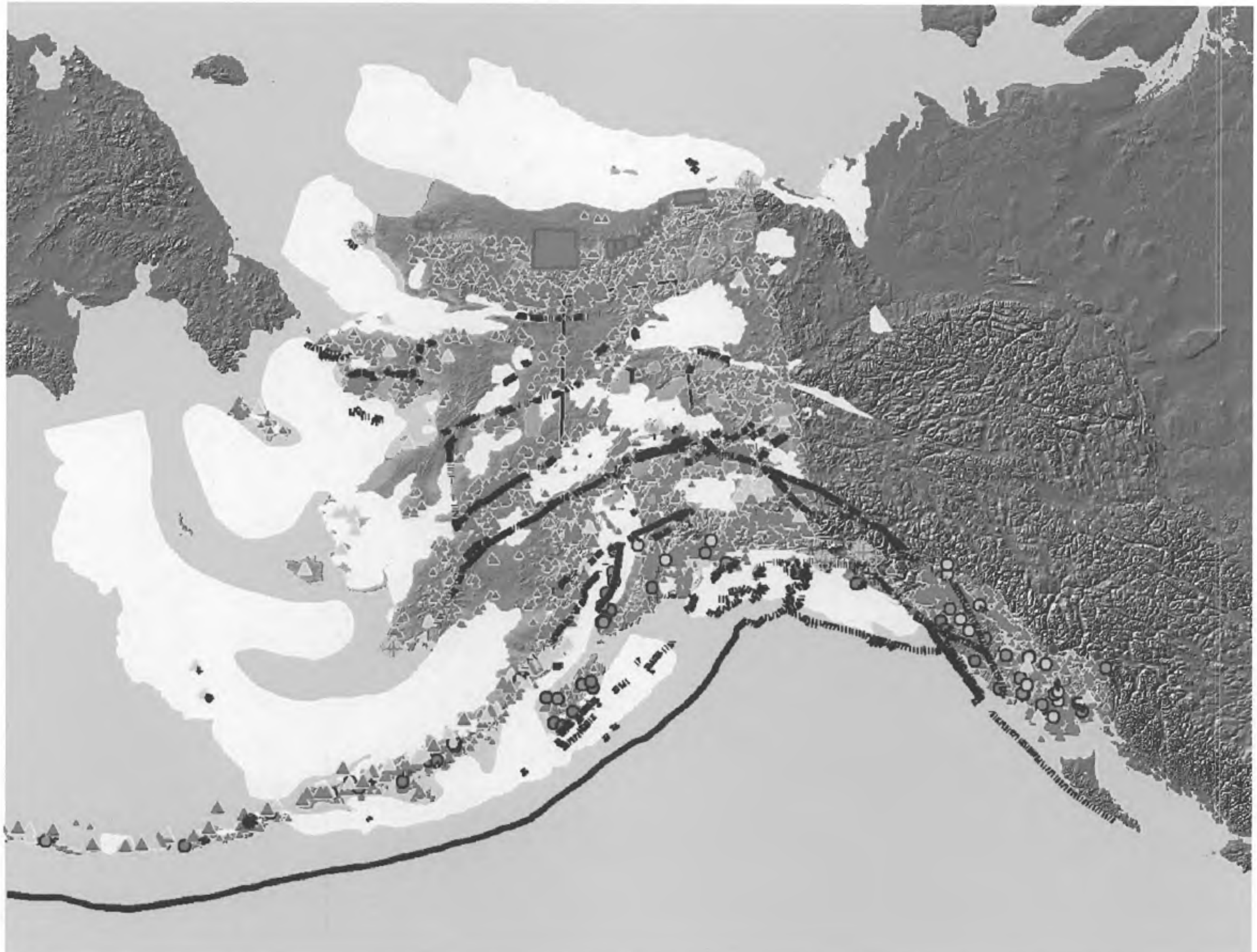
MISSION STATEMENT

Alaska Statutes 41.08.020

Conduct geological and geophysical surveys to determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources; the locations and supplies of groundwater and construction materials; and the potential geologic hazards to buildings, roads, bridges, and other installations and structures.

DGGS Program Overview

Challenge



Alaska Geological Facts

- Alaska's natural resource endowment unequaled in US
- Alaska has more seismicity, volcanoes, and geologically hazardous areas than any other state in the US.
- 156,000 sq mi. (~100 mm acres) is State controlled land and is the Primary Focus of DGGS

Division of Geological & Geophysical Surveys

- **State Geologist and Director** — Robert Swenson
  - Geological Scientist I — James Clough
  - Geological Scientist I — Laurel Burns
    - Geologist III — Vacant
  - **Division Operations Manager** — Rodney Combellick
    - Administrative Officer — Vickie Butherus
      - Administrative Assistant — April Woolery
      - Office Assistant II — Rhea Supplee

ENERGY RESOURCES
North Slope & Cook Inlet
Frontier basins
Rural energy

- Geologist V — David LePain
  - Geologist IV — Marwan Wartes
  - Geologist IV — Robert Gillis
  - Geologist III — David Mauel
  - Geologist III — Trystan Herriott
  - Geologist II — Andrea Loveland

MINERAL RESOURCES
Mineral resource studies
Bedrock geologic mapping
Geophysical surveys

- Geologist V — Melanie Werdon
  - Geologist IV — David Szumigala
  - Geologist IV — Lawrence Freeman
  - Geologist III — Brent Elliott
  - Geologist III — Gerald Griesel

ENGINEERING GEOLOGY
Geologic Hazards
Engineering Geology
Construction Materials

- Geologist V — DeAnne Stevens
  - Geologist IV — Trent Hubbard
    - Geologist I — Patricia Gallagher
    - College Intern I — Rachel Westbrook
  - Geologist IV — Gabriel Wolken
    - College Intern I — Matthew Balasz
  - Geologist IV — Nicole Kinsman
    - Geologist I — Vacant
  - Geologist IV — Richard Koehler
    - Geologist I — Rebecca-Ellen Farrell

VOLCANOLOGY
Alaska Volcano Observatory

- Geologist V — Christopher Nye
  - Geologist III — Janet Schaefer
  - Geologist III — Katharine Bull
  - Analyst/Programmer IV — Seth Snedigar
  - Geologist III — Cheryl Cameron

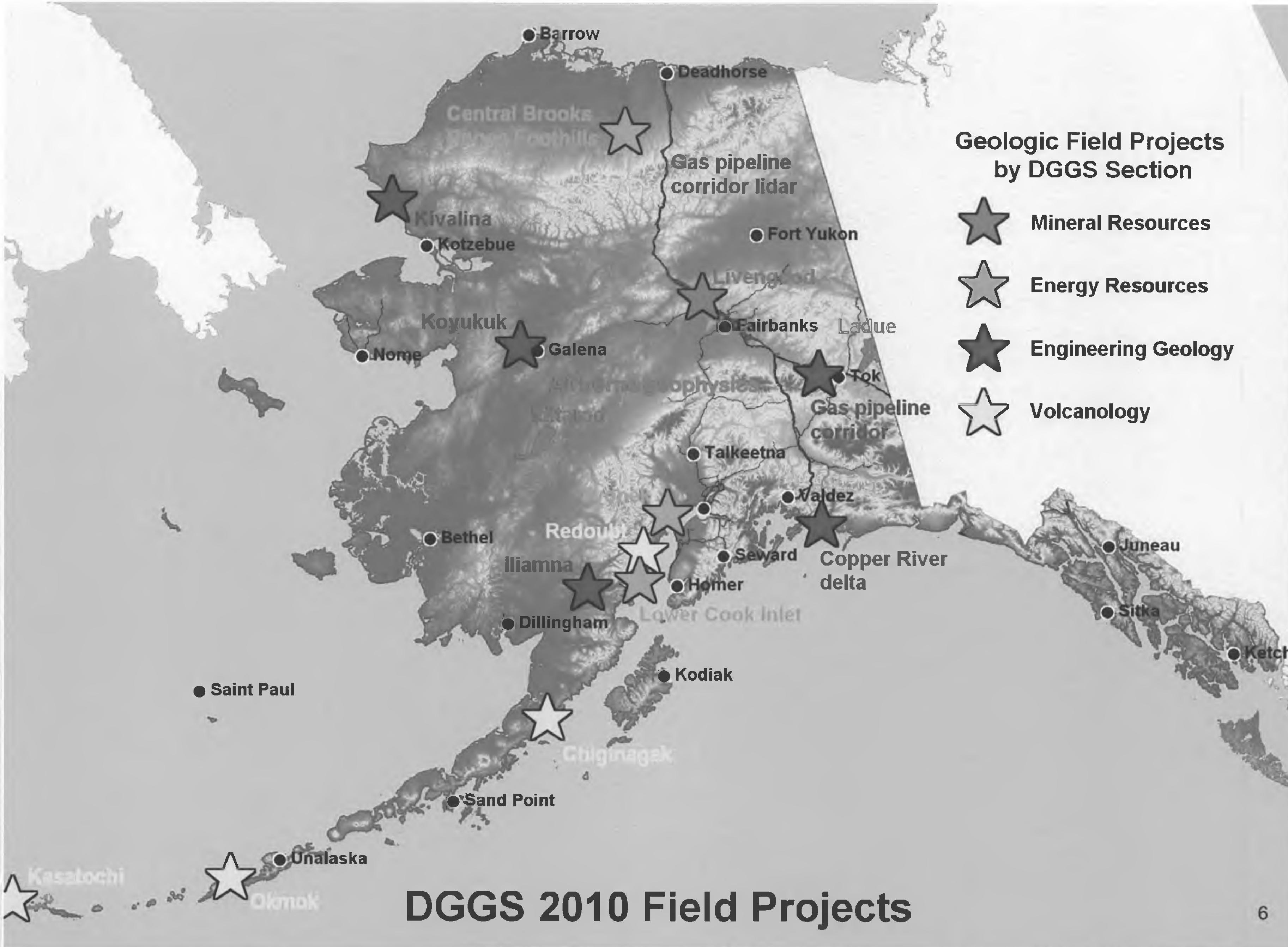
GEOLOGIC COMMUNICATIONS
Public outreach
Information management
Publications & Website

- Publications Specialist III — Paula Davis
  - Publications Specialist I — Joni Robinson
  - Natural Resource Technician II — Joyce Outten
  - Microcomputer/Network Technician I — Barbara Kirchner
  - Microcomputer/Network Specialist I — Kenneth Woods
  - Cartographer III — Vacant
  - Analyst/Programmer IV — Mary Seitz
  - Geologist III — Jennifer Athey
    - College Intern I — Katie McGinnis
  - Geologist III — Simone Montayne

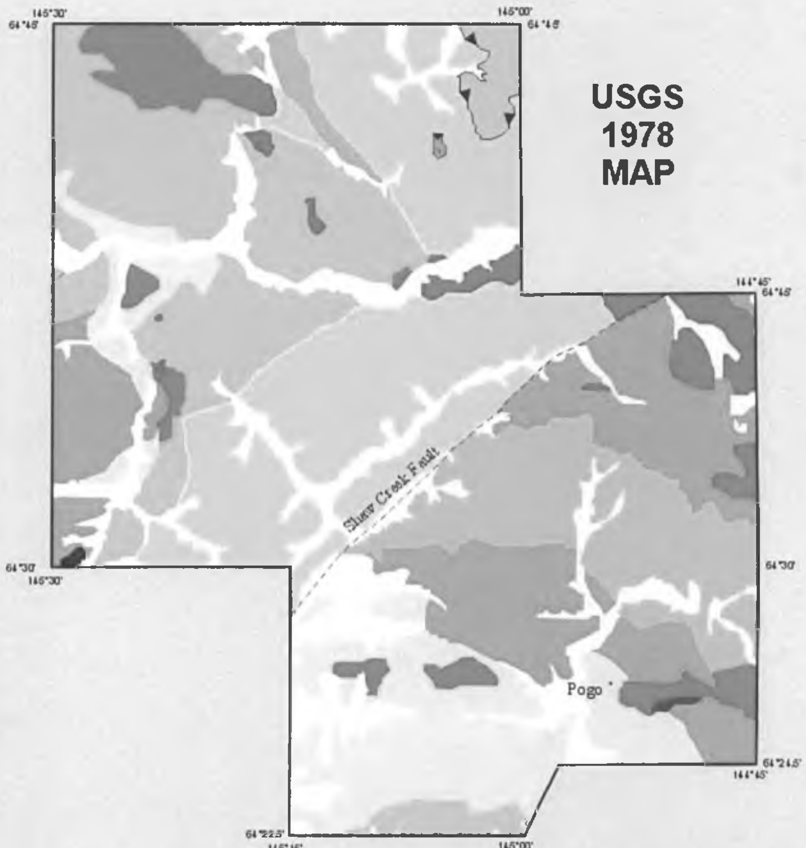
GEOLOGIC MATERIALS CENTER
Core storage facility
Geologic samples archive

- Geologist IV — Kenneth Papp
  - Geologist III — Jean Riordan
  - Natural Resource Technician II — Kurt Johnson
  - College Intern I — Herbert Mansavage
  - College Intern I — Joseph Skutca
  - College Intern I — Kjol Johnson

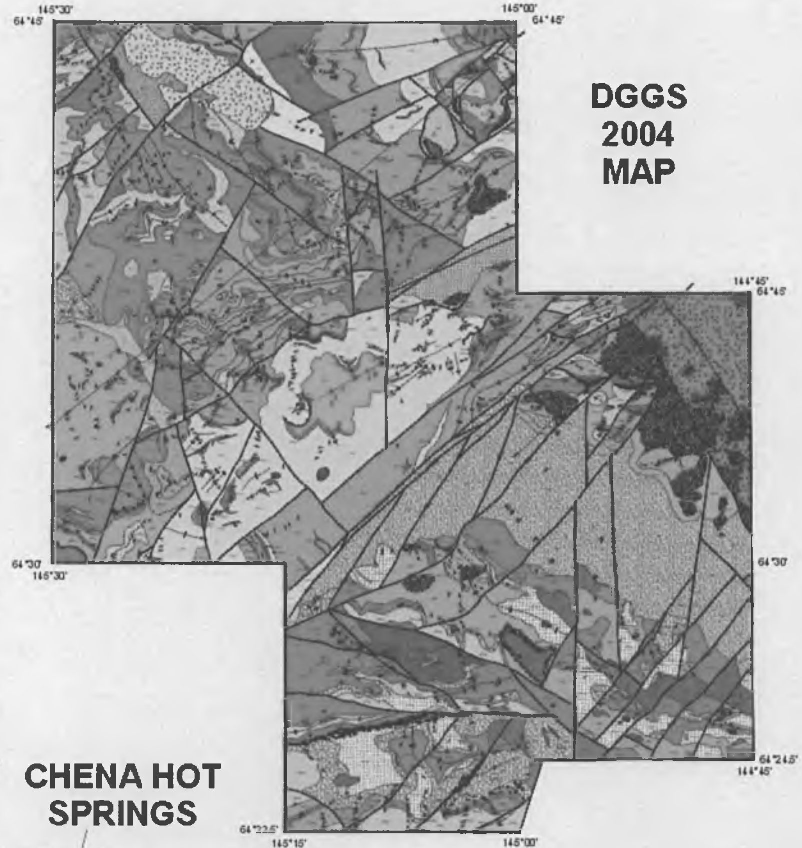
Legend:
- Non-permanent
- Student intern
- Vacant


Geologic Field Projects by DGGS Section
Mineral Resources
Energy Resources
Engineering Geology
Volcanology
Barrow
Deadhorse
Central Brooks
Gas pipeline corridor lidar
Kivalina
Kotzebue
Fort Yukon
Livengood
Fairbanks
Ladue
Koyukuk
Galena
Nome
Tok
Gas pipeline corridor
Talkeetna
Valdez
Bethel
Redoubt
Iliamna
Seward
Copper River delta
Homer
Juneau
Lower Cook Inlet
Dillingham
Sitka
Ketch
Kodiak
Saint Paul
Chiginagak
Sand Point
Unalaska
Kasatochi
Okmok
DGGS 2010 Field Projects
6

High Resolution Geologic mapping

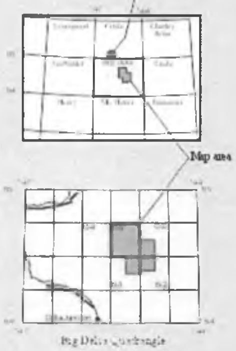


USGS
1978
MAP



DGGS
2004
MAP

CHENA HOT SPRINGS

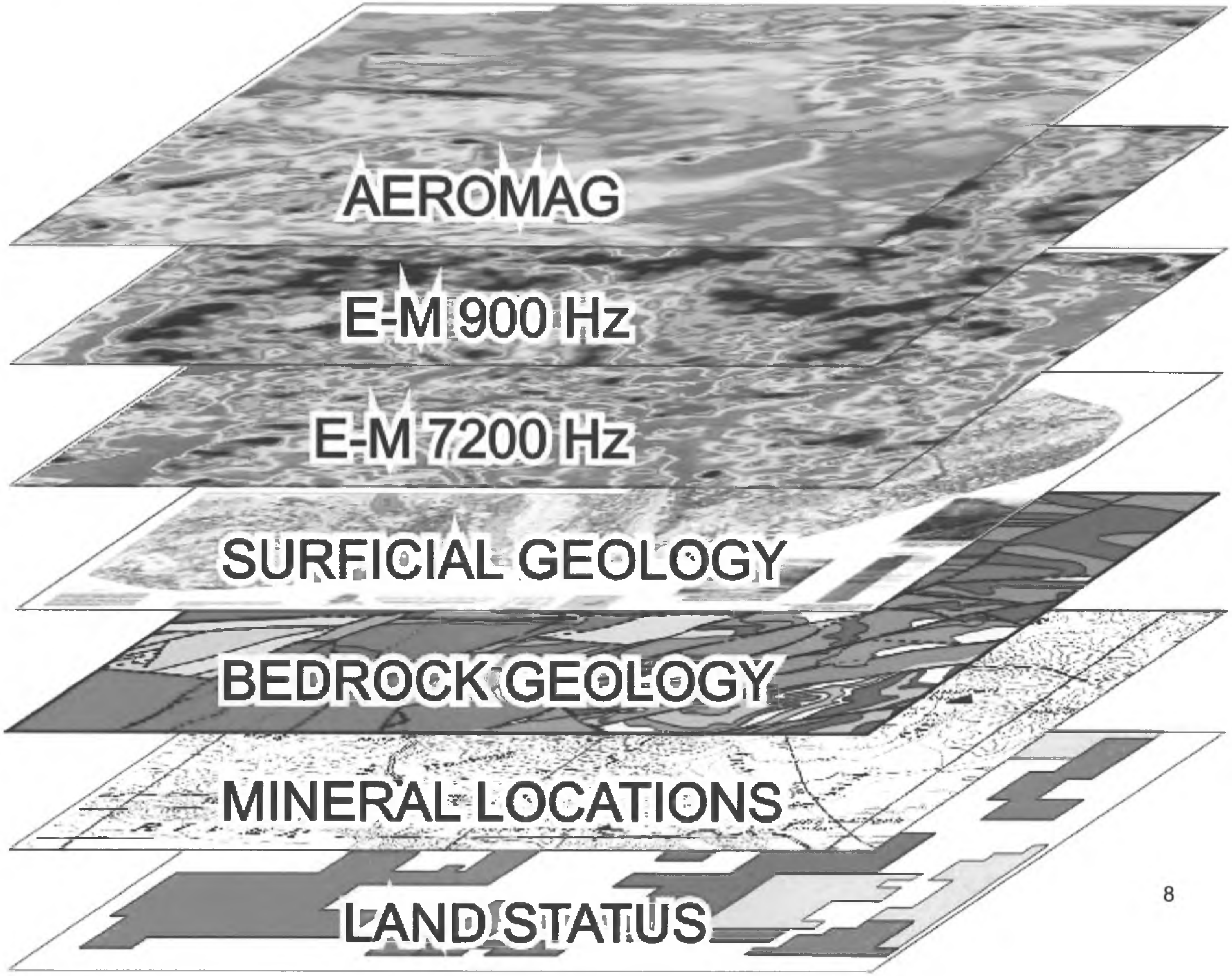


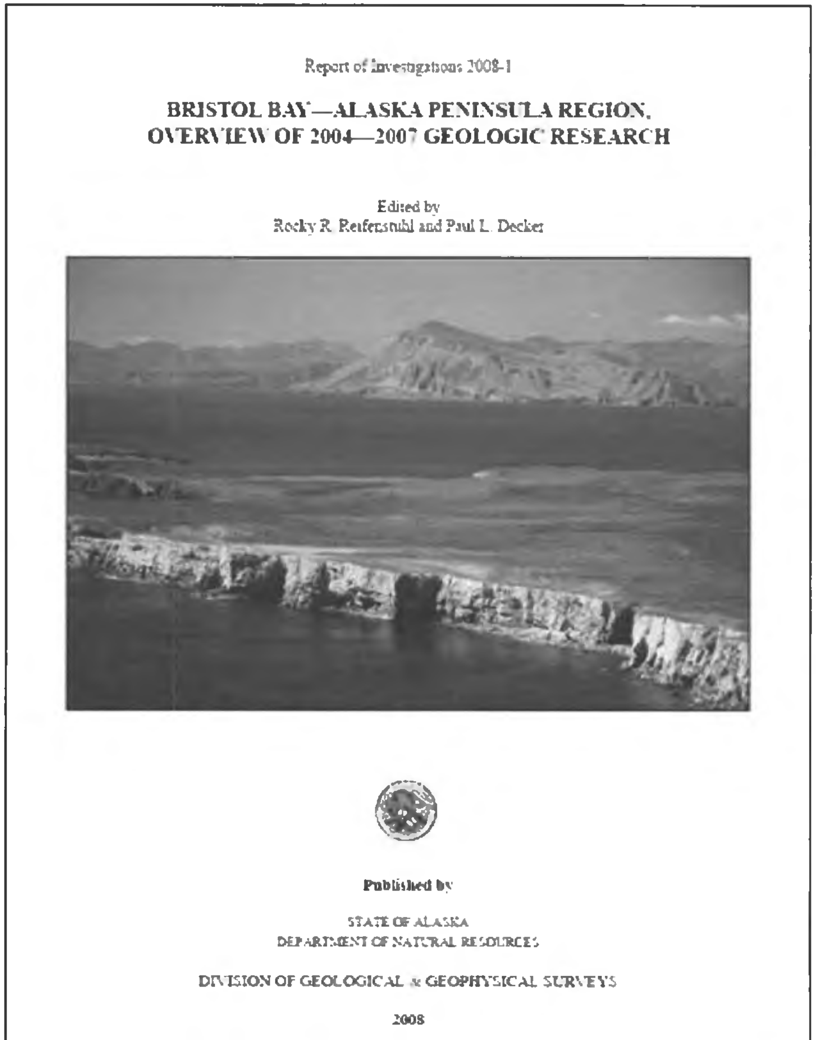
Weber and others, 1978
(1:250,000-scale geologic map)

0 10 MILES

Werdon and others, 2004
(1:63,360-scale bedrock geologic
map made using DGGS's airborne
magnetic, resistivity, and radiometric data)

DGGS Integrated Mapping Program




Report of Investigations 2008-1

BRISTOL BAY—ALASKA PENINSULA REGION, OVERVIEW OF 2004—2007 GEOLOGIC RESEARCH

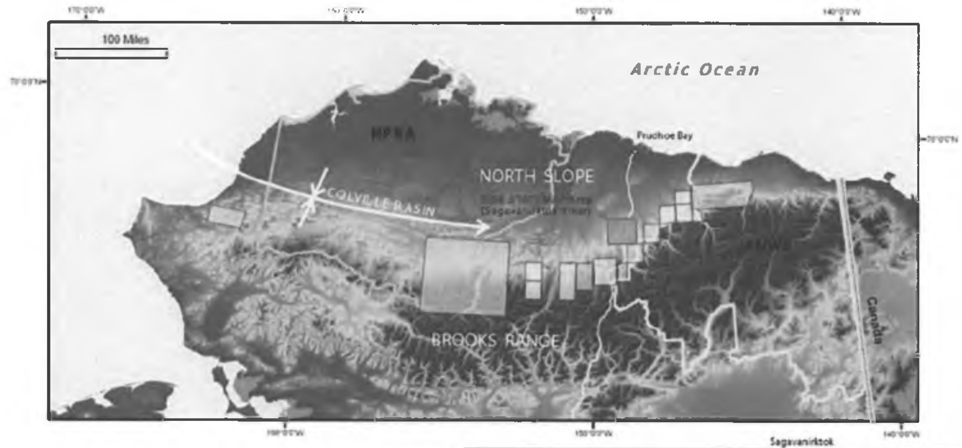
Edited by
Rocky R. Reifenstuhl and Paul L. Decker

Published by

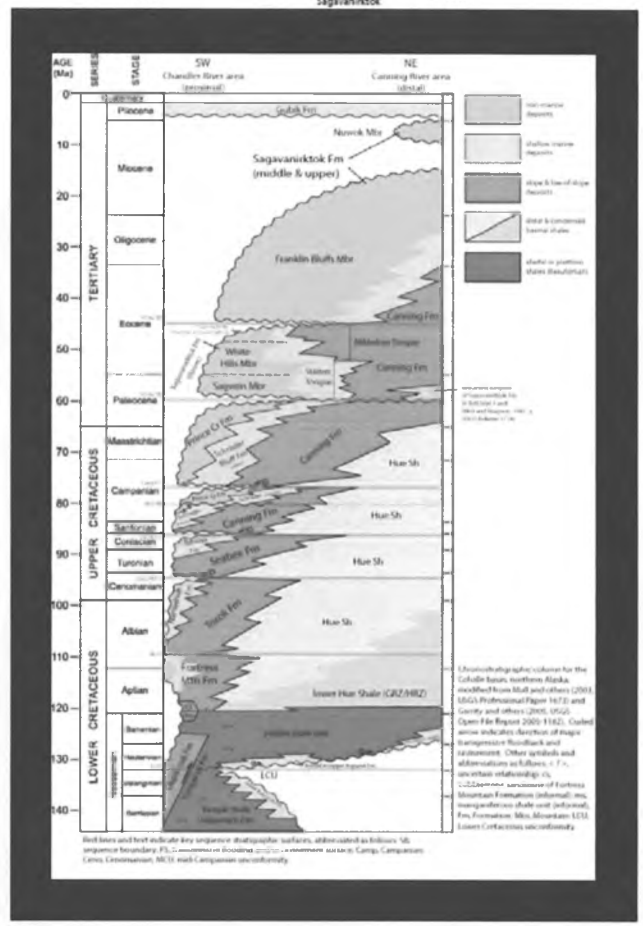
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

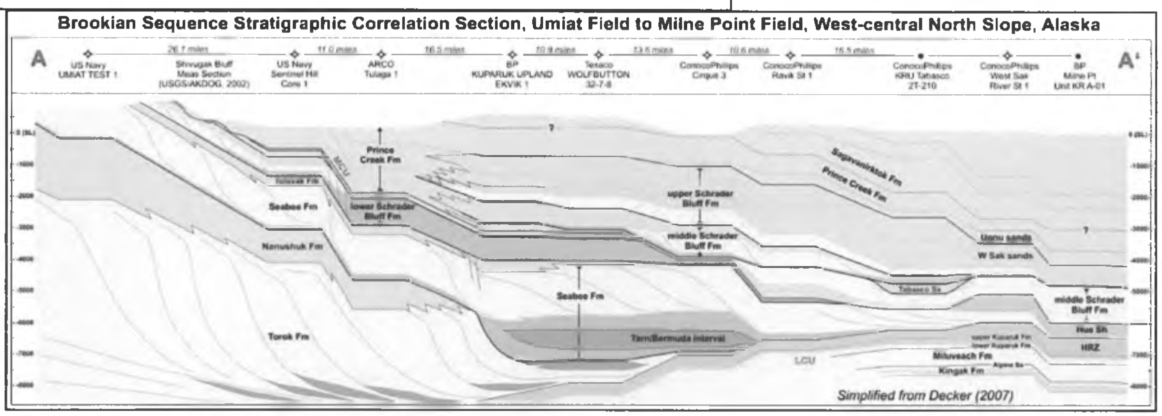
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

2008



Program Results





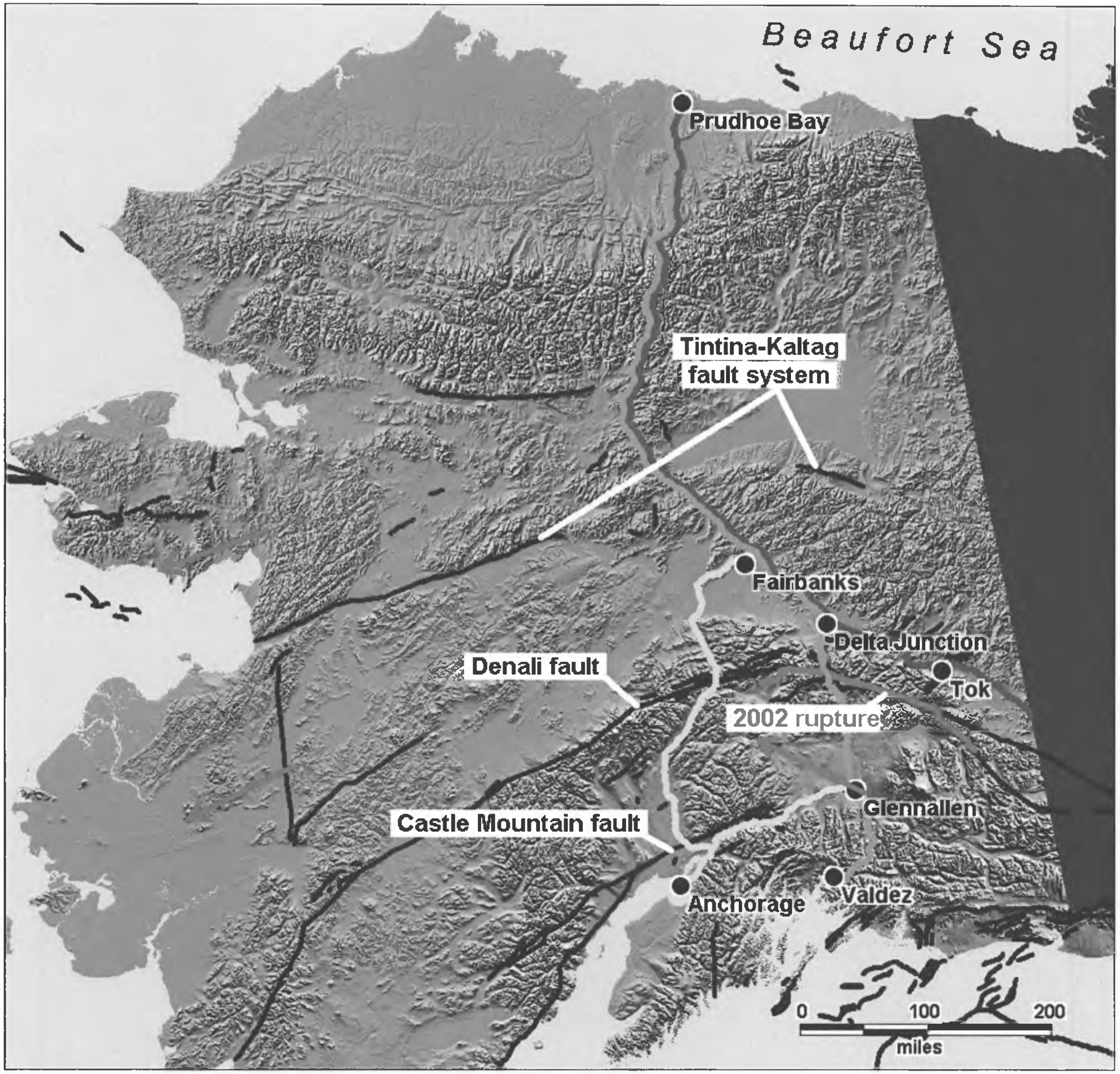
The Resource Development Chain

Engineering Geology Infrastructure Studies

Geologic Hazards Evaluation

- Active Faults
- Landslides
- Thermokarst
- Tsunami

- Material Sites
- Resource Potential

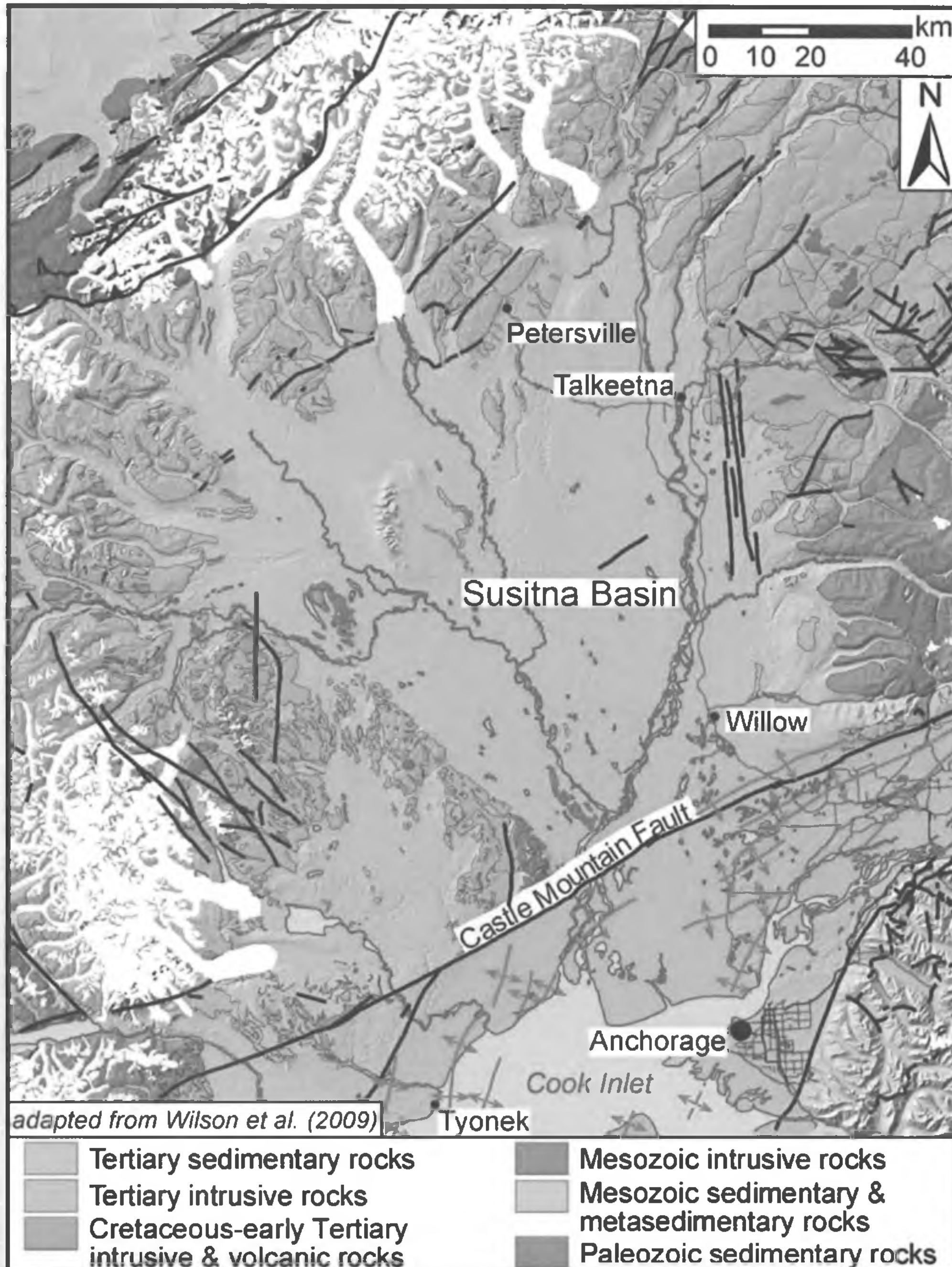


In-state Natural Gas Potential

Susitna Basin – focus of 2011 work

Other prospective basins:

- Yukon Flats
- Middle Tanana (Nenana)
- Susitna
- Copper River
- Colville



Airborne Geophysical/Geological Mineral Inventory (AGGMI)

UNSURVEYED CANDIDATE AREAS (TRIANGLES) OF STATE, STATE-SELECTED, & NATIVE LANDS (NOT IN ORDER OF PRIORITY)

1 DeLong Mountains
2 Baird Mountains
3 Candle
4 Nome North
5 Marshall
6 Shotgun Hills
7 Sleetmute
8 Pebble area
9 Jurassic Arc
10 Arctic (Ambler schist belt)
11 Upper Kobuk River
12 Wiseman
13 Chandalar
14 W. Melozi
15 Shaw Creek/Upper Salcha
16 Delta
17 60-Mile Butte
18 Bonnifield South
19 Paxson/McLaren
20 Gold Hill
21 Farewell
22 Yentna
23 Skwentna

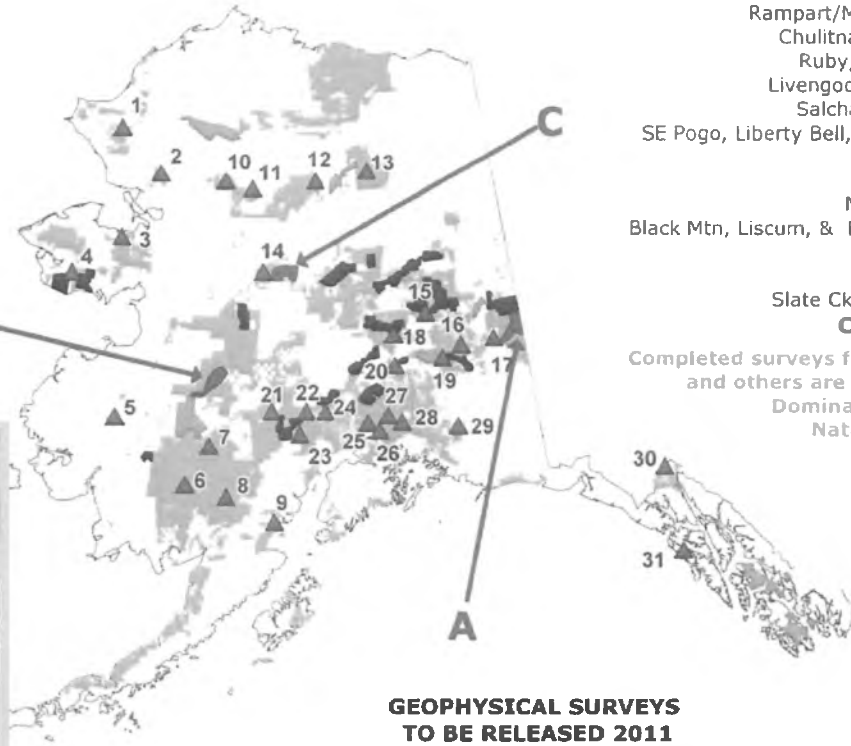
GEOPHYSICAL SURVEY TRACTS & RELEASE DATES
All surveys shown managed by Alaska Division of Geological & Geophysical Surveys (DGGS).

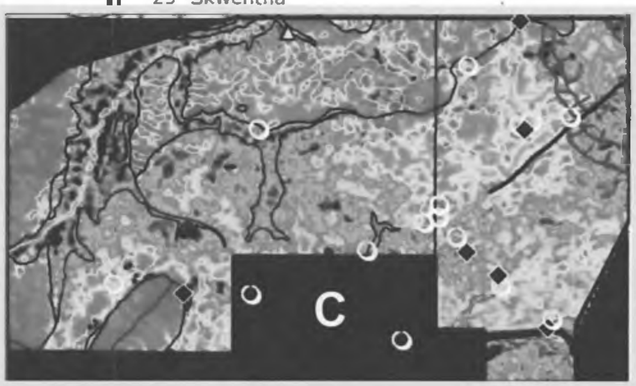
Completed surveys funded by Alaska State Legislature are shown in blue or magenta. Dominantly State- and Native-interest lands surveyed.

Nome west, Circle, Valdez Creek, Nyac, 1994
Fairbanks, Richardson, 1995
Rampart/Manley, 1996, 1997
Chulitna, Petersville, 1997
Ruby, Iron Creek, 1998
Livengood, Fortymile, 1999
Salcha River/Pogo 2000
SE Pogo, Liberty Bell, Broad Pass, 2002
Council, 2003
Goodpaster, 2005
NE Fairbanks, 2006
Black Mtn, Liscum, & E Richardson, 2006
Bonnifield, 2007
Styx River, 2008
Slate Ck-Slana River, 2009
C - Moran, 2010

Completed surveys funded by US BLM and others are shown in orange. Dominantly Federal- and Native-interest lands surveyed.

Stikine, 1997
Koyukuk, 1998
Ketchikan, 1999
Aniak, 2001
Sleetmute, 2003
Delta River, 2003
southern NPR-A, 2006
western Fortymile, 2008





GEOPHYSICAL SURVEYS TO BE RELEASED 2011

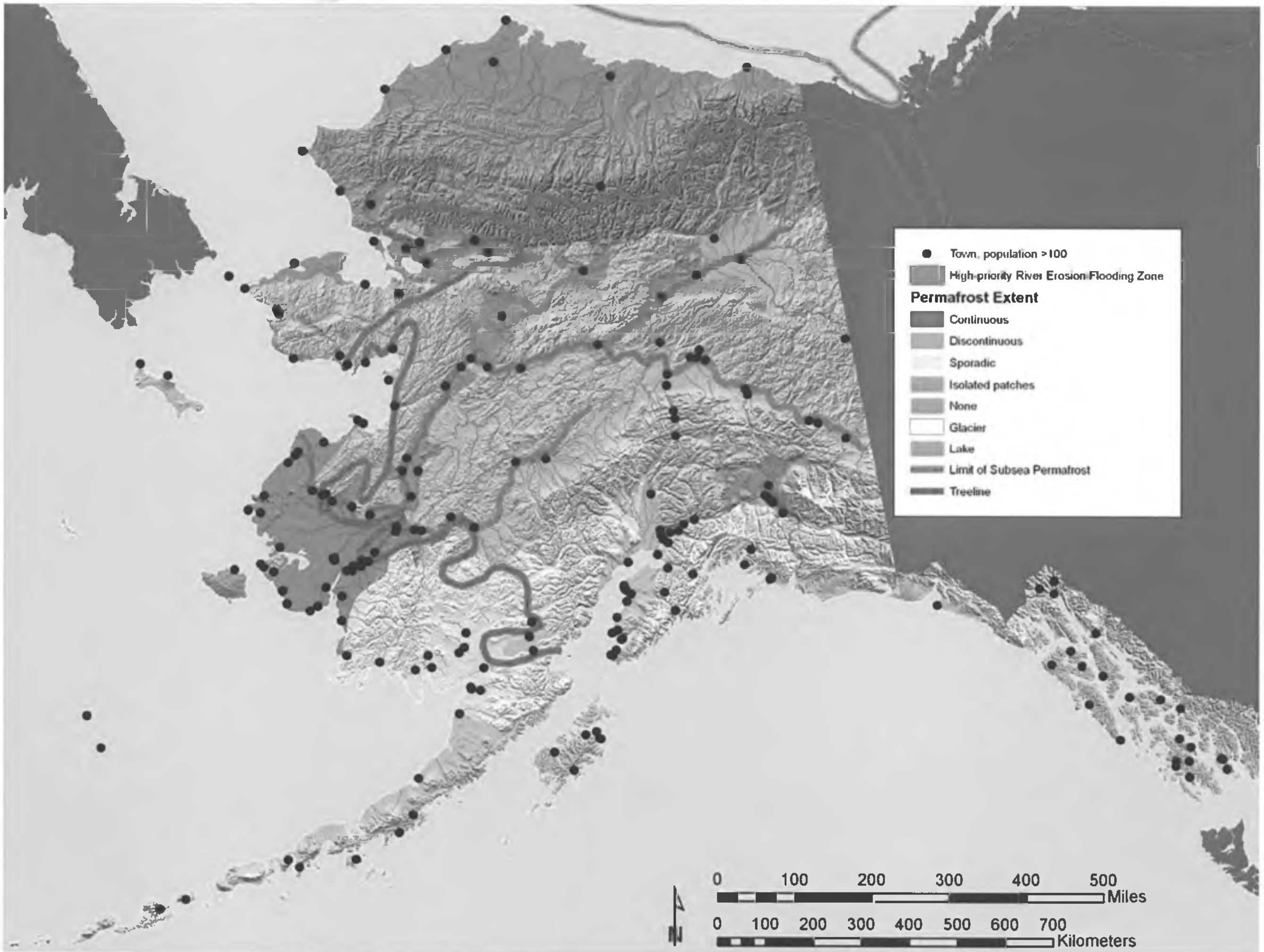
A - Ladue area, east-central Alaska, and
B - Iditarod area, western Alaska

Both funded by the Alaska State Legislature

State interest lands shown in light blue.

DGGS ALASKA AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY

Geologic Hazards Related to Climate Change

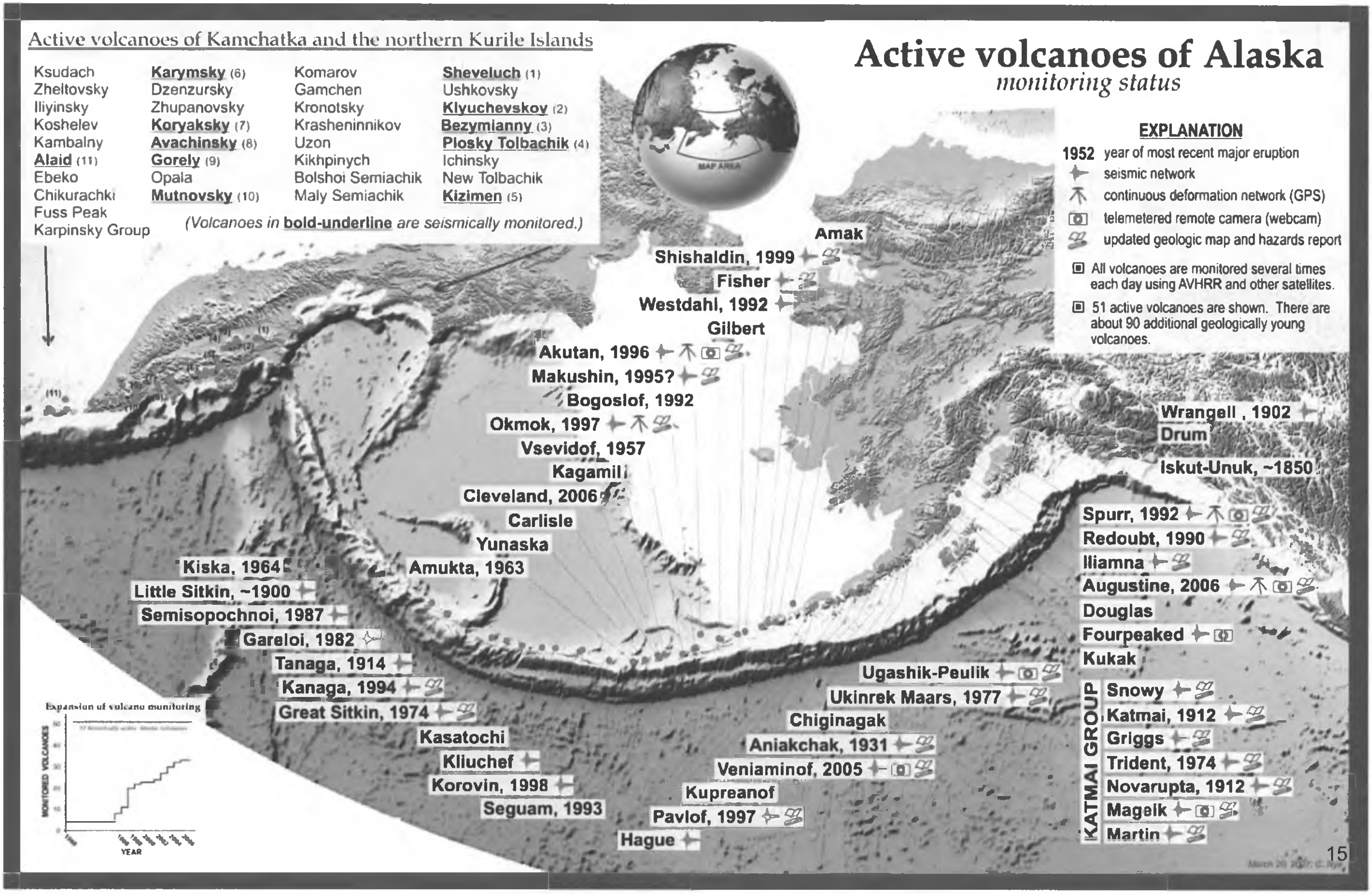


New CIP Project

- Permafrost-rich ground
- Potentially unstable slopes
- Shores prone to erosion
- Areas at risk for flooding

Volcano monitoring – Alaska Volcano Observatory

USGS – DGGS – UAF

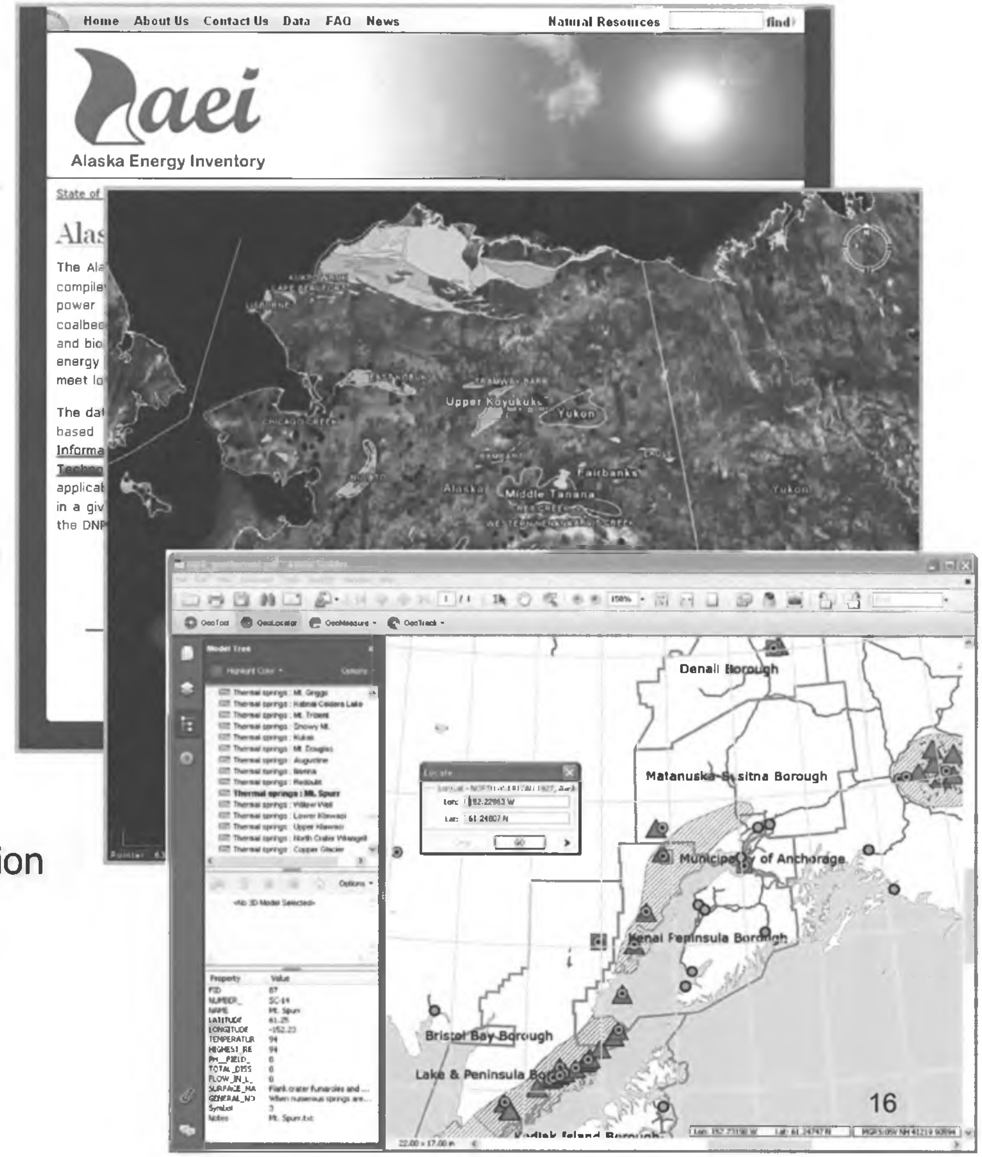


Alaska Energy Data Inventory

- Consolidating Alaska's energy resources data
  - Resource data suitable for electrical power generation and space heating needs
  - Natural gas, coal, coalbed and shalebed methane, gas hydrates, geothermal, wind, hydro, and biomass
  - Available energy meeting local needs?

- Making the data accessible
  - Alaska Mapper, Google Earth, and Terrago Technologies' GeoPDF format
  - http://energyinventory.alaska.gov
  - Query and download data; view data with existing infrastructure

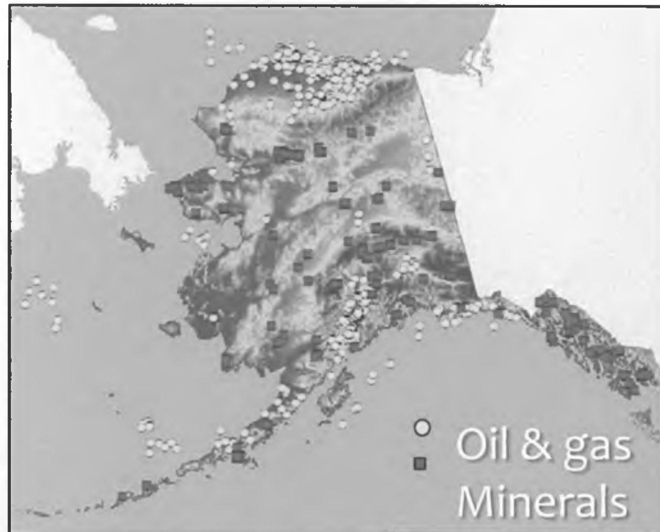
- Involvement
  - DGGS, Alaska Energy Authority, DNR Division of Forestry, DNR LRIS, UAF/GINA
  - CCHRC, USGS, USDOE, DNR DOG, BLM, DMLW, Div. Agriculture, DEC



Alaska Geologic Materials Center

State Archive of Representative Geologic Samples

- ○ Rock core samples and drill cuttings representing about 13 million feet of exploration and production drilling
- ○ Samples from more than 1,600 oil & gas exploratory and production wells from nearly every major sedimentary basin in the state
- ■ Nearly 300,000 feet of diamond-drill core samples from more than 1,100 exploratory hard-rock mineral drill holes



Moving toward a better position on the storage spectrum

POOR — EXCELLENT

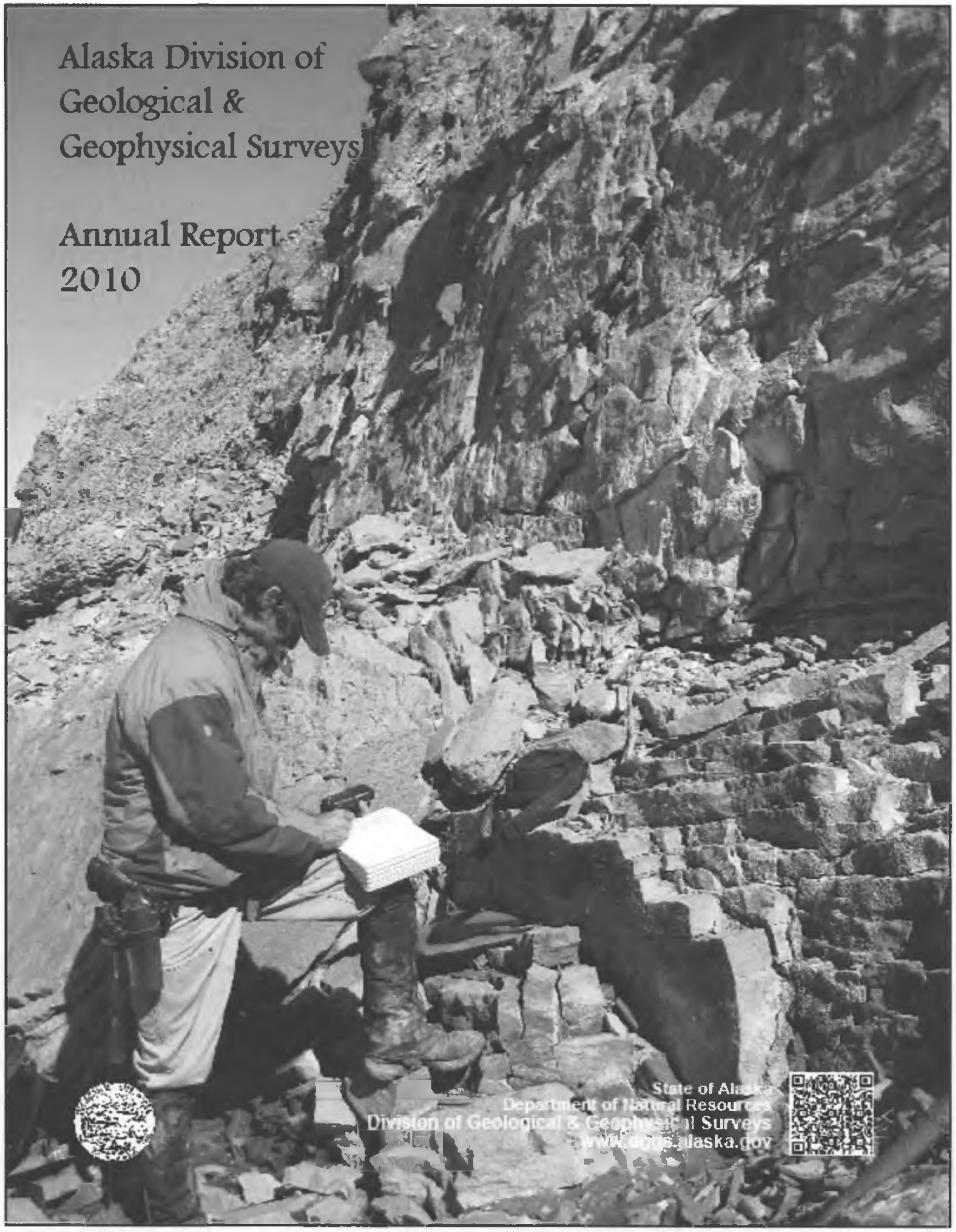
Foreign country
Unorganized and unmaintained, the valuable information once held by these core samples is lost.

Alaska
The current AGMC facility has limited workspace, is 150% over capacity, and is poorly designed for geologic sample storage.

U.S. and Canada
Modern facilities include Alberta Core Research Center (bottom), Oklahoma Geological Survey, Texas Bureau of Economic Geology (top), and U.S. Geological Survey Denver.

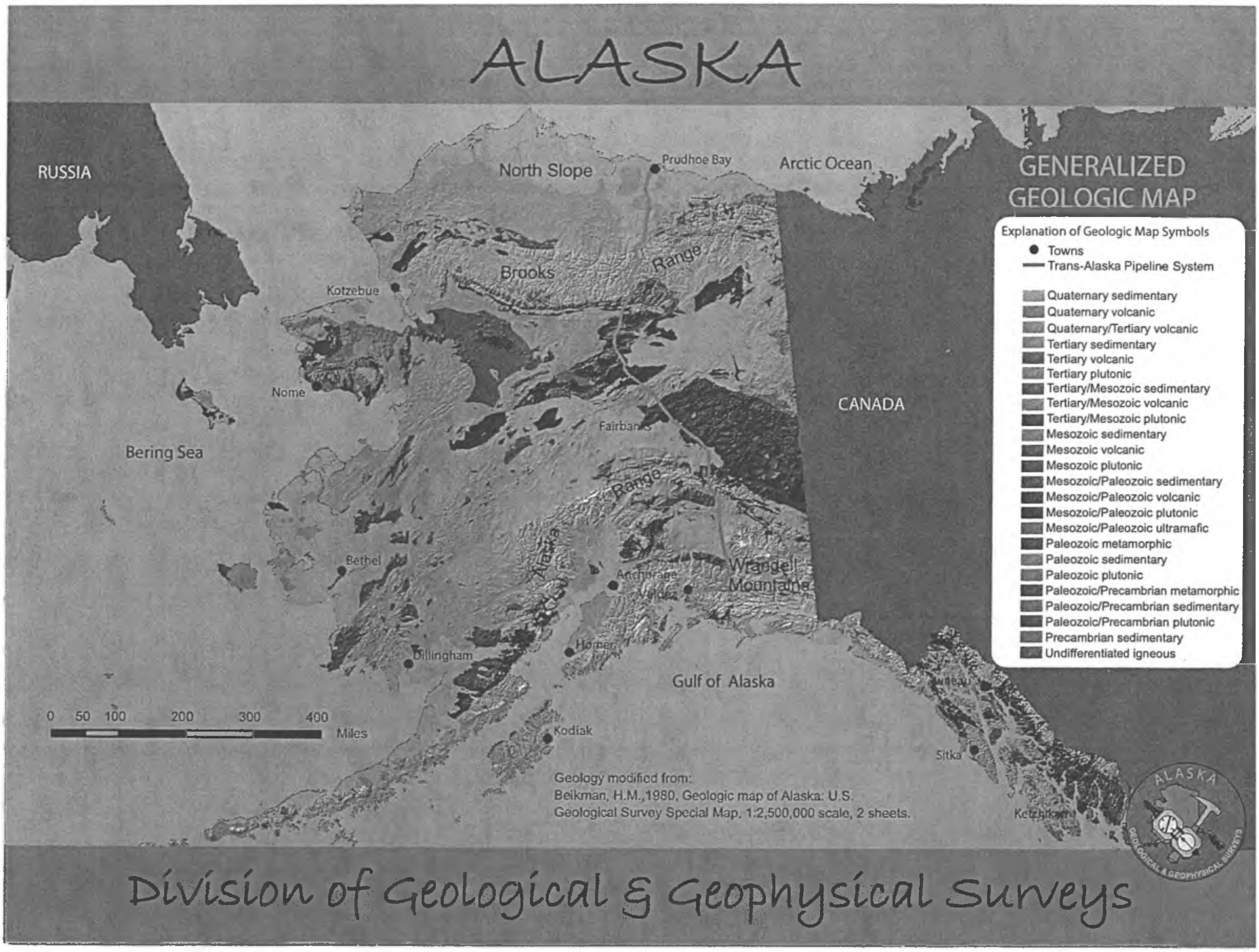
2010 Accomplishments

- Completed 1,756 square miles of geologic mapping, addressing the State's highest priority needs in **assessment of energy resources, mineral resources, and geologic hazards**.
- Released 653 square miles of airborne geophysical survey data in the Moran area west of Tanana and flew two new airborne geophysical surveys covering a total of 1,600 square miles in the Fortymile and Iditarod mining districts.
- Completed reports summarizing fossil fuel and geothermal energy resource potential for each of the 11 energy regions defined by the Alaska Energy Authority
- Completed follow-up geologic investigations of deposits resulting from the 2008-2009 eruptions of Redoubt, Kasatochi, and Okmok Volcanoes. All three were major eruptions that had unusual aspects and significant consequences for commercial aircraft or critical infrastructure.
- Initiated a $1.853 million contract to collect airborne LiDAR (Light Detection and Ranging) data over the proposed large-diameter natural-gas pipeline corridors, with funding from the state and federal Alaska Pipeline Project offices.
- Completed field geologic mapping and hazards assessment of the first two of many communities in Alaska facing severe erosion and flooding hazards and possible relocation.
- Released an online version of the Alaska Geologic Materials Center (GMC) sample inventory to the public in April. This inventory, available in Google Earth format, allows users to quickly and easily view details of the GMC's materials repository before visiting the facility.
- Distributed more than 5,000 hard-copy geologic and geophysical reports and maps to the public and recorded nearly 112 million web page views on the DGGS and Alaska Volcano Observatory websites.



DGGS Annual Report

- Available online at:
  - www.dggs.alaska.gov
- Complete Outline of Division's Mission
- Program Descriptions
- Program Products
- Access to all Alaska Geologic Data & Information Through Robust Web Database & Public Interface


ALASKA
GENERALIZED GEOLOGIC MAP
RUSSIA
North Slope
Prudhoe Bay
Arctic Ocean
Brooks Range
Kotzebue
Nome
Bering Sea
Fairbanks
CANADA
Alaska Range
Bethel
Anchorage
Valdez
Wrangell Mountains
Dillingham
Homer
Gulf of Alaska
Kodiak
Juneau
Sitka
Ketchikan
0 50 100 200 300 400 Miles
Explanation of Geologic Map Symbols
Towns
Trans-Alaska Pipeline System
Quaternary sedimentary
Quaternary volcanic
Quaternary/Tertiary volcanic
Tertiary sedimentary
Tertiary volcanic
Tertiary plutonic
Tertiary/Mesozoic sedimentary
Tertiary/Mesozoic volcanic
Tertiary/Mesozoic plutonic
Mesozoic sedimentary
Mesozoic volcanic
Mesozoic plutonic
Mesozoic/Paleozoic sedimentary
Mesozoic/Paleozoic volcanic
Mesozoic/Paleozoic plutonic
Mesozoic/Paleozoic ultramafic
Paleozoic metamorphic
Paleozoic sedimentary
Paleozoic plutonic
Paleozoic/Precambrian metamorphic
Paleozoic/Precambrian sedimentary
Paleozoic/Precambrian plutonic
Precambrian sedimentary
Undifferentiated igneous
Geology modified from:
Beikman, H.M.,1980, Geologic map of Alaska: U.S. Geological Survey Special Map, 1:2,500,000 scale, 2 sheets.
ALASKA
GEOLOGICAL & GEOPHYSICAL SURVEYS
Division of Geological & Geophysical Surveys

GEOLOGIC MAP OF ALASKA

Alaska is a geologically complex state with a tremendous variety of exposed rocks and sediments representing every geologic era except the Precambrian (older than 543 million years). The state is rich in energy and mineral resources and is subject to nearly every type of major geologic hazard. To learn more about the geology, resources, and hazards of Alaska, visit the following state-affiliated websites:

Alaska Division of Geological & Geophysical Surveys, http://dggs.alaska.gov
Alaska Geology, http://akgeology.info
Alaska Volcano Observatory, http://avo.alaska.edu
Alaska Earthquake Information Center, http://giseis.alaska.edu

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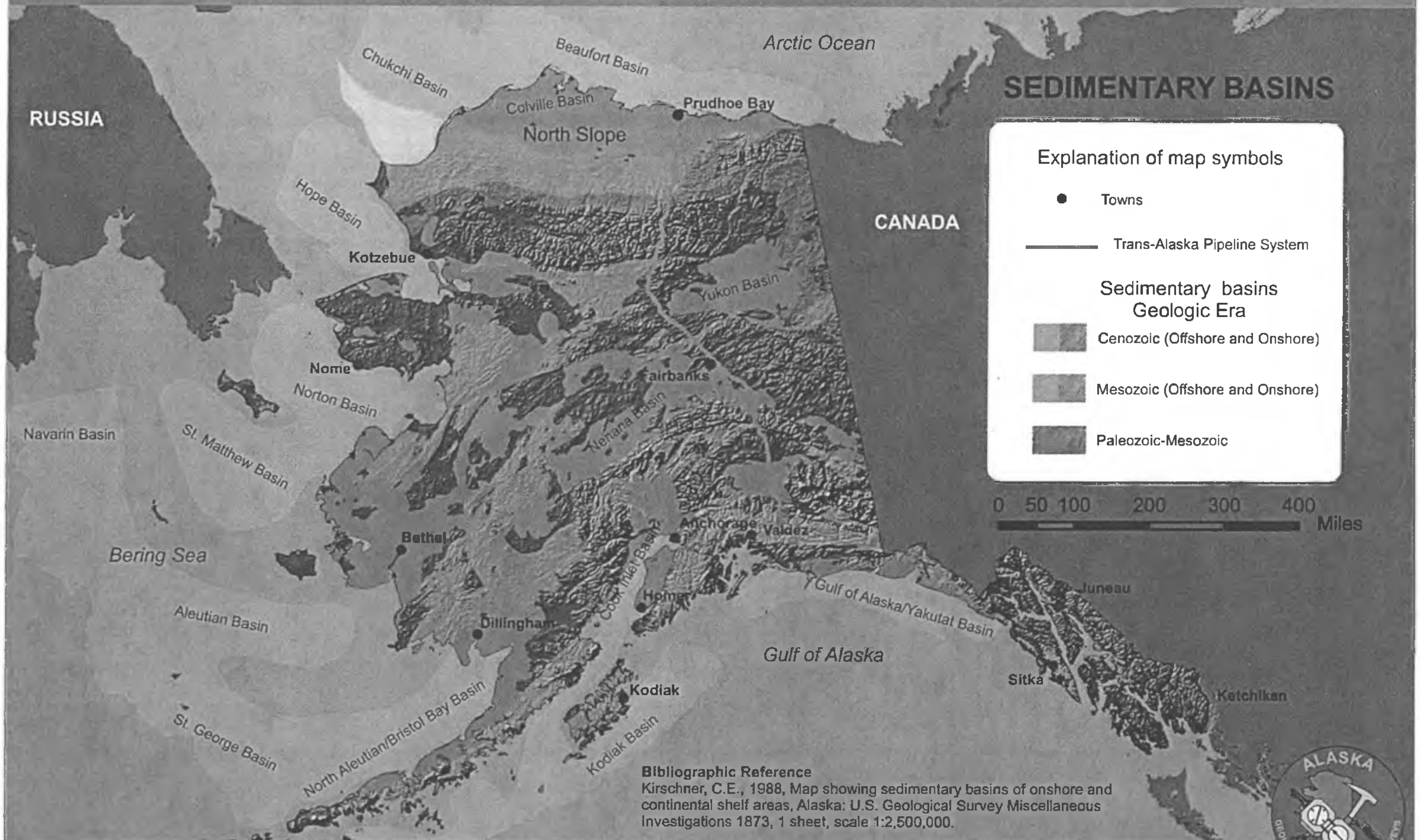
STATE OF ALASKA/DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
3354 College Road Fairbanks, AK 99709-3707
Email: dggspubs@alaska.gov
Phone: 907-451-5000 Fax 907-451-5050
http://dggs.alaska.gov
Map and graphics by Alfred G. Sturmann, 2007

Alaska Department of
NATURAL
RESOURCES

ALASKA



Bibliographic Reference
Kirschner, C.E., 1988, Map showing sedimentary basins of onshore and continental shelf areas, Alaska: U.S. Geological Survey Miscellaneous Investigations 1873, 1 sheet, scale 1:2,500,000.

Division of Geological & Geophysical Surveys

SEDIMENTARY BASINS MAP OF ALASKA

Alaska's complex tectonic history has provided geologic settings for a diverse suite of sedimentary basins, including passive margins, accretionary fore-arc and back-arc, and orogenic foreland. Many of these provinces are endowed with rich source-rock intervals that have led explorers to the discovery of energy resources across the state. To learn more about the geology and energy resources of Alaska, visit the following state-affiliated websites:

Alaska Division of Geological & Geophysical Surveys, http://www.dggs.dnr.state.ak.us
Alaska Geology, http://akgeology.info
Alaska Division of Oil & Gas, http://www.dog.dnr.state.ak.us
Alaska Oil & Gas Conservation Commission, http://www.aogcc.alaska.gov/

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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
3354 College Road Fairbanks, AK 99709-3707
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http://www.dggs.dnr.state.ak.us
Map and graphics by Alfred G. Sturmann, 2007

Alaska Department of NATURAL RESOURCES


ALASKA
ALASKA MINERAL PROJECTS
Arctic Ocean
Prudhoe Bay
Western Arctic Coal
RUSSIA
Red Dog
Kotzebue
Council
Rock Creek
Nome
Bluff
Fairbanks
Fort Knox
Pogo
CANADA
Colorado Creek
Donlin Creek
Bering Sea
Bethel
Anchorage
Valdez
Homer
Kodiak
Gulf of Alaska
Kensington
Juneau
Bokan Mountain
Explanation of Map Symbols
Towns
Trans-Alaska Pipeline System
Exploration Project
Major Lode Mine
Development Project
Placer Mineral Occurrence (ARDF)
Lode Mineral Occurrence (ARDF)
ALASKA
Division of Geological & Geophysical Surveys

MINERAL PROJECTS OF ALASKA

(data compiled 8/1/10)

The unmatched geologic diversity of the state of Alaska hosts a wide range of metallogenic settings and mineral commodities.

- More than 7,300 placer and lode (hardrock) metallic mineral occurrences are documented in the Alaska Resource Data Files (ARDF) database.
- Placer gold mining across Alaska has produced more than 24.5 million ounces of gold from 1880 to the present.
- Alaska's large lode (hardrock) mines produced zinc, lead, gold, silver, and coal worth in excess of $2.4 billion in 2009.

Annual mineral exploration expenditures in Alaska account for about one-third of the annual mineral exploration expenditures in the United States. Continued exploration at the Pebble (copper, gold, and molybdenum), Donlin Creek (gold), and Livengood (gold) deposits indicates that there are still mammoth mineral deposits that may be developed in Alaska. There is high likelihood that other world-class Alaska mineral deposits remain to be discovered.

The Alaska Division of Geological & Geophysical Surveys (DGGS) publishes an annual report produced in cooperation with the Alaska Department of Commerce, Community and Economic Development that details activities and accomplishments of Alaska's mineral industry. This report, along with a wealth of other information about the geology, geologic hazards, and mineral and energy resources of Alaska, are available on the DGGS website. The ARDF database is available from the U.S. Geological Survey via the akgeology.info website.

Please visit these Alaska state-affiliated websites:

- Alaska Division of Geological & Geophysical Surveys, http://dggs.alaska.gov
- Alaska Geology and Mineral Data Information, http://akgeology.info
- Alaska Department of Natural Resources Mining Resources Section, http://dnr.alaska.gov/mlw/mining/index.htm
- Alaska Department of Commerce, Community and Economic Development, http://www.commerce.alaska.gov/oed/minerals/mining.htm

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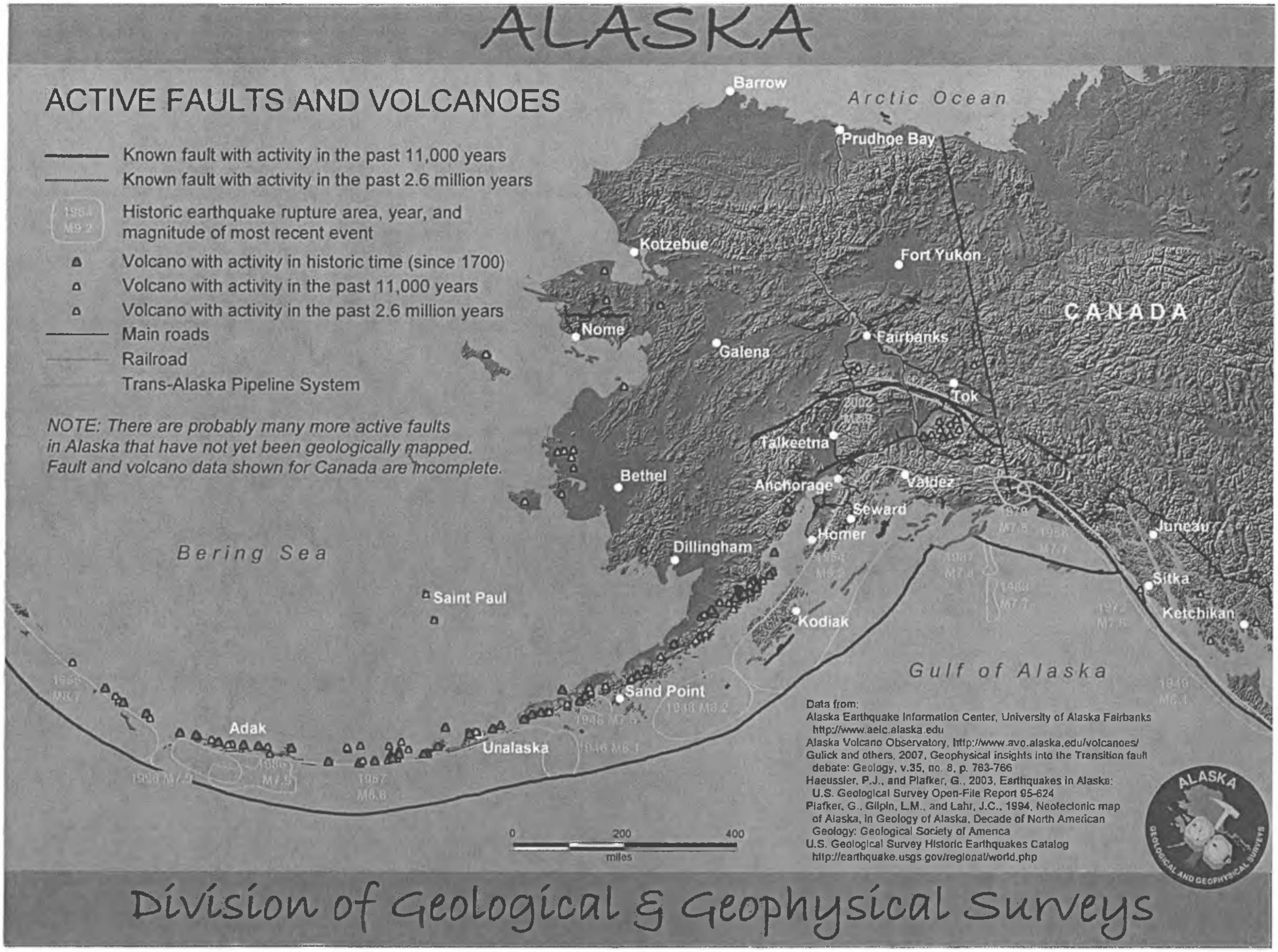
http://dggs.alaska.gov

Map and graphics by Alfred G. Sturmann and David J. Szumigala, 2009

Alaska Department of NATURAL RESOURCES


ALASKA
ACTIVE FAULTS AND VOLCANOES
Known fault with activity in the past 11,000 years
Known fault with activity in the past 2.6 million years
Historic earthquake rupture area, year, and magnitude of most recent event
Volcano with activity in historic time (since 1700)
Volcano with activity in the past 11,000 years
Volcano with activity in the past 2.6 million years
Main roads
Railroad
Trans-Alaska Pipeline System
NOTE: There are probably many more active faults in Alaska that have not yet been geologically mapped. Fault and volcano data shown for Canada are incomplete.
Barrow
Arctic Ocean
Prudhoe Bay
Kotzebue
Fort Yukon
CANADA
Nome
Galena
Fairbanks
Tok
Talkeetna
Bethel
Anchorage
Valdez
Seward
Homer
Juneau
Dillingham
Bering Sea
Saint Paul
Kodiak
Sitka
Ketchikan
Gulf of Alaska
Sand Point
Adak
Unalaska
1948 M8.2
1946 M8.1
1957 M8.6
0 200 400
miles
Data from:
Alaska Earthquake Information Center, University of Alaska Fairbanks http://www.aeic.alaska.edu
Alaska Volcano Observatory, http://www.avo.alaska.edu/volcanoes/
Gulick and others, 2007, Geophysical insights into the Transition fault debate: Geology, v.35, no. 8, p. 763-766
Haeussler, P.J., and Plafker, G., 2003, Earthquakes in Alaska: U.S. Geological Survey Open-File Report 95-624
Plafker, G., Gilpin, L.M., and Lahr, J.C., 1994, Neotectonic map of Alaska, in Geology of Alaska, Decade of North American Geology: Geological Society of America
U.S. Geological Survey Historic Earthquakes Catalog http://earthquake.usgs.gov/regional/world.php
Division of Geological & Geophysical Surveys

ACTIVE FAULTS AND VOLCANOES IN ALASKA

Eleven percent of the world's recorded earthquakes have occurred in Alaska, including seven of the ten largest in the United States and three of the ten largest in the world. About 2,000 earthquakes are recorded in Alaska every month.

Since 1900, Alaska has had an average of:

- A "great" earthquake (magnitude 8 or larger) every 13 to 15 years
- A magnitude 7 to 8 earthquake every 1 to 2 years
- About 6 magnitude 6 to 7 earthquakes per year
- About 50 magnitude 5 to 6 earthquakes per year
- About 340 magnitude 4 to 5 earthquakes per year

This map shows faults that have been active in historic time or show geologic evidence of activity during the past 11,000 years (Holocene), and faults that show evidence of activity during approximately the preceding 2.6 million years (Pleistocene). Rupture area boundaries delineate the approximate extent of the initial epicenter and aftershocks of large earthquakes recorded since 1900. Considering the high rate of seismicity in Alaska, with earthquakes occurring in most areas of the state, there are probably many more active faults that have not yet been geologically mapped.

Alaska has more than 50 volcanoes that have been active during historic time (since about 1700). These volcanoes in Alaska make up well over three-quarters of U.S. volcanoes that have erupted in the past two hundred years. An additional ~90 volcanoes in Alaska show evidence of activity during the Holocene or Pleistocene epochs.

DGGS- and University of Alaska-affiliated web sites about earthquake and volcano hazards in Alaska:

Alaska Seismic Hazards Safety Commission
http://seismic.alaska.gov

Alaska Volcano Observatory
http://avo.alaska.edu

Alaska Earthquake Information Center
http://www.aeic.alaska.edu

Requires Letter Postage

STATE OF ALASKA/DEPARTMENT OF NATURAL RESOURCES
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Map and graphics by Rod Combellick, revised October 2010

Alaska Department of NATURAL RESOURCES

State of Alaska
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Geologic maps:

Solving problems by understanding our world

Assessing Resource Endowment

Photo provided by Teck Cominco Alaska Inc.

Overview of Alaska's Red Dog Mine, the world's largest zinc producer.

Infrastructure Design and Safety

Photo courtesy of U.S. Geological Survey

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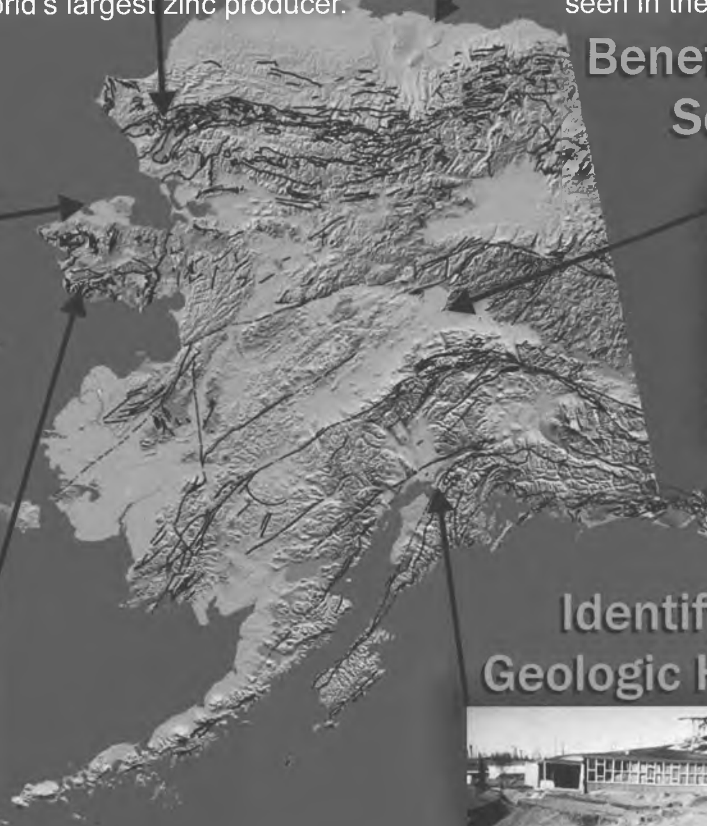
Structures constructed directly on permafrost will cause the underlying ice to melt and damage to the structure. Special construction techniques, as seen in the above photos, are required.

Mitigating Effects of Climate Change

Photos courtesy of Alaska Department of Commerce and Economic Development

The village of Shishmaref is facing evacuation due to rising temperatures, which are causing a reduction in sea ice, thawing of permafrost along the coast, and making the shoreline more vulnerable to erosion.



The Alaska geologic map above is a modification of the complete version with legend available at http://www.dggs.dnr.state.ak.us.

Benefiting Alaskans through Scientific Knowledge

The student pointing out erosion in permafrost is learning to see his environment in a new way.

Using Integrated Science to Protect the Environment

Seward Peninsula moose tooth breakage is attributed to naturally occurring heavy metals in the bedrock. Metals are absorbed by plants and affect moose nutrition.

Identifying Geologic Hazards

Photo courtesy U.S. Geological Survey

Government Hill Elementary School torn apart by subsidence at the head of a landslide that occurred during the 1964 earthquake.

Geologic maps are our most important and complete compilation of information about the solid Earth we live on. Consequently, geologic maps are fundamental to understanding natural, earthbound processes and solving real-world environmental problems directly affecting people, plants, and other animals. The following Alaskan examples represent a sampling of the many uses of geologic maps.

Assessing Resource Endowment

Alaska, arguably the most resource-rich state, is also the most unmapped and under-explored state. Geologic mapping and related data suggest where to find a host of **necessary resources** for providing energy, building materials, and products ranging from cement to plastic to batteries.

Key Resources of Alaska

Metals.......	Gold, zinc, copper, lead, silver, tin, mercury, platinum, etc. necessary to make items such as bikes, batteries, computers, and mirrors
Energy.......	Oil, gas, coal, and geothermal for heat, electricity, and fuel, and products such as plastics, asphalt, clothing, etc.
Materials....	Riprap for erosion control, sand and gravel for roads and construction, decorative stone, limestone/marble for making cement
Minerals.....	Jade, diamonds, emeralds, soapstone, ceramics, barite, etc.
Water........	Potable water; the most basic resource often taken for granted

Identifying Geologic Hazards

Due to its active and structurally complex geology, high relief, variable climate, and large coastal zones, Alaska is particularly prone to both large and small magnitude geologic hazards. Effective **mitigation of risk** from catastrophic geologic hazards requires knowledge and understanding of local geology and geologic processes.

Geologic mapping will help determine...

... areas at risk of river and ocean shoreline erosion – information that villages and municipalities can use to correctly manage and develop their lands.

... the eruptive history of volcanoes, leading to timely prediction of environmentally devastating events like toxic gas emissions, tsunamis, and large ash clouds

... where unstable ground could lead to landslides, road failure, building collapse, and infrastructure damage.

... the location and character of faults. Prediction of earthquake damage is possible by mapping soft sediments, which through liquefaction exacerbate the damage.

... who should install radon mitigation. Hazardous radon levels have been detected in Fairbanks area homes built on a specific Paleozoic rock unit.

by Jennifer E. Athey
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Infrastructure Planning

Development planning utilizes geologic maps to determine areas of suitable geologic and engineering character for many kinds of land use.

- Underlying rock units affect construction and stability of homes, commercial buildings, roads, dams, airports, and bridges. Erosion resistance varies dramatically by rock type, determined only through detailed geologic mapping.
- Design new transportation routes on sound bedrock with the fewest geologic hazards.
- Identify quality soils and farm land through geochemistry of decomposing rock.
- Predict well depths and water quality from local geologic knowledge.

Environmental Protection

The geology exposed at the earth's surface is a fundamental and critical component of all **ecosystems and watersheds**. Geologic knowledge is essential for resource conservation and protection, sustainable development issues, human health protection, and implementation of successful environmental regulatory programs. We use geologic mapping to:

✓ Identify areas of groundwater recharge and protect water from pollution and depletion.
✓ Determine whether hazardous chemicals are naturally occurring or human induced.
✓ Delineate ecosystems, critical wildlife habitats, and vegetation communities.

Predicting Effects of Climate Change

Alaska has been touted as the "barometer" for climate change, since the Arctic environment responds more quickly to warmer temperatures. Maps will help predict where to expect the **effects of warming**.

Shorelines – Determine future inundation due to accelerated erosion. In particular, Shishmaref is in imminent danger due to increased erosion from storms.

Permafrost areas – Interior Alaska's thawing permafrost is collapsing houses and destroying roads.

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Benefiting All Alaskans

Aside from the obvious scientific benefits for Alaska discussed above, geologic mapping brings **hidden benefits**, too.

- Alaskans are empowered by understanding Alaska's wonderful natural landscapes.
- Geologic mapping promotes public connection to natural surroundings and facilitates wise development choices.
- Local hire with on-the-job training, high school and University internships, support for student research, and money into local economies frequently accompany geologic mapping projects.

State of Alaska
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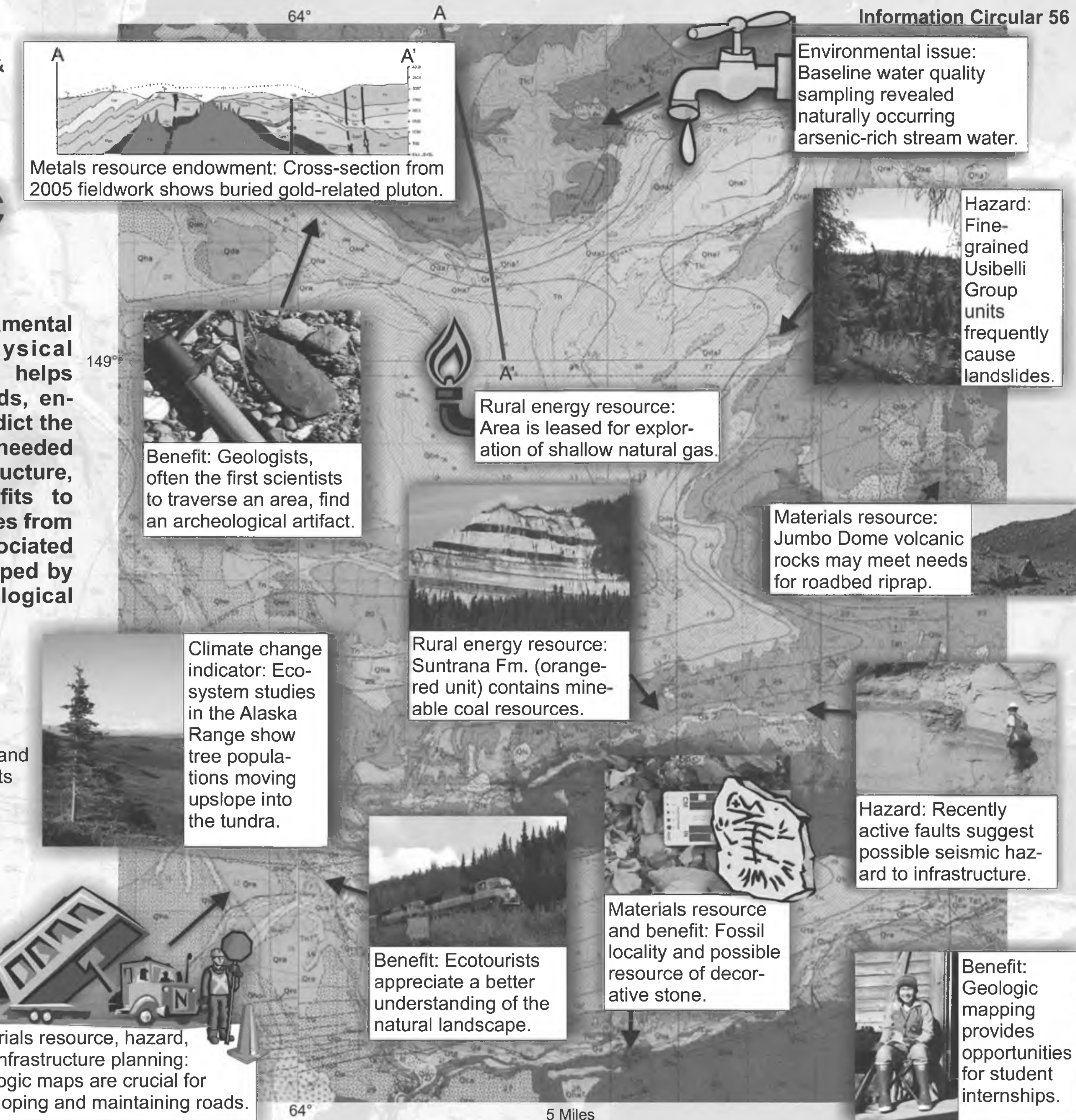
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Using Geologic Maps

Geologic maps provide fundamental information about the physical environment. This knowledge helps protect us from natural hazards, ensure a viable environment, predict the effects of climate change, find needed resources, plan new infrastructure, and provide additional benefits to Alaskans. Here are real examples from the Alaska Range foothills associated with the area geologically mapped by Clyde Wahrhaftig (U.S. Geological Survey) in 1970.

Geologic Units

- Quaternary sedimentary units
- Paleozoic Totatlanika and Healy schists
- Tertiary Nenana Gravel and Usibelli Group sedimentary rocks



Metals resource endowment: Cross-section from 2005 fieldwork shows buried gold-related pluton.

Environmental issue: Baseline water quality sampling revealed naturally occurring arsenic-rich stream water.

Hazard: Fine-grained Usibelli Group units frequently cause landslides.

Benefit: Geologists, often the first scientists to traverse an area, find an archeological artifact.

Rural energy resource: Area is leased for exploration of shallow natural gas.

Materials resource: Jumbo Dome volcanic rocks may meet needs for roadbed riprap.

Climate change indicator: Ecosystem studies in the Alaska Range show tree populations moving upslope into the tundra.

Rural energy resource: Suntrana Fm. (orange-red unit) contains mineable coal resources.

Hazard: Recently active faults suggest possible seismic hazard to infrastructure.

Materials resource and benefit: Fossil locality and possible resource of decorative stone.

Benefit: Ecotourists appreciate a better understanding of the natural landscape.

Materials resource, hazard, and infrastructure planning: Geologic maps are crucial for developing and maintaining roads.

Benefit: Geologic mapping provides opportunities for student internships.

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DGGS Minerals Resources Program:

A Brief Introduction and Proposed Study of Rare Earth Element Mineral Deposit Potential in Alaska

David Szumigala

Alaska Division of Geological & Geophysical Surveys

February 2, 2011

DGGS Minerals Program

The Alaska Division of Geological & Geophysical Surveys (DGGS) is tasked with determining the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material; and the potential geologic hazards to buildings, roads, bridges, and other installations and structures (AS 41.08.020). The Mineral Resources Section at DGGS collects, analyzes, and provides information on the geological and geophysical framework of Alaska as it pertains to the state's mineral resources.

As part of our mission of evaluating the mineral resources of Alaska, DGGS is proposing to study the potential of rare earth element mineralization in Alaska. This paper will provide a brief overview of rare earth elements, their uses, current worldwide sources of production, and the need to assess the potential of rare earth element resources in Alaska.

Introduction to Rare Earth Elements

Rare earth elements and the supply and demand of these resources have been major news items and the global mining industry has ramped up exploration for mineral deposits containing rare earth elements. This paper will provide a brief overview of rare earth elements, their uses, and the potential for these metals in Alaskan mineral deposits.

Rare earth elements (REEs) are a group of seventeen chemical elements that occur together in the periodic table (Figure 1). The group consists of yttrium (Y) and the 15 lanthanide elements (lanthanum (La), cerium (Ce), praseodymium (Pr), neodymium (Nd), promethium (Pm), samarium (Sm), europium (Eu), gadolinium (Gd), terbium (Tb), dysprosium (Dy), holmium (Ho), erbium (Er), thulium (Tm), ytterbium (Yb), and lutetium (Lu)). Scandium (Sc) is found in most rare earth element deposits and is sometimes classified as a rare earth element. The rare earth elements are all metals and the group is often referred to as the "rare earth metals". These metals have many similar properties and those properties often cause them to be found together in mineral deposits.

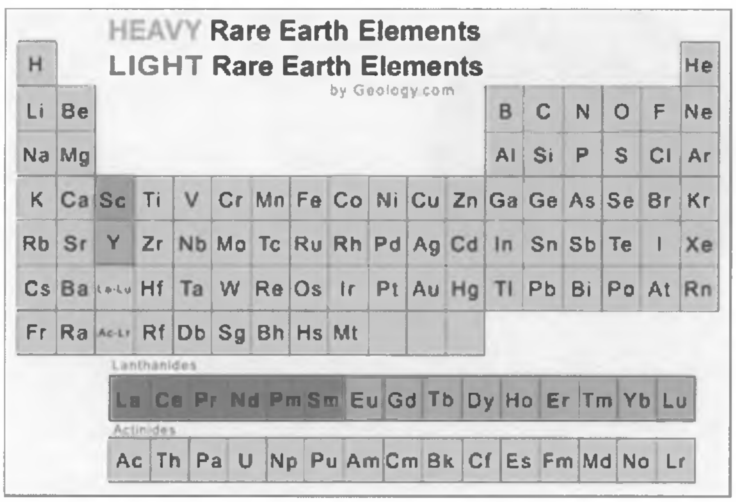

Figure 1. Periodic table with rare earth elements highlighted.

The rare earth elements are often informally subdivided into "Heavy Rare Earths" and "Light Rare Earths". Lanthanum, cerium, praseodymium, neodymium, promethium and samarium are generally referred to as the "light rare earths". Yttrium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium are generally considered the "heavy rare earths". Although yttrium is lighter than the light rare earth elements, it is included in the heavy rare earth group because of its chemical and physical associations with heavy rare earths in natural deposits.

Uses of Rare Earth Elements

Rare earth metals and alloys that contain them are used in many devices that people use every day such as: computer memory, DVD's, rechargeable batteries, cell phones, car catalytic converters, magnets, fluorescent lighting and much more. The table below lists the major categories of REE usage in the United States.

During the past twenty years there has been an explosion in demand for many items that require rare earth metals. Twenty years ago there were very few cell phones in use but the number has risen to over 5 billion in use today. The usage of computers and DVDs has grown almost as fast as cell phones.

United States REE Usage (2009 data, USGS Mineral Commodity Summaries for Rare Earths)

Use	Percent
Chemical Catalysts	22
Metallurgy & alloys	21
Petroleum refining	14
Catalytic converters	13
Glass polishing and ceramics	9
Phosphors for monitors, television, lighting	8
Permanent magnets	7
Electronics	3
Other	3

Many rechargeable batteries are made with rare earth compounds. Demand for the batteries is being driven by demand for portable electronic devices such as cell phones, readers, computers and cameras.

Several pounds of rare earth compounds are in batteries that power electric vehicles and hybrid-electric vehicles. As concerns for energy independence, climate change and other issues drive the sale of electric vehicles the demand for batteries made with rare earth compounds will climb even faster.

Rare earths are used as catalysts, phosphors and polishing compounds. These are used for air pollution control, illuminated screens on electronic devices and optical-quality glass. All of these products are expected to experience rising demand.

Other substances can be substituted for rare earth elements in their most important uses; however, these substitutes are usually much less effective and have a higher cost.

Critical Defense Uses of Rare Earth Elements

Rare earth elements play an essential role in modern national defense. Night-vision goggles, precision-guided weapons and other defense technology rely on various rare earth metals. Rare earth metals are key ingredients for making the very hard alloys used to make armored vehicles and projectiles that shatter upon impact in thousands of sharp fragments. Substitutes can be used for rare earth elements in some defense applications, however, those substitutes are not as effective and that will diminish military superiority. Several uses of rare earth elements are summarized in the table below.

Department of Defense Uses of Rare Earth Elements	
Element	Use
Lanthanum	Night-vision goggles
Neodymium	Laser range-finders, guidance systems, communications
Europium	Fluorescents and phosphors in lamps and monitors
Erbium	Amplifiers in fiber-optic data transmission
Samarium	Permanent magnets stable at high temperatures
Samarium	Precision-guided weapons
Samarium	"White noise" production in stealth technology

In 2010, the U.S. Government Accountability Office GAO) assessed the likelihood of national security risks arising from the U.S.'s nearly 100 percent dependency on non-domestic sources (primarily China) for REEs, which recently cut its exports by 72 percent. The GAO report concluded U.S. defense systems will likely continue to depend heavily upon REEs, on the basis of current technology and system designs utilizing REEs, and a lack of effective non-REE substitutes. The lack of a domestic REE supply chain presents national security concerns for the U.S., and diminishes its ability to be a world-technology leader. It is essential for the U.S. to identify domestic sources for REEs in order to reduce the nation's vulnerability to disruptions in global supply.

Are These Elements Really "Rare"?

Rare earth elements are not as "rare" as their name implies. Thulium and lutetium are the two least abundant rare earth elements - but they each have an average crustal abundance that is nearly 200 times greater than the crustal abundance of gold (Haxel et al., 2005). Figure 2 shows the relative abundance of rare earth elements to rock-forming, industrial, and precious metal elements. However, these metals are very difficult to mine because it is unusual to find them in concentrations high enough for economical extraction.

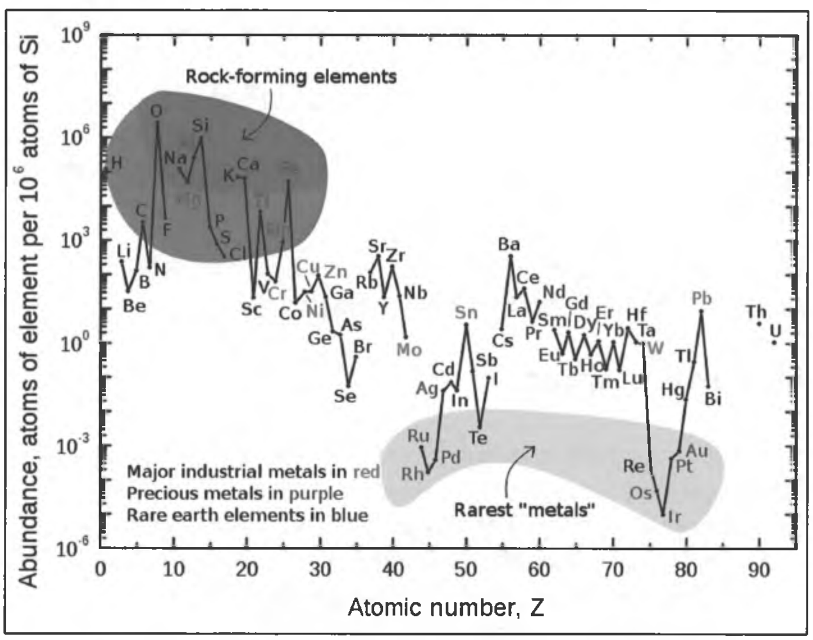

Figure 2. Abundance of elements in the earth's crust per million of Si atoms (USGS).

The most abundant rare earth elements are cerium, yttrium, lanthanum and neodymium (2). They have average crustal abundances that are similar to commonly used industrial metals such as chromium, nickel, zinc, molybdenum, tin, tungsten and lead (1). Again, they are rarely found in extractable concentrations.

The principal sources of rare earth elements are the minerals bastnäsite, monazite, and loparite and the lateritic ion-adsorption clays. Despite their high relative abundance, rare earth minerals are more difficult to mine and extract than equivalent sources of transition metals (due in part to their similar chemical properties), making the rare earth elements relatively expensive. Their industrial use was very limited until efficient separation techniques were developed, such as ion exchange, fractional crystallization and liquid-liquid extraction during the late 1950s and early 1960s.

Rare Earth Element Production

Significant amounts of rare earth elements are produced in only a few countries. China is currently the dominant producer of rare earth elements and is believed to be responsible for over 95% of the world mine production on a rare earth oxide equivalent basis (Haxel et al., 2005). Other countries with notable production in 2009 were: Brazil, India, Kyrgyzstan and Malaysia (USGS, 2011). Minor production may have occurred in Indonesia, Commonwealth of Independent States, Nigeria, North Korea and Vietnam (USGS, 2011).

China became the world's dominant producer of rare earth elements in the early 1990s, when production at the Mountain Pass mine in California began to decline (Figure 3). China's dominance increased rapidly and in 2000 China accounted for about 90% of world rare earth production. China sold rare earths at such low prices that the Mountain Pass mine and others throughout the world were unable to compete.

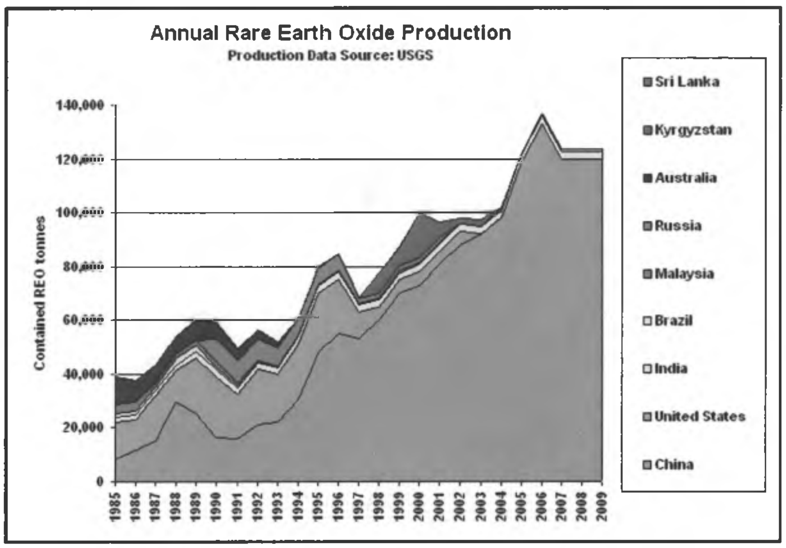

Figure 3. Worldwide production of rare earth oxides from 1987 to 2009 (USGS Minerals Yearbooks).

In early 2010 China accounted for over 95% of the world's rare earth production. China is also the dominant consumer of rare earth elements, used mainly in manufacturing electronics products for domestic and export markets. Japan and the United States are the second and third largest consumers of rare earth materials. The rare-earth separation plant at Mountain Pass, CA, resumed operation in 2007 and continued to operate throughout 2010 by processing previously mined rare-earth concentrates.

In 2010 China announced that they would significantly restrict their rare earth exports to ensure a supply for domestic manufacturing. This announcement triggered some panic buying and rare earth prices shot up to record high levels.

China's future export policies are unpredictable, but they are expected to favor China's domestic interests, needs, and economic development. Additionally, the total expected production of REEs in China is expected to be insufficient for worldwide demand.

World Rare Earth Mineral Resources

Rare earth elements are relatively abundant in the Earth's crust, but discovered minable concentrations are less common than for most other ores. U.S. and world resources are contained primarily in bastnäsite and monazite. Figure 4 shows the location of some of the most important REE occurrences and deposits. Bastnäsite deposits in China and the United States constitute the largest percentage of the world's rare-earth economic resources, while monazite deposits in Australia, Brazil, China, India, Malaysia, South Africa, Sri Lanka, Thailand, and the United States constitute the second largest segment. Apatite, cheralite, eudialyte, loparite, phosphorites, rare-earth-bearing (ion adsorption) clays, secondary monazite, spent uranium solutions, and xenotime make up most of the remaining resources. Undiscovered resources are thought to be very large relative to expected demand (U.S. Geological Survey, 2011).

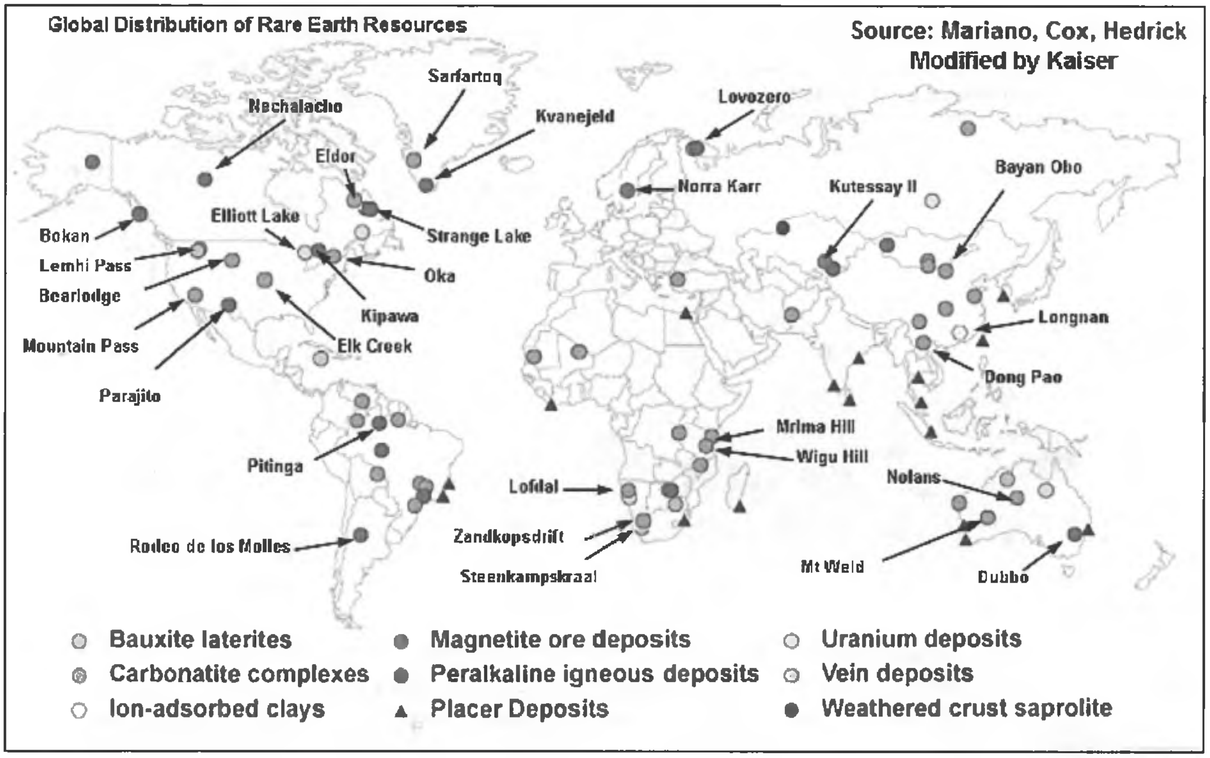

Figure 4. Global distribution of known rare earth element resources. Figure from Mariano et al., 2010, modified by Kaiser Research Online (http://www.kaiserbottomfish.com/s/Education.asp?ReportID=362761).

Exploration efforts to develop rare earth element projects surged in 2010, and investment and interest increased dramatically. Economic assessments continued in North America at Bear Lodge in Wyoming; Diamond Creek in Idaho; Elk Creek in Nebraska; Hoidas Lake in Saskatchewan, Canada; Lemhi Pass in Idaho-Montana; and Nechalacho (Thor Lake) in Northwest Territories, Canada. Other economic assessments took place in other locations around the world, including Dubbo Zirconia in New South Wales, Australia; Kangankunde in Malawi; Mount Weld in Western Australia, Australia; and Nolans Project in Northern Territory, Australia.

Assessing Alaska's Rare Earth Element Potential

Mineral resources comprise a major part of Alaska's economic assets. Alaska is considered highly prospective with regards to strategic and critical minerals needed for domestic uses. Figure 5 shows a table of mineral commodities currently imported into the United States. Alaska produces some of these minerals, has produced some of these minerals in the past, and has the potential to produce some quantity of most of these imported mineral commodities in the future. The location and magnitude of these resources are largely unknown, yet that knowledge is key to orderly development of the State and maintenance of a stable economy. The State of Alaska cannot efficiently manage or develop assets that are unknown and not quantified. The benefits of a thorough mineral-resource information base include: 1) Enhancing community and local government economies and revenue opportunities; 2) Stimulating private-sector exploration and competitive development of Alaska's mineral resources; 3) Developing transportation corridors and infrastructures, which always requires cost justification based on prior knowledge of resources; and 4) Developing long-term decisions on management of state-interest lands.

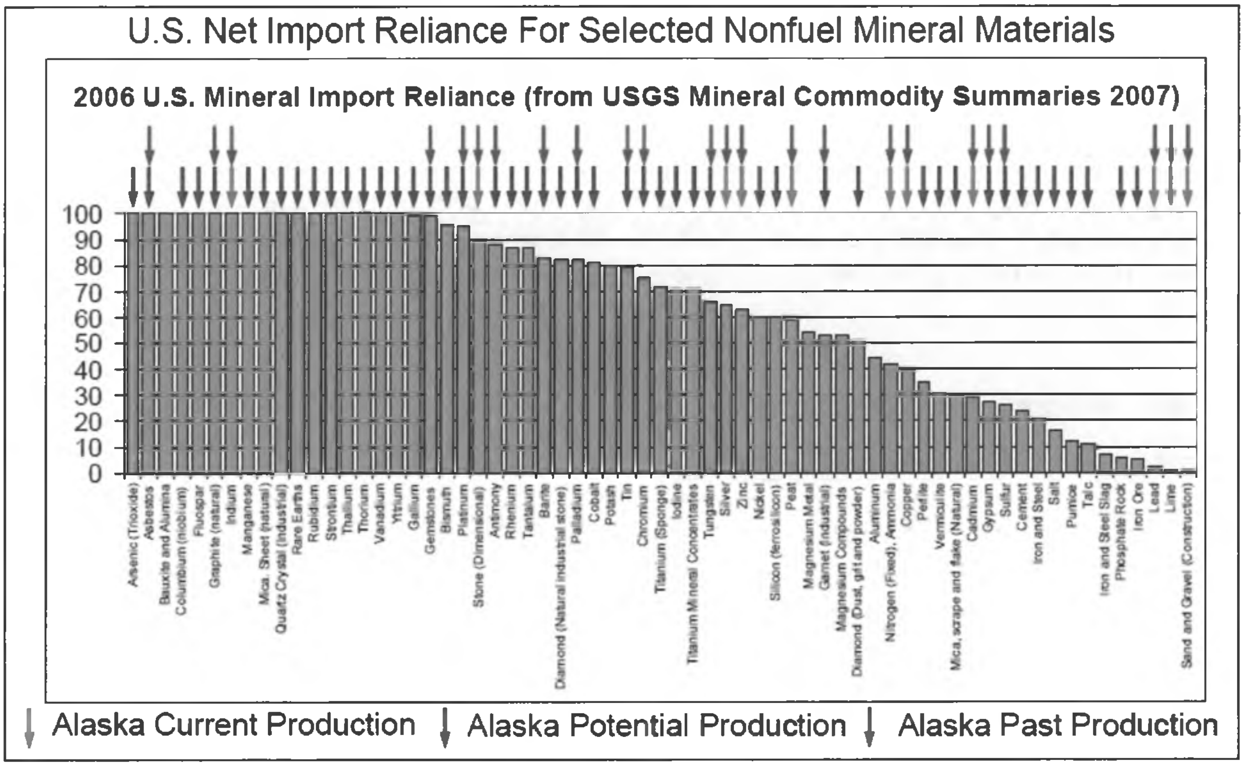

Figure 5. The United States relies on imports of critical minerals to satisfy current needs. Alaska has the potential to produce many of these minerals and materials. Alaska currently and historically has produced 24 of the 65 shown in this figure.

The Alaska Division of Geological & Geophysical Surveys (DGGS) proposed a 3-year project to provide information critical for assessing Alaska's Rare Earth Element (REE) and Strategic Minerals potential. Many areas of Alaska are geologically permissible for hosting REEs, but the lack of basic data statewide hinders evaluation of Alaska's REE potential. The most significant REE prospect in Alaska is the Bokan Mountain property, located 37 miles southwest of Ketchikan. Preliminary assessments suggest the area contains one of the largest REE deposits in North America, with significant enrichments in heavy REEs. Alaska has more than 70 additional known mineral occurrences (attached map) and millions of acres of selected or conveyed lands with the potential to contain REEs, but the mineral-resource potential of these occurrences and lands is poorly understood. There has been no systematic resource evaluation for REEs in Alaska by state government and the only known mineral industry exploration solely devoted to REEs is currently being conducted at Bokan Mountain.. The DGGS Rare Earth Element Assessment and Strategic Minerals project is specifically designed to address this data and knowledge gap.

In 2010, U.S. House and Senate bills were introduced to encourage reestablishment of domestic REE industries. The DGGS Rare Earth Element and Strategic Minerals Assessment project is in line with the Alaska Legislature's recent House Resolution (HR16) urging Congress to advance development of new REE reserves in the U.S., and continued exploration for REE deposits in Alaska. By assessing Alaska's potential for REEs, the State of Alaska will benefit from expanded mineral-industry investment in exploration and development and associated employment, better understand the natural resources of its lands for land-management purposes, and contribute to the nation's need for domestic supplies of these critically important elements. Information resulting from this REE assessment will be an important resource to help Alaska for many years into the future.

This three-year project will determine the potential of state lands for hosting REE mineral deposits by conducting geologic field work throughout Alaska, obtaining appropriate supporting analytical data, evaluating currently available and newly collected data, determining Alaska-specific REE mineral-deposit models, and publishing the results of our studies.

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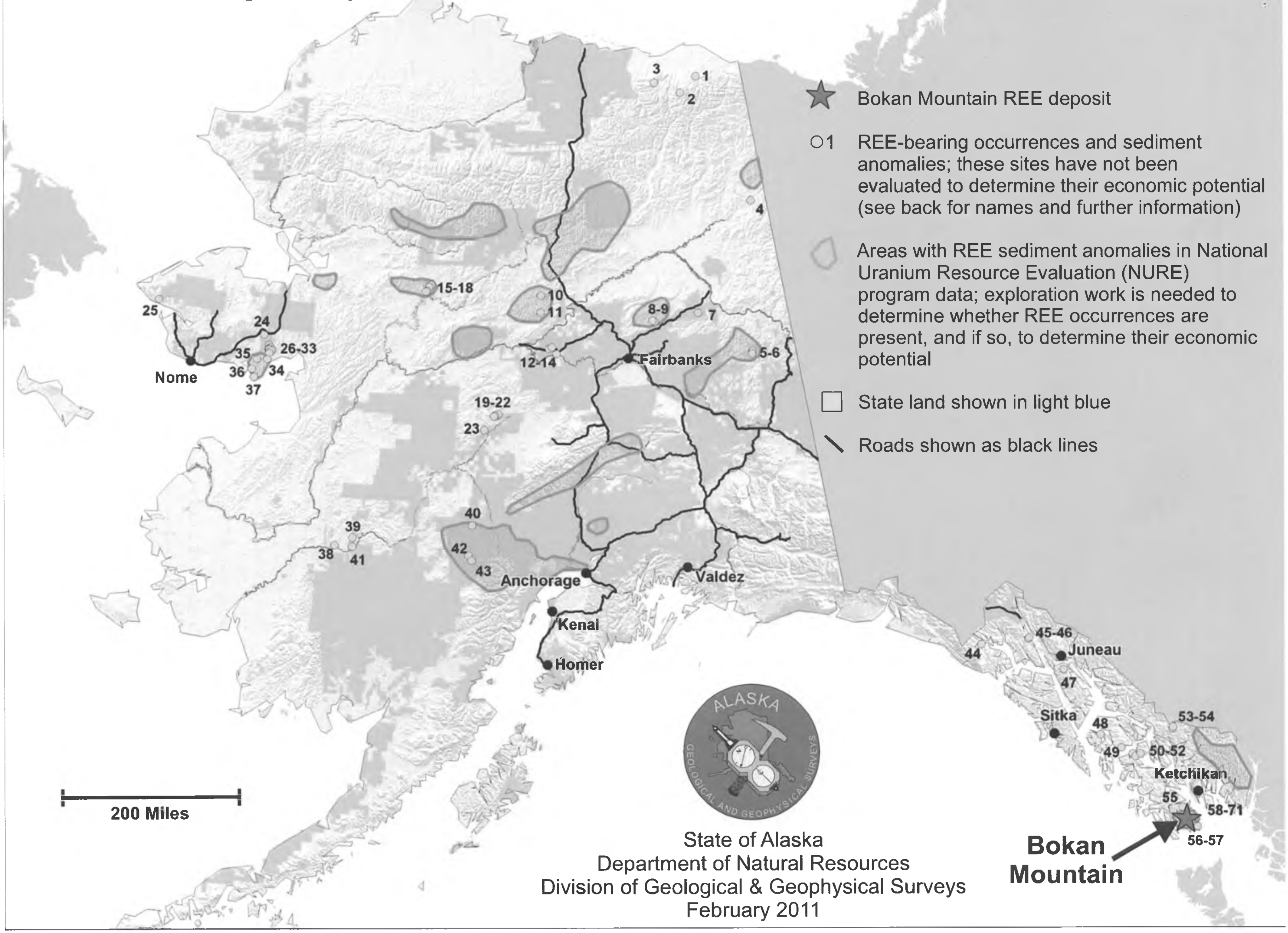
http://geology.com/articles/rare-earth-elements/

Haxel, Gordon B., Hedrick, James B., and Orris, Greta J., 2005, Rare Earth Elements – critical resources for high technology: U.S. Geological Survey Fact Sheet 087-02, 4 p.

Mariano, Anthony, Cox, Clint and Hedrick, James, Economic Evaluation of REE and Y Mineral Deposits: presentation at the 2010 Annual Meeting of the Society for Mining, Metallurgy & Exploration [SME], Phoenix, Arizona, available at http://www.smenet.org/rareEarthsProject/SME_2010_Mariano.pdf, 33p.

U.S. Geological Survey, 2011, Rare earths, Mineral Commodity Summaries, 2p.

ALASKA'S RARE EARTH ELEMENT POTENTIAL



State of Alaska
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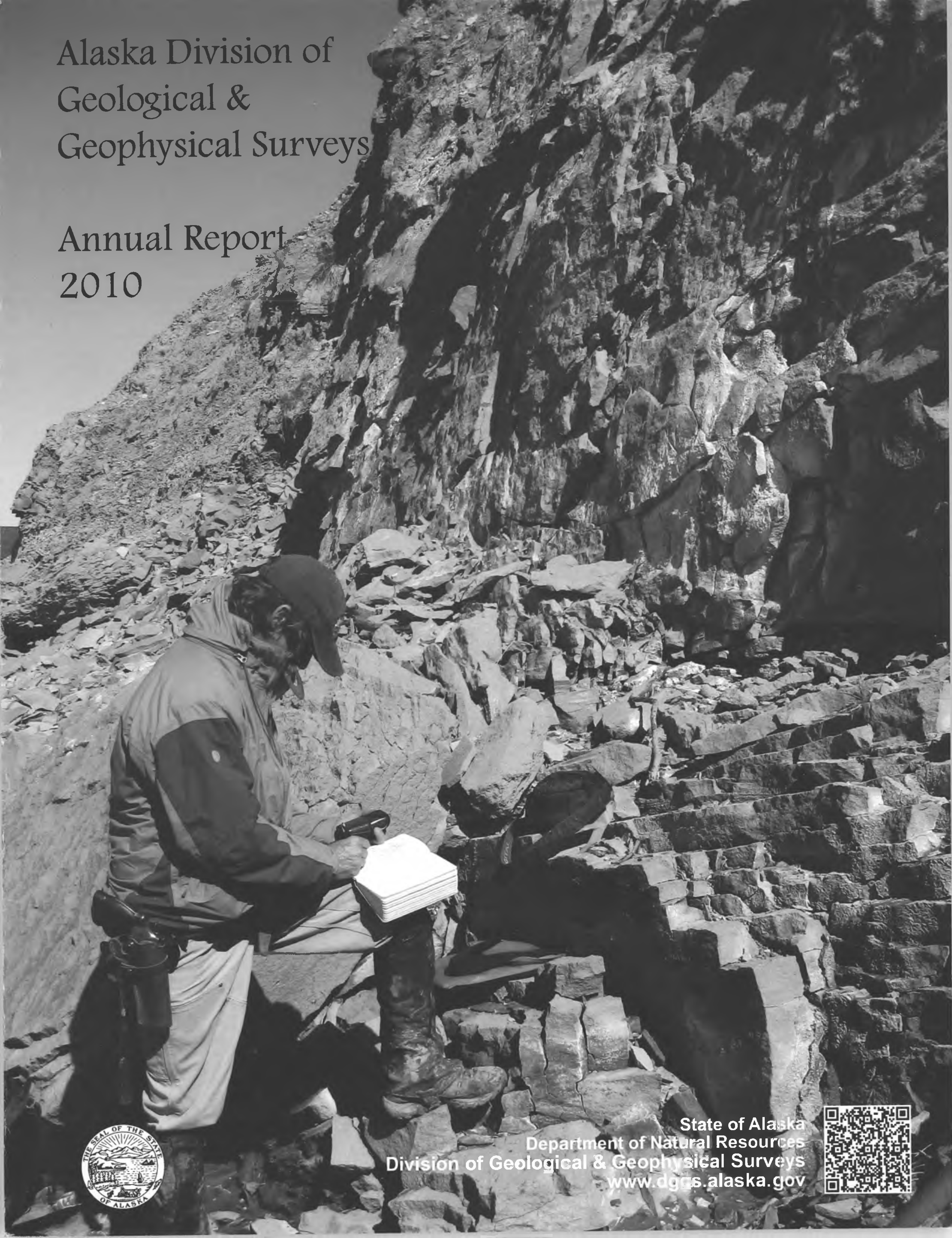
February 2011

Map No.	ARDF No.	Historical site name(s)	Elements (minor elements)
1	DP003	Aichilik River	Y, Yb, REE
2	ML015	Okpilak River	Mo, U (F, possibly REE)
3	ML013	Fire Creek	P (REE)
4	CO027	Unnamed	Pb, REE
5	EA037	Unnamed (on Slate Creek)	REE, Th
6	EA039	Ruby Creek	REE, Th
7	CI027	Hot Springs Creek	U?, REE, Th?, W
8	CI078	Unnamed (near head of Hope Creek)	F (Cu, Mo, Pb, REE?, Sb, W, Zn)
9	CI051	Roy Creek; Little Champion Creek	U (REE)
10	BT018	Unnamed (southeast of Sithylemenkat Lake)	Sn (As, Bi, Cs, Cu, Nb, Pb, Rb, REE, Ta, W)
11	TN009	Unnamed (Spooky Valley)	Ag, Pb, Zn (Bi, La, Mo, Sn, U, W)
12	TN083	Unnamed (upper Idaho Gulch)	Ce, Nb (Ag, REE, U)
13	TN099	Tofty Ridge	Ce, Nb, Y (Ag, REE, U)
14	TN115	Karshner Creek	REE
15	HU008	Boston Ridge	REE, Th, U
16	HU011	Unnamed (northeast ridge of Caribou Mountain)	REE, Th, U
17	HU016	Unnamed (in Zane Hills, south of upper Caribou Creek)	REE, Th, U
18	SH010	Unnamed (northeast of Solsmunket Lake)	W (REE, Th, U)
19	MD003	Unnamed	Th, U (REE)
20	MD002	Unnamed	Th, U (Ce, REE)
21	MD004	Unnamed	Nb, Th, U (Ce, REE, W)
22	MD005	Unnamed	Th, U (Ce, Rb)
23	MD012	Unnamed	Zn (Ce, Rb)
24	BN094	Windy Creek	Mo, Pb, Zn (Ag, Ba, La, Sn)
25	TE042	Unnamed (on Tin Creek, tributary to Lost River)	Be, Sn, F
26	SO044	Unnamed (on Rock Creek)	REE, U
27	SO043	Unnamed (tributary to Vulcan Creek)	REE, U
28	SO042	Unnamed (tributary to Clear Creek)	REE, U
29	SO040	Unnamed (tributary to Clear Creek)	REE, U
30	SO041	Unnamed (tributary to Clear Creek)	REE, U
31	SO039	Unnamed (tributary to Clear Creek)	REE, U
32	SO038	Unnamed (tributary to Clear Creek)	REE, Sn, U, W
33	SO037	Clear Creek	REE, U
34	SO036	Kwiniuk River	Cu, REE, W
35	SO159	Unnamed (east of Eagle Creek)	REE, Th, U
36	SO003	Golovnin Bay	REE, U, W
37	SO001	Cape Darby	REE, U, W
38	RM020	Unnamed (southern Russian Mountains)	Sb (Nd, Ta, U)
39	SM005	Unnamed (northeast of head of Getmuna Creek)	Ce, Hg, Nb, Zn (Au, Cr, Cu)
40	MG036	Eudialyte	REE, Zr (Th, U)
41	SM037	Unnamed (northeast of lower Sue Creek)	Ce, La, Sm, Th, U, W, Zr (Au, Cu, Hg, Pb)
42	LH006	Unnamed (near Swift River)	REE
43	LH007	Unnamed (near Swift River)	REE
44	MF026	Monarch No. 1 and No. 2	Au (Ag, Pb, REE)
45	JU060	William Henry	Cu, Pb, REE, Zn (Au)
46	JU057	Lucky Six; William Henry	Cu, Pb, REE, Th, U, Zn
47	JU254	Unnamed (near Salmon River)	REE (Y, Zr, Nb, Th, La, Ce, Pr, Nd)
48	PE001	Unnamed (near mouth of Port Camden)	Th, U (Ce, La)
49	PE021	Unnamed (near Totem Bay)	Th, U (Ce, La, Nd)
50	PE056	Unnamed (near Salmon Bay)	REE, Th, U (Mo)
51	PE055	Paystreak Vein; Marker Vein	U, Th, REE (Mo)
52	PE060	Unnamed (along Snow Passage)	F (Au, Ba, Ce, La)
53	BC004	Unnamed (near Cone Mountain)	U? (Ce, La, Mo, Nd, Th)
54	BC090	Unnamed (near Black Crag)	Ag, Au, Cu, Mo, Zn (Ce, La, Nd, Sm, Th, U)
55	CR172	Unnamed (at head of Dora Bay)	Nb, REE, Y
56	DE042	Unnamed (near Mallard Bay)	Au, Ce, Cu, La, U (Y, Zr)
57	DE043	Unnamed (north shore, Stone Rock Bay)	Au, Ce, Cu, La, U (Y, Zr)
		BOKAN MOUNTAIN PROPERTY (named sites listed below)	
58	DE020	Little Jim; Little Joe No. 1, Little Joe No. 2	(Nb, REE, Th, Ti, U, Zr)
59	DE030	Shore	Be, Nb, REE, Th, Ti, U, Y, Zn, Zr
60	DE028	Upper Cheri	Be, Nb, REE, Th, U, Y, Zr
61	DE029	Cheri; Cheri No. 1	Be, Nb, REE, Th, U, Y, Zr
62	DE031	Geoduck	Be, Nb, REE, Th, U, Y, Zr
63	DE015	Geiger	Nb, REE, Ta, Th, U, Y, Zr (F, Ge, Pb, Zn)
64	DE019	Wennie (Lazo Group); I and L No. 1 and 2	Nb, REE, Th, U
65	DE017	Sunday Lake	Nb, REE, Th, U, Y, Zr
66	DE027	Carol Ann; Carol Ann No. 1; Carol Ann No. 2; Carol Ann No 3; Dotson	Nb, REE, Th, U, Y
67	DE021	I,L, and M; ILM; I, L, and M Nos. 1-3	Nb, REE, Th, Y, U, Zr
68	DE022	Irene-D	Nb, REE, U, Y, Zr
69	DE023	I and L; I and L Nos. 3-5	Nb, Th, U (Ce, Dy, Er, F, Gd, Ho, La, Nd, Pb, Y, Yb, Zn, Zr)
70	DE016	Boots	REE, Th, U
71	DE025	Historic Ross-Adams mine	U (REE, Th)

Sources: modified from http://ardf.wr.usgs.gov/; NURE sediment data from http://pubs.usgs.gov/of/1997/ofr-97-0492/state/nure_ak.htm

Alaska Division of Geological & Geophysical Surveys

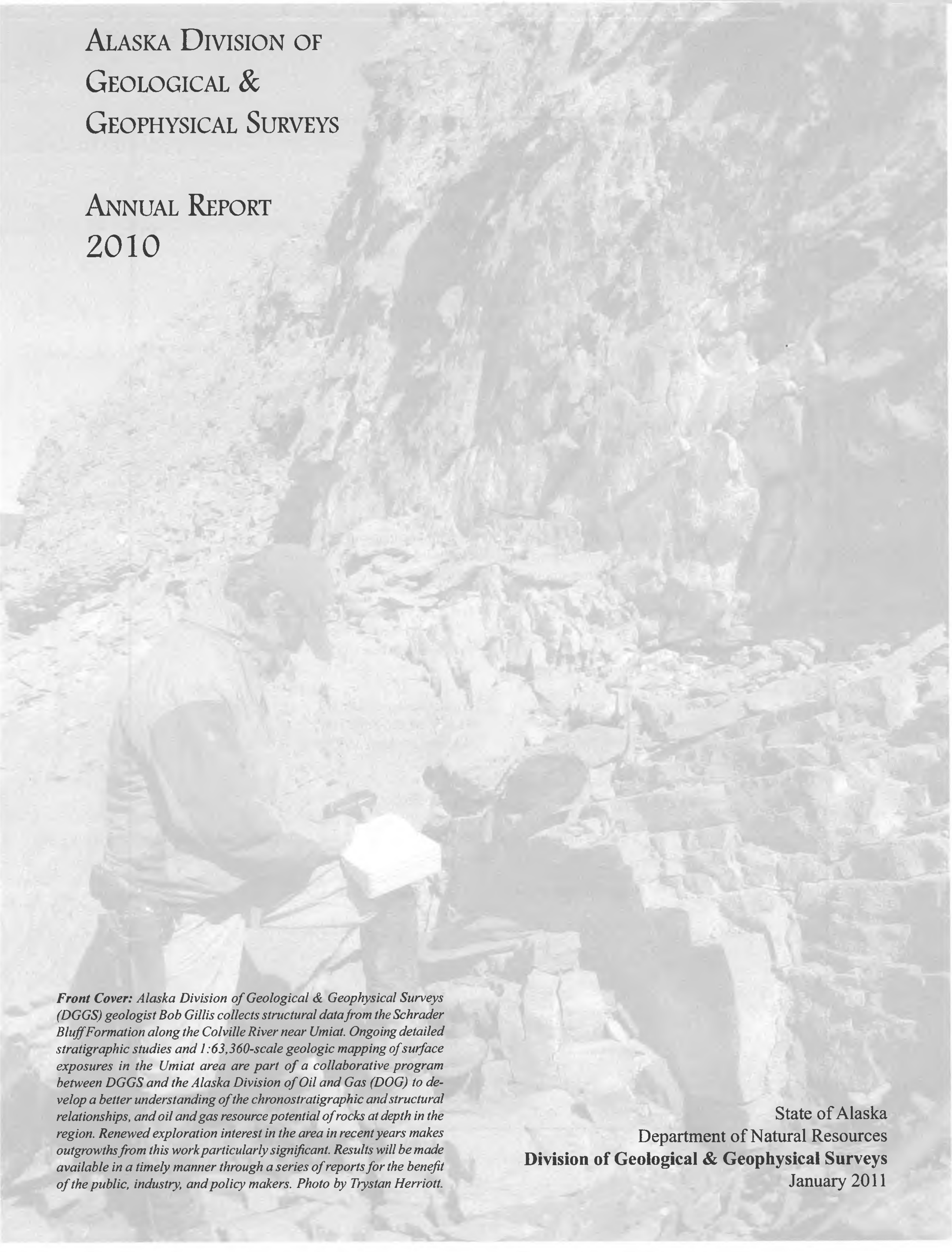
Annual Report 2010



State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys
www.dggs.alaska.gov

Alaska Division of Geological & Geophysical Surveys

Annual Report 2010



Front Cover: *Alaska Division of Geological & Geophysical Surveys (DGGS) geologist Bob Gillis collects structural data from the Schrader Bluff Formation along the Colville River near Umiat. Ongoing detailed stratigraphic studies and 1:63,360-scale geologic mapping of surface exposures in the Umiat area are part of a collaborative program between DGGS and the Alaska Division of Oil and Gas (DOG) to develop a better understanding of the chronostratigraphic and structural relationships, and oil and gas resource potential of rocks at depth in the region. Renewed exploration interest in the area in recent years makes outgrowths from this work particularly significant. Results will be made available in a timely manner through a series of reports for the benefit of the public, industry, and policy makers. Photo by Trystan Herriott.*

State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys
January 2011

STATE OF ALASKA
Sean Parnell, *Governor*

DEPARTMENT OF NATURAL RESOURCES
Daniel S. Sullivan, *Commissioner*

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
Robert F. Swenson, *State Geologist and Director*

Division of Geological & Geophysical Surveys publications can be inspected on the web at http://www.dggs.alaska.gov/ or at the following locations. Address mail orders to the Fairbanks office.

Alaska Division of Geological
& Geophysical Surveys
3354 College Road
Fairbanks, Alaska 99709-3707

University of Alaska Anchorage Library
3211 Providence Drive
Anchorage, Alaska 99508

Elmer E. Rasmuson Library
University of Alaska Fairbanks
Fairbanks, Alaska 99775-1005

Alaska Resource Library
3150 C Street, Suite 100
Anchorage, Alaska 99503

Alaska State Library
State Office Building, 8th Floor
333 Willoughby Avenue
Juneau, Alaska 99811-0571

Publication of this report is required by Alaska Statute 41.08.

Contents

FIGURE

Division of Geological & Geophysical Surveys
ANNUAL REPORT 2010

INTRODUCTION

MISSION STATEMENTS
DEPARTMENT OF NATURAL RESOURCES

Mission: Develop, conserve, and enhance natural resources for present and future Alaskans

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Mission: Determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material; and the potential geologic hazards to buildings, roads, bridges, and other installations and structures (AS 41.08.020)

HISTORY

The present Division of Geological & Geophysical Surveys (DGGS) evolved from Alaska's Territorial Department of Mines. That heritage is reflected in the Division's ongoing commitment to the application of geology to improve the welfare of Alaska citizens. The current name and mission of the Division were established in 1972 with the passage of Alaska Statute AS 41.08.

Territorial Department of Mines, 1959
Division of Mines and Minerals, 1959–1966
Division of Mines and Geology, 1966–1970
Division of Geological Survey, 1970–1972
Division of Geological & Geophysical Surveys, 1972–Present

LEADERSHIP

Ten qualified professional geoscientists have served as State Geologist:
Jim Williams, 1959–1971
William Fackler, 1971–1973
Donald Hartman, 1973–1975
Ross G. Schaff, 1975–1986
Robert B. Forbes, 1987–1990
Thomas E. Smith, 1991–1995
Milton A. Wiltse, 1995–2002
Rodney A. Combellick, 2003–January 2005
Mark D. Myers, February–October 2005
Robert F. Swenson, November 2005–present

By statute the State Geologist serves as the Director of the Division of Geological & Geophysical Surveys in the Department of Natural Resources (DNR) and is appointed by the DNR Commissioner. Since the early 1970s, the State Geologists have been selected from lists of candidates prepared by the geologic community and professional societies within Alaska. A department order in 2002 formalized a process whereby the Geologic Mapping Advisory Board oversees evaluation of candidates and provides a list to the Commissioner. The qualifications and responsibilities of the State Geologist and the mission of DGGS are defined by statute.

STATUTORY AUTHORITY

Alaska Statutes Sec. 41.08.010. Division of geological and geophysical surveys. There is established in the Department of Natural Resources a Division of geological and geophysical surveys under the direction of the state geologist. (1 ch 93 SLA 1972)

Sec. 41.08.015. State geologist. The commissioner of natural resources shall appoint the state geologist, who must be qualified by education and experience to direct the activities of the Division. (1 ch 93 SLA 1972)

Sec. 41.08.020. Powers and duties. (a) The state geologist shall conduct geological and geophysical surveys to determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources; the locations and supplies of groundwater and construction materials; the potential geologic hazards to buildings, roads, bridges and other installations and structures; and shall conduct such other surveys and investigations as will advance knowledge of the geology of Alaska. With the approval of the commissioner, the state geologist may acquire, by gift or purchase, geological and geophysical reports, surveys and similar information.

Sec. 41.08.030. Printing and distribution of reports. The state geologist shall print and publish an annual report and such other special and topical reports and maps as may be desirable for the benefit of the State, including the printing or reprinting of reports and maps made by other persons or agencies, where authorization to do so is obtained. Reports and maps may be sold and all money received from these sales shall be paid into the general fund. (1 ch 93 SLA 1972)

LOCATION

The Division's administrative headquarters and personnel moved from Anchorage to Fairbanks in 1987. The close proximity of the Division to the earth science research laboratories of the University of Alaska Fairbanks campus has a strategic benefit to the DGGS program. University faculty and students are important adjunct members of many DGGS project teams.

Current DGGS staff totals 38 permanent full-time professional and support personnel, a Director, Division Operations Manager, and six student interns.

ORGANIZATION

DGGS is one of eight divisions and five offices in the Alaska Department of Natural Resources. Under the overall administration of the Director's Office, the Division of Geological & Geophysical Surveys is organized into five sections and the Geologic Materials Center (fig. 1). The Division also administers the 11-member Alaska Seismic Hazards Safety Commission.

Division of Geological & Geophysical Surveys offices in Fairbanks

Geologic Materials Center in Eagle River

Back L to R: Rod Combellick, Bob Swenson
Front L to R: April Woolery, Vickie Butherus, Rhea Supplee

The **Director's Office** provides strategic planning for the Division's programs to ensure that DGGS is meeting the needs of the public under the guidelines of AS 41.08.020, manages the Division's fiscal affairs, and provides personnel and clerical services. The Director acts as a liaison between the Division and local, state, federal, and private agencies; seeks out and encourages cooperative geologic programs of value to the state; and advises the Commissioner of the Department of Natural Resources about geologic issues.

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
CURRENT ORGANIZATIONAL CHART

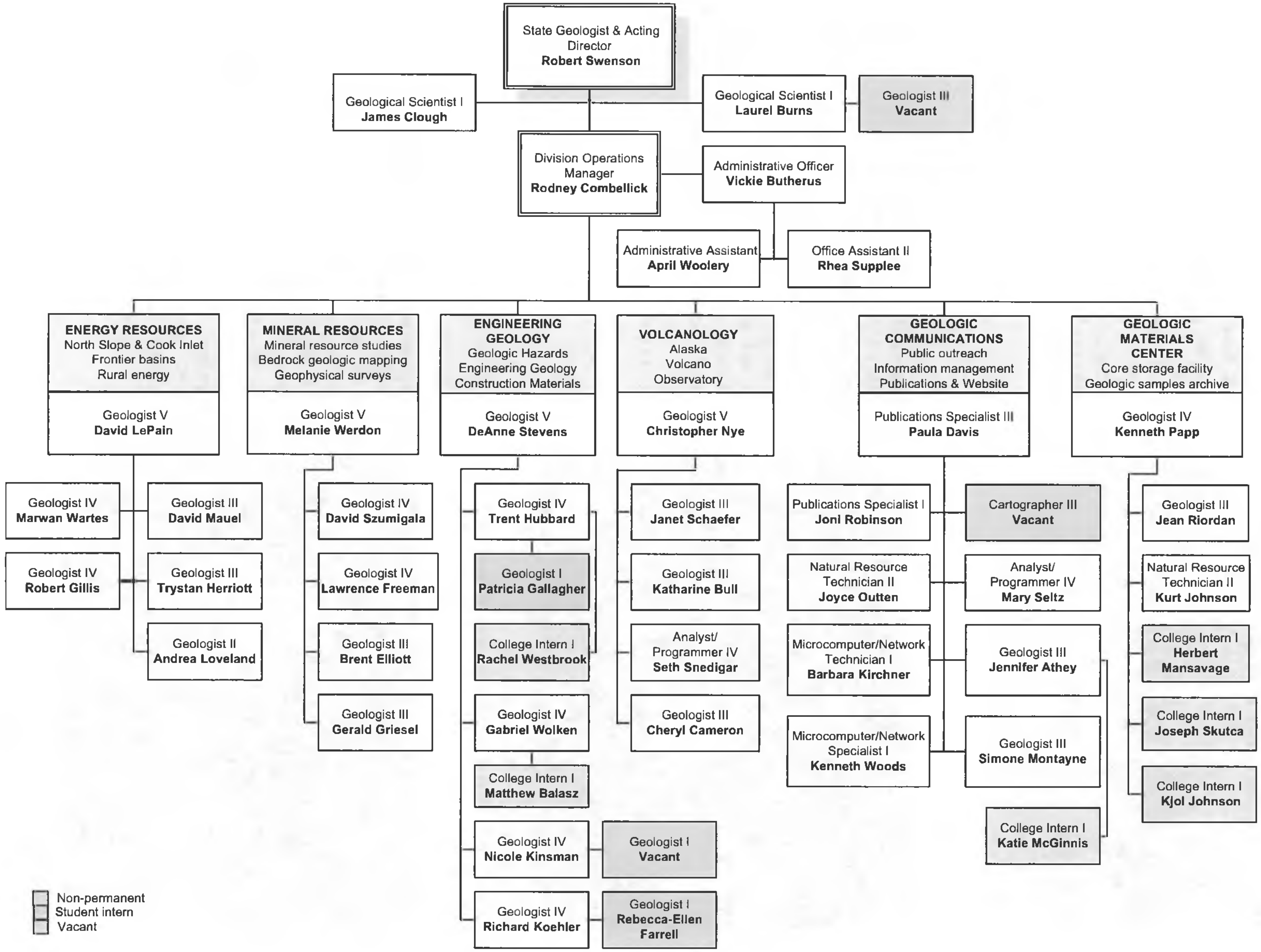


Figure 1. *Organizational chart for the Alaska Division of Geological & Geophysical Surveys.*

L to R: Trystan Herriott, Andrea Loveland, Bob Gillis, Dave Maule, Marwan Wartes, Jim Clough, Dave LePain

The **Energy Resources Section** generates new information about the geologic framework of frontier areas that may host undiscovered oil, gas, coal, or geothermal resources. Summary maps and reports illustrate the geology of the state's prospective energy basins and provide data relating to the location, type, and potential of the state's energy resources. The Energy Resources Section seeks to improve the success of state-revenue-generating commercial oil and gas exploration and development and to identify local sources of energy for rural Alaska villages and enterprises.

Back L to R: Gerry Griesel, Brent Elliott, Larry Freeman
Front L to R: Dave Szumigala, Melanie Werdon, Laurel Burns

The **Mineral Resources Section** collects, analyzes, and makes available information on the geological and geophysical framework of Alaska as it pertains to the mineral resources of the state. Summary maps and reports illustrate the geology of the state's prospective mineral terranes and provide data on the location, type, and potential of the state's mineral resources. These data aid in the state's management of mineral development, and help to encourage mineral exploration in Alaska, which provides employment opportunities and revenue for Alaska's citizens.

Back L to R: Trent Hubbard, Gabriel Wolken, Richard Koehler, Nicole Kinsman Matthew Balasz
Front L to R: Rebecca-Ellen Farrell, Trish Gallagher, De Anne Stevens

The **Engineering Geology Section** collects, analyzes, and compiles geologic data useful for engineering and hazard risk-mitigation purposes. Surficial-geologic maps portray the distribution of unconsolidated surficial-geologic materials and provide information on their engineering properties and potential as sources of construction materials and placer minerals. Studies of major geologic hazards such as earthquakes, active faults, and tsunamis result in reports outlining potential hazards in susceptible areas. The section advises other DNR divisions and state agencies regarding potential hazard risks to proposed developments and land disposals.

The **Volcanology Section,** established in 2007, focuses on processes and hazards associated with the more than 50 active volcanoes in Alaska. The section is home for the DGGS participants in the Alaska Volcano Observatory (AVO), an interagency collaboration between the U.S. Geological Survey, University of Alaska Fairbanks Geophysical Institute, and DGGS. Volcanology Section staff conduct geologic studies of active volcanoes to estimate their future eruptive potential and behavior, thus aiding in mitigating volcano-hazard risks. Results of these studies are released as maps and reports. The section also creates and maintains a very large, public, web-accessible database of information on volcano history and current activity (www.avo.alaska.edu), as well as an internal website providing communication, record keeping, and data sharing within AVO. In 2008 the section became heavily involved in geothermal resource issues, providing information to other agencies and the private sector and participating in state activities leading up to the geothermal lease sale at Mt. Spurr and providing technical reviews of proposals to the Renewable Energy Fund established by HB152 in 2008.

Back L to R: Chris Nye, Janet Schaefer, Seth Snedigar
Front L to R: Kate Bull, Cheryl Cameron

The **Geologic Communications Section** publishes and delivers Division-generated geologic information to the public and maintains and improves public access to Alaska's geologic and earth science information. Advances in computer technology have resulted in faster preparation of maps and reports and a wider awareness of DGGS's available Alaska geologic resources. This section designs, implements, maintains, and improves a database for the Division's digital and map-based geological, geophysical, and geochemical data; a database for the Division's physical samples that are housed in Eagle River; and websites for the Division (www.dggs.alaska.gov) and for the Alaska Seismic Hazards Safety Commission (http:www.seismic.alaska.gov).

Back L to R: Bobby Kirchner, Joyce Outten
Middle L to R: Joni Robinson, Susan Seitz, Ken Woods
Front L to R: Jen Athey, Simone Montayne, Paula Davis

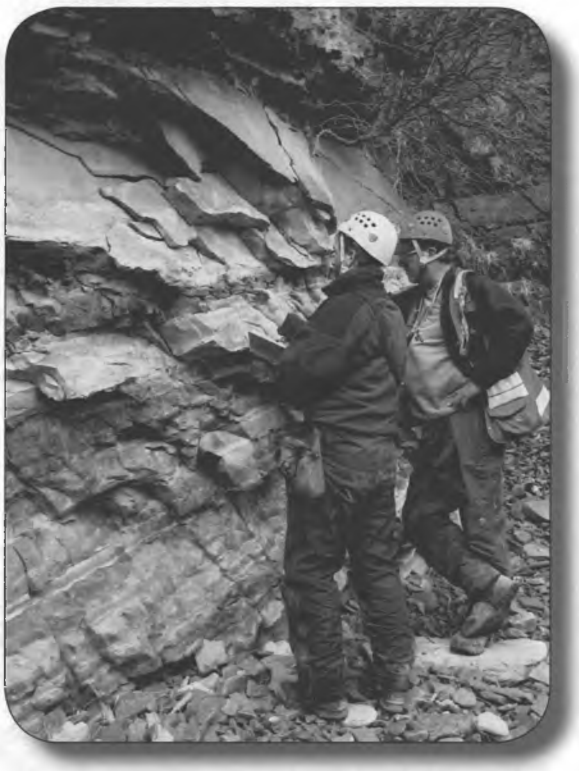
The **Geologic Materials Center** is the state's single central repository for representative geologic samples of oil- and gas-related well cores and cuttings, mineral deposit core samples, and regional geologic voucher samples. These materials are routinely used by industry to enhance the effectiveness and success of private-sector energy and mineral exploration ventures. New materials are continuously acquired; access to the materials at the GMC is free. To ensure that the value of the GMC holdings is maintained over time, any new data or processed samples generated from privately funded analyses of the geologic materials stored there must be donated to the GMC database.

L to R: Ken Papp, Robert Ravn, Herbie Mansavage, Kjol Johnson, Jean Riordan, Don Hartman, Joseph Skutca, John Reeder, Kurt Johnson, Allison Empey

The Alaska Seismic Hazards Safety Commission is charged by statute (AS §44.37.067) to recommend goals and priorities for seismic risk mitigation to the public and private sectors and to advise the Governor and Legislature on policies to reduce the state's vulnerability to damage from earthquakes and tsunamis. The Commission is administered by DGGS and consists of 11 members appointed by the Governor from the public and private sectors for three-year terms. The Commission produces a separate annual report to the Governor and Legislature and has its own website, http:www.seismic.alaska.gov.

RELATIONSHIPS WITH OTHER STATE AGENCIES

DGGS provides other DNR agencies with routine analyses and reviews of various geologic issues such as geologic-hazards evaluations of pending oil and gas lease tracts; area plans; competitive coal leases; geologic assessments of land trades, selections, or relinquishments; mineral potential; and construction materials



availability. The DGGS Energy Resources Section works closely with geologic personnel in the Division of Oil and Gas (DOG) on issues related to energy resources and in providing geologic control for the subsurface oil-related geologic analyses conducted by DOG. Each year DGGS prepares an annual report on the status of Alaska's mineral industry in cooperation with the Office of Economic Development in the Department of Commerce, Community & Economic Development. DGGS continues to collaborate with the Information Resource Management Section in the DNR Support Services Division as more geologic data are compiled and organized in digital formats amenable to merging with other land information. The Engineering Geology Section works closely with the Division of Homeland Security & Emergency Management (DHSEM) in the Department of Military and Veterans Affairs to evaluate hazards, develop scenarios for hazards events, and prepare the State Hazard Mitigation Plan. Additionally, the Engineering Geology Section participates in the Alaska Coastal Management Program to advise on geologic hazards issues and review coastal district plans and project applications. The Volcanology Section works with DHSEM and the Division of Environmental Conservation to mitigate effects of ongoing eruptions, and with the Alaska Energy Authority to provide technical expertise concerning geothermal resources. DGGS also evaluates resource potential around the state that may provide viable alternatives for energy development in rural Alaska.

Funding to support work requested by other DNR agencies mostly has been drawn from DGGS's annual general fund appropriation. However, for larger inter-division or other one-time efforts responding to special needs, the work is often supported by interagency fund transfers, Capital Improvement Project (CIP) funding, federal cooperative agreements, or private industry grants that supplement DGGS's general funds.

RELATIONSHIPS WITH LOCAL GOVERNMENTS

Most of the cooperative efforts implemented by DGGS with borough and municipal governments are conducted on a mutually beneficial but informal basis. For example, DGGS participates in a federally funded cooperative program to develop tsunami-inundation maps for coastal communities. In Kodiak, Homer, Seldovia, and Seward, communities for which inundation maps have been prepared in recent years, the city and borough governments worked closely with DGGS and other project cooperators to help design the project outputs to best benefit their needs for planning evacuation areas and routes. Similar cooperative efforts are currently underway with Whittier and Sitka for the next tsunami-inundation maps to be generated by this program. The Engineering Geology Section has worked closely with several communities to develop a field-geoscience outreach program for middle- and high-school students in rural Alaska, and has initiated a program working with coastal and river communities to help assess hazards and alternatives for mitigating the effects of erosion, flooding, and other surface process that threaten their sustainability. Similarly, the Energy Resources Section has worked closely with rural communities to help assess potential local energy resources as alternatives to importing expensive diesel fuel.

RELATIONSHIP WITH THE UNIVERSITY OF ALASKA

DGGS has had a long and productive professional association with geoscientists and students in various departments of the University of Alaska. University

of Alaska faculty work as project team members on DGGS projects and provide special analytical skills for generating stratigraphic, structural, geochemical, and radiometric-age data. Collaborative research projects and program oversight help provide both organizations with focused work plans that complement one another. University students employed as DNR/DGGS interns also are an important part of the DGGS work force. While working on current DGGS projects, the students learn a wide variety of geology-related skills ranging from conventional geologic mapping and sample preparation techniques to modern digital database creation and geographic information systems. Some graduate students are able to apply their DGGS intern work to their thesis projects. DGGS and the University make frequent use of each other's libraries and equipment. DGGS's Volcanology Section has a long-term cooperative relationship with the UAF Geophysical Institute resulting from partnership in the Alaska Volcano Observatory. University faculty and students occasionally visit the Geological Materials Center in Eagle River to study the geology represented in cores and surface samples from around the state.

RELATIONSHIPS WITH FEDERAL AGENCIES

DGGS often has cooperative programs with the U.S. Geological Survey (USGS), the U.S. Bureau of Land Management (BLM), and the U.S. Department of Energy. Periodically in the past, DGGS has also engaged in cooperative programs with the U.S. Minerals Management Service (MMS; now the Bureau of Ocean Energy Management, Regulation and Enforcement, or BOEMRE), National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). DGGS receives some federal funds from matching grants for which the Division must compete nationally with other organizations on a yearly basis. DGGS has been successful in securing funds to support mineral inventory mapping, surficial and earthquake hazards-related mapping, volcanic-hazards evaluations, and studies related to oil & gas and geothermal potential. Although DGGS has historically been very successful in receiving federal grants and appropriations, the process is highly competitive and these funds are therefore project-specific or complementary to state-funded programs and do not replace state General Fund money. Federal funding is pursued only for projects that are needed to advance the division's statutory mission.

Three ongoing cooperative programs with federal agencies have provided support for key elements of the DGGS mission in recent years. One is the Alaska Volcano Observatory (AVO), a partnership established in 1988 and consisting of USGS, DGGS, and the University

of Alaska Fairbanks Geophysical Institute. The USGS funds and administers the program for the purpose of providing a coordinated approach to mitigating volcano-hazard risks to the public, the state infrastructure, and air commerce. A second longstanding cooperative federal program is the STATEMAP component of the National Cooperative Geologic Mapping Program, established by Congress in 1992 and administered by USGS. STATEMAP provides matching funds for geologic-mapping projects according to priorities set by the Alaska Geologic Mapping Advisory Board (see below). A third major federal program is the Minerals Data & Information Rescue in Alaska (MDIRA) program, established by Congress in 1997. DGGS has completed numerous MDIRA projects, administered by USGS and BLM, for the purpose of recovering, indexing, archiving, and making publicly available minerals information at risk of becoming lost due to downsizing of public and private minerals-related programs. Although primary MDIRA funding for DGGS ended in early FY2010, in FY11 DGGS received a final allocation of remaining funds, which is being used to complete two ongoing MDIRA-related projects.

ALASKA GEOLOGIC MAPPING ADVISORY BOARD

The Alaska Geologic Mapping Advisory Board guides DGGS in pursuing its goal of providing earth science information to the Alaska public. A number of prominent geologists and community leaders, with a variety of backgrounds and a broad spectrum of experience in Alaska, have agreed to serve on the advisory board. The purpose of the board is multifold:

- To identify strategic geologic issues that should be addressed by the state.
- To inquire into matters of community interest relating to Alaska geology.
- To provide a forum for collection and expression of opinions and recommendations relating to geologic investigation and mapping programs for Alaska.
- To make recommendations toward identifying Alaska's diverse resources and promoting an orderly and prudent inventory of those resources.
- To increase public awareness of the importance of geology to the state's economy and to the public's health and safety.
- To promote communication among the general public, other government agencies, private corporations, and other groups that have an interest in the geology and subsurface resources of Alaska.
- To facilitate cooperative agreements between DGGS and other agencies, professional organizations, and private enterprise to develop data repositories and enhance the state's resource inventory and engineering geology programs.
- To communicate with public officials as representatives of groups interested in the acquisition of Alaska geologic information.
- To enlist public and legislative support for statewide geologic resource inventories and engineering geology programs.

The board held its first meeting in Fairbanks on October 22, 1995, and meets usually three times a year to discuss state needs, review DGGS programs, and provide recommendations to the State Geologist. The members solicit and welcome comments and suggestions from the public concerning state needs and DGGS programs throughout the year.

Current members of the board are:

Curt Freeman
Avalon Development Corporation, representing the minerals industry
Curt Freeman is President of Avalon Development Corporation, a consulting mineral exploration firm based in Fairbanks, Alaska.

Peter Haeussler
U.S. Geological Survey, representing the federal government, earthquakes hazards, and mapping interests.
Peter Haeussler is a geologist in the Anchorage office of the USGS Geologic Division, specializing in earthquake hazards, tectonics, and geologic mapping.

Tom Homza
Shell Exploration and Production, Alaska
Tom Homza is a Staff Geologist at Shell with more than ten years experience in oil and gas exploration and development in Alaska and represents the oil industry in mapping advice and structural interpretation.

Paul Layer
University of Alaska Fairbanks Department of Geology and Geophysics, representing the academic community
Dr. Paul Layer is an Associate Professor of Geophysics at the University of Alaska Fairbanks and former Head of the Department of Geology and Geophysics. He is currently Interim Dean of the College of Natural Science and Mathematics.

David Stanley
Alaska Department of Transportation & Public Facilities (DOTPF), representing state government and the engineering geology and geotechnical community
David Stanley is Chief Engineering Geologist of DOTPF, overseeing geotechnical studies in support of development and maintenance of the state's highways and airports.

FY2010 ACCOMPLISHMENTS

The Division of Geological & Geophysical Surveys (DGGS) is charged by state statute to generate new, objective, peer-reviewed information about the geology of Alaska, the potential of Alaska's land for production of minerals, fuels, and construction materials, and the potential geologic hazards to its people and infrastructure. As in past years, in FY2010 the Division successfully performed geological and geophysical mineral inventory mapping, generated new geologic data to support energy exploration, conducted hazard investigations, performed geologic and hazards studies on active volcanoes, and streamlined geologic data archival and dissemination.

MAJOR ACCOMPLISHMENTS IN FY2010

Energy Resources

- Conducted field geologic mapping, structural, and stratigraphic studies on the North Slope in collaboration with the Division of Oil & Gas and U.S. Geological Survey, collecting geologic data for evaluating the hydrocarbon potential of the Brooks Range foothills.
- Published a bedrock geologic map covering 480 square miles in the Kanayut River area south of Umiat.
- Finished editing a multi-chapter volume addressing key geologic relationships in the central Sagavanirktok Quadrangle relevant to oil and gas exploration on the North Slope.
- Published a report on the geology of potential reservoir sands in the Nanushuk Formation on the North Slope.
- Conducted field geologic mapping, structural, and stratigraphic studies in Cook Inlet in collaboration with the Division of Oil & Gas and U.S. Geological Survey, collecting data relevant to assessing the hydrocarbon potential of Cook Inlet basin.
- Completed draft reports summarizing potential fossil fuel and geothermal energy potential for each of the 11 Alaska Energy Authority energy regions.
- Published a multi-chapter volume addressing the geology of potential reservoir sands in Cook Inlet.
- Published new data on potential reservoir seal integrity for selected oil- and gas-bearing formations in Cook Inlet.
- Presented new data relevant to oil and gas exploration in the North Slope foothills and upper Cook Inlet to government and industry representatives at the annual meeting of the American Association of Petroleum Geologists.
- Presented new data relevant to the oil and gas potential of the Bristol Bay and Cook Inlet regions at the annual meeting of the Geological Society of America.
- Presented new data relevant to oil and gas exploration in the North Slope foothills and upper Cook Inlet to academic, government, and industry representatives at a two-day public meeting organized and hosted jointly by the Division of Geological & Geophysical Surveys and Division of Oil and Gas.
- Participated in multiple meetings with Apache Corporation to discuss the petroleum geology of Cook Inlet basin.
- Served on graduate student advisory committees for four University of Alaska geology students.
- Completed a short course on thermochronology laboratory methods.

Mineral Resources

- Published Alaska's Mineral Industry 2008 (Special Report 63), an authoritative annual report of statewide mining activity, in collaboration with the Alaska Department of Commerce, Community & Economic Development.
- Completed a draft bedrock geologic map of 113 square miles in the Slate Creek area, eastern Alaska Range.
- Completed a draft bedrock geologic map of 822 square miles of the Alaska Highway Corridor between Tetlin Junction, Interior Alaska, and the Canada border as part of an overall project to provide framework geologic information for the proposed natural gas pipeline route.
- Published geochemical reports for the Eastern Bonnifield and Chistochina mining districts, including new data to encourage mineral exploration and for understanding the geologic framework of Alaska.
- Initiated bedrock geologic mapping and mineral-resource assessment of 275 square miles of the Livengood–South area, Interior Alaska.
- Presented talks and posters at numerous state, national, and international conferences, to inform mineral industry and government representatives about current Alaska mineral industry activity and new DGGS Mineral Resources geologic studies, with the primary goals of disseminating geologic information and encouraging mineral industry investment in Alaska.
- Released airborne geophysical surveys of 653 square miles of the Moran area, Tanana and Melozitna quadrangles, Interior Alaska.

- Initiated airborne geophysical surveys of 750 square miles of the Ladue area, eastern-Interior Alaska.
- Initiated airborne geophysical surveys of 850 square miles of the Iditarod area, southwestern Alaska.

Engineering Geology and Hazards

- Completed draft and final maps and reports resulting from geologic mapping and hazards evaluation of 700 square miles along the Alaska Highway between Dot Lake and Tetlin Junction as the second part of a continuing study of the proposed natural gas pipeline corridor.
- Conducted fieldwork to map 800 square miles along the Alaska Highway between Tetlin Junction and the Canada border as the third segment of the proposed natural gas pipeline corridor. Publication is anticipated in fall of 2011.
- Completed fieldwork for 170 square miles in the Kivalina area in support of surficial-geologic mapping and hazards evaluations of coastal communities.
- Completed fieldwork for 255 square miles in the Koyukuk area in support of surficial-geologic mapping and hazards evaluations of communities at risk for hazards related to climate change.
- Presented new data at national professional meetings on ice-age catastrophic outburst floods in the Dot Lake–Tetlin Junction segment of the proposed gas pipeline corridor, and fault hazard studies in the Tyonek–Beluga area.
- Initiated a new program to collect high-resolution LiDAR (Light Detection and Ranging) data along the proposed natural gas export pipeline corridors in Alaska.
- Resumed collaborative efforts with the USGS to compile the Quaternary Fault and Fold Database, an online digital resource for active geologic structures in the state. The database will be completed and merged with the national database in 2011.
- Supported the Division of Homeland Security & Emergency Management's Statewide Hazards Mitigation Committee by reviewing and contributing to the updated Statewide Hazards Mitigation Plan.
- Supported the Alaska Energy Authority by reviewing alternative energy project proposals for potential geologic hazards that would need to be addressed in project implementation.
- Participated in multiple meetings and discussions as part of the Statewide Digital Mapping Initiative (SDMI), which has the primary goals of acquiring new and better digital map data for Alaska, including orthoimagery and digital elevation models, and making existing map products more readily accessible.
- Supported the Alaska Coastal Management Program (ACMP) by reviewing Coastal Project Questionnaires, advising project review coordinators on natural hazards issues, and reviewing and contributing to the ACMP Strategy and Assessment Plan.
- Completed agency reviews regarding potential geologic hazards and engineering-geologic considerations for multiple DNR land disposal and subdivision projects and for Environmental Impact Statements of the U.S. Department of the Interior's Bureau of Land Management (BLM).
- Led teacher workshops in Fairbanks as part of DGGS's ongoing involvement in MapTEACH (Mapping Technology Experiences with Alaska's Community Heritage), a geoscience education-outreach project developed by DGGS in collaboration with the University of Alaska Fairbanks and University of Wisconsin–Madison. MapTEACH is now being run by the University of Alaska Geography program, which has embraced it as its "flagship K–12 outreach program."
- Secured funding from the federal Coastal Impact Assistance Program (CIAP) to continue a major new DGGS program of coastal community geohazards evaluation and geologic mapping in support of coastal district and community planning.
- Provided administrative support for the Alaska Seismic Hazards Safety Commission. The Commission produces a separate annual report.

Volcanology

- Installed the Hazard Alert Notification System (HANS) at Cascades, Long Valley, and Yellowstone Volcano Observatories and trained personnel in its use. HANS was designed and created by DGGS/Volcanology and is now the alert notification system used exclusively at all U.S. volcano observatories.
- Processed 215 Redoubt tephra samples and created ash-fall density contour maps and volume calculations for all 19 explosive events of the 2009 eruption of Redoubt volcano. These ash-fall maps were used extensively in collaborations with ash-fall modelers to refine predictive models of ash deposition.
- Conducted annual water quality monitoring at Mother Goose Lake and the King Salmon River by collecting water samples and measuring the pH of natural acid water draining from Chiginagak volcano's crater lake. Acidification of these

drainages eliminated once-robust salmon runs between 2005 and 2009.

- Conducted field studies at Kasatochi volcano as part of an interdisciplinary, interagency team assessing the eruption and its impact on the local ecosystem. Kasatochi was one of a handful of major auklet nesting colonies, hosting several hundred thousand birds annually.
- Provided technical reviews of geothermal energy proposals to the Rural Energy Fund for the Alaska Energy Authority.
- Assisted DGGS/Geologic Communications in creating a system to deliver archived geospatial data over the web as part of the National Geological and Geophysical Data Preservation Program (NGGDPP).
- Purchased and installed three new servers and one data storage array. Two machines are taking over the AVO website and database (we now have three fully mirrored copies of the website and database), and one machine plus storage array serves and stores GIS data through ArcGIS and SQL Server. The three database servers run three-way-way replication, so a change on any one machine propagates to all other machines.
- Began writing and editing content submissions from more than 20 authors who are contributing to a summary publication of the 2009 eruption of Redoubt volcano.
- Conducted fieldwork to describe and sample the 2009 lava dome on Redoubt Volcano. Conducted further fieldwork to describe the effects of the 2009 eruption as well as the geologic history of the volcano.
- Procured and provided logistical coordination and support for interagency–AVO flight activities throughout Alaska.
- Co-wrote several chapters in USGS Professional Paper 1769 covering the 2006 eruption of Augustine Volcano. The report was published online in December 2010 (http:pubs.usgs.gov/pp/1769/).
- Scanned more than 3,000 (to date) photographic slides of volcanoes taken over the past several decades. These are important legacy images for tracking morphologic change due to eruptions.
- Responded to more than 500 emails to the Alaska Volcano Observatory.
- Continued development of GeoDIVA, the database that feeds the AVO website, by completing modal analyses of samples from the Redoubt 2009 eruption; compiling additional sample metadata, which increased the total recorded samples to 7,200 from 4,400; verifying and loading additional geochemical data, doubling the number of samples included; and updating the bibliography through 2009—now 4,500 references.
- Presented several papers at national and international geosciences meetings.
- Designed and published a deck of playing cards as a novel way to highlight Alaska's 52 historically active volcanoes. This deck helps raise the general public's consciousness of the existence of volcanoes in Alaska, an important first step in hazard risk mitigation.

Geologic Information Management and Delivery

- Edited, designed, and published 1 Annual Report, 2 Information Circulars, 1 Miscellaneous Publication, 1 Newsletter, 8 Preliminary Interpretive Reports, 3 Raw Data Files, 3 Reports of Investigation, and 1 Special Report. The division also released geophysical data for two areas, the Slate Creek–Slana River survey, and the Moran survey in the Melozitna and Tanana quadrangles.
- Distributed 5,157 DGGS reports and maps during the year and collected $7,142.20 in revenue from the sale of those reports. One of the hottest new sellers was Information Circular 59, an educational deck of playing cards with photos and other information about each of the 52 active Alaska volcanoes, for only $6.
- DGGS's website was visited 1,159,318 times during the fiscal year. The usage was highest in November and December, but dropped shortly afterward, when IT staff restricted bandwidth-intensive visits by webcrawlers such as Google.
- DGGS customers downloaded 525 free digital data packages from the publications website. These shapefiles and data tables are ready to be used in ArcGIS and other GIS programs. The most popular package was Miscellaneous Publication 133, Historically Active Volcanoes of Alaska; in second place was Miscellaneous Publication 8, Geothermal Resources of Alaska; running a close third was Special Report 37, Coal Resources of Alaska; and right behind was Information Circular 38, Volcanoes of Alaska.
- Added a complex new module to the DGGS website (www.dggs.alaska.gov) for loading and displaying geologic hazards information; this work is part of the final deliverable for an Alaska Coastal Management Program (ACMP) grant.
- The incidence of DGGS server downtime during FY2010 was virtually zero.
- Added a significant new function to the AASG website to load and display AASG Foundation information. Upgraded existing code to fulfill information requests and completed general

maintenance and content management tasks for the site. DGGS took over design and maintenance of the Association of American State Geologists website (www.stategeologists.org) as part of its membership responsibility in the organization.

- Provided training for DGGS staff on writing FGDC-compliant metadata to accompany datasets downloaded by the public. Additionally, 13 metadata files were edited to comply with DGGS digital data distribution requirements; files were loaded into the DGGS database and made available via the national geospatial one-stop website (geodata.gov).
- Presented a poster entitled "Alaska Geologic Materials Center (GMC) database: A web-based inventory" at the AASG–USGS Geoscience Data Preservation Techniques Workshop in Denver, July 14–15, 2009. Response to the presentation again showed that many other state geological surveys and federal agencies see DGGS as a model for setting up a database to accommodate vast quantities of geology-related data.
- Prepared and submitted a proposal to the U.S. Geological Survey for the FY2011 National Geologic and Geophysical Data Preservation Program (NGGDPP). The USGS awarded funding for a program to create a new online index for Alaska's energy data that might otherwise be permanently lost.
- Updated the DGGS online publications and database infrastructure to accommodate U.S. Bureau of Mines Alaska publications. These publications, which document mineral deposits identified in Alaska during past scientific research by staff of the former U.S. Bureau of Mines, continue to be sought after by industry explorationists and state and federal agencies. After the John Rishel Mineral Information Center closed in Juneau, the digital versions had disappeared. The publications are available only in printed form, in limited numbers, are irreplaceable, and very difficult to find. Scanning and posting them to the DGGS website preserves them in digital form.
- Compiled a photo inventory for the Geologic Materials Center that documents more than 18,000 DGGS surface geologic samples (60 percent of the total inventory of DGGS samples).
- The staff library received sizeable donations of valuable material: North Slope maps and reports (from retired DGGS geologist Gil Mull); gravity reports (from John Myer, DOG); Northern Latitudes Mining Reclamation Workshop proceedings; Tectonics and JGR journals and other reports (University of Colorado); rare editions of glacier reports (from retired DGGS geologist Richard Reger); DGGS and USGS reports (from NOAA Denver, University of Nevada, University of Nebraska, and an unknown Anchorage donor); an Alaska Railroad report from 1913 (from University of Nebraska); and others.
- Prepared displays for: the Alaska Miners Association November conference in Anchorage; Alaska Miners Association Biennial Conference in Fairbanks in March; the Tanana Valley State Fair for Mining Day; and the Governor's Picnic. A poster and paper were presented at the Digital Mapping Techniques (DMT) '09 conference and were posted on USGS DMT website; a presentation for GSA '09 was given on Database Best Practices and posted to the GSA website; and a "Digital Geologic Mapping" page was created for Wikipedia and accepted by ProjectGeology.
- Completely updated the DGGS cartographic manual to accommodate the many changes in the conversion from manual to digital cartography over the past decade or so. The manual provides guidance to encourage the products created by this division to have a uniform look and feel, and it provides many specifications that are helpful in making map sheets and accompanying booklets. Since the last update, the entire cartographic process has changed; the previous version was written for hand-scribed maps and now all of our products are generated digitally.
- Added a new, more powerful server to the computer resources of the division to facilitate individual backups; users were upgraded to an improved statewide mail archiving system; and the storage capacity of the division's main fileserver was increased by 15 terabytes.
- Acquired the "dggs.alaska.gov" and "seismic.aiaska.gov" domain names to facilitate the translation of our long, query-string-populated web addresses into plain English.
- Configured DGGS computer hardware so that it has consistently and successfully run backups for all of the division's servers and desktop computers. They also reconfigured local data storage for website/database to allow for automatic recovery of hard drive failures.
- Assisted with the addition of three new Alaska Volcano Observatory (AVO) servers to the State of Alaska network in April to allow for bandwidth conservation, GIS mapping tools, and database synchronization. During this fiscal year, DGGS also began sharing bandwidth for the AVO webserver with UAF, thus increasing access and resources for DGGS.

- Facilitated the addition of the Geologic Materials Center (GMC) in Eagle River to the State of Alaska Wide Area Network; through this connection, the GMC is now able to access the main fileserver in Fairbanks, the DGGS Oracle database, and the DGGS ArcGIS licenses.

Geologic Materials Center

- Hosted 424 visits to the GMC in Eagle River by industry, government, and academic personnel to examine rock samples and processed materials. Collaboration from these visits helped acquire 4,010 process slides, oil and gas material representing 78,496 feet from 37 wells, 15,180 feet of hard-rock mineral core, 2,500 pounds of surface samples, and 13 new technical data reports.
- An online version of the Alaska GMC inventory was released to the public in April 2010. This dataset, available in Google Earth format, includes oil and gas well locations, mineral prospect locations, sample types, and box-level details for more than 80 percent of the materials inventory available at the GMC. The online inventory allows users to quickly and easily view details of the GMC's materials repository before visiting the facility—the number one request from GMC users.
- Incorporated geologic formation-top picks into the GMC online inventory in October 2010. In-kind data contributions by the Alaska Oil and Gas Conservation Commission and U.S. Geological Survey were compiled by GMC staff and entered into the database. GMC users can now view all of the oil and gas well material associated with a particular geologic formation and therefore more easily identify the materials available at the GMC that represent their intervals of interest.
- Contract curator and former Alaska State Geologist Don Hartman has confirmed and detailed the material, box by box, for the State, USGS, NPR-A, Oxy, and Shell sample collections to improve the quality of the GMC inventory.
- Organized, documented, and detailed approximately 90 percent of the hard-rock material stored in more than 20 shipping containers. These efforts will improve the in-house materials database inventory, allowing staff to help users of the facility find information more quickly and pave the way for a future web interface to query the available materials at the GMC.
- The GMC now has the capability to lay out and display boxes of core for an entire well or borehole after staff reorganized and cleaned out the rear garage/lab area of the main warehouse. This area was previously occupied by equipment that was outdated, in poor working order, or potentially dangerous to use.
- The GMC is actively curating two subsets of valuable core sample collections at risk of severe material and data loss with funding in part from the National Geologic and Geophysical Data Preservation Program. The Amchitka and coalbed methane core curation projects are 50 and 10 percent complete, respectively.
- The GMC Curator visited the USGS Core Research Center in Denver, CO, the Austin Core Research Center in Austin, TX, and the GSC Calgary Geological Core and Sample Repository in Alberta, Canada, to learn about inventory management and the policies and procedures established at each facility. The knowledge gained during this trip will contribute immensely towards the design phase and planned future progress of a new core repository in Alaska and will help improve the management of the current GMC.
- The GMC reduced its natural gas consumption by nearly 40 percent, saving approximately $6,600 over a 12-month period, by making the main warehouse more energy efficient.
- Completed approximately 25 percent of the GMC inventory-mapping project. The inventory map will identify available empty shelves and provide the location and counts of specific material types, more accurate box-number and volume estimates, and unique IDs for each box. This effort will make the future transition to a new repository much more manageable.
- Continued to assist DGGS with database definitions and structure information for a future planned web-accessible sample-inventory database.

KEY ISSUES FOR FY2011-2012

Updating and Improving the Alaska Geologic Materials Center

- Our ability to develop the State's natural resources and maintain a robust economic engine is at a critical juncture. Significant investment in infrastructure will be required in the coming years to advance exploration and development efforts statewide. The Geologic Materials Center (GMC) is a key part of that resource infrastructure and is the "first stop" for oil and gas and mineral exploration companies that are attempting to prospect in the complex geology of Alaska.
- The GMC facility archives samples and rock core representing more than 13 million feet and 1,600 oil and gas exploration and development wells; 300,000 feet of mineral diamond core wells, and irreplaceable samples from geologic mapping and research done in every corner of the state.
- Although the GMC is being maintained in its current condition, the facility is more than 150 percent above its designed sample-storage capacity, and is very poorly designed to handle the frequent requests for reasonable access to the material.
- The GMC currently utilizes 60 portable containers as temporary storage facilities for recent sample acquisitions. These shipping containers are unlighted, unheated, and house thousands of feet of core, some of which will disintegrate with repeated freeze-thaw cycles. It is important to note that this collection represents hundreds of millions of dollars of acquisition and preservation costs and is in significant risk of damage or loss.
- Providing efficient and comprehensive access to these data is critically important for viable exploration programs, for both seasoned Alaska exploration companies and new companies that are trying to identify potential exploration areas.
- The core and sample observation areas are essentially unusable for confidential work and examination of more than a few feet of core length. An exploration company's ability to keep their activities confidential is critical to exploration success in a fiercely competitive environment. Often the core must be taken off site for substantial projects, creating a significant security threat to the unique core, and an expensive alternative for the exploration company. All of these factors results in a reluctance by some companies to make use of the facility because they must go through the onerous effort of transporting and unnecessarily handling the material at risk.
- A facility concept study, funded through a special federal appropriation, was completed in July 2006. The study identified the most feasible options for design and provided cost estimates for various configurations. It is the basis for our FY09 CIP-funded project to support the next phase, which is architectural and engineering design of the facility.
- **A significant challenge for DGGS in the near term will be to convince the public, lawmakers, and government officials of the importance of upgrading this facility and providing the funding necessary to keep this critical data source safe and accessible. We have initiated a multi-agency task force that will finalize the site selection and identify public funding sources to support the project.**

Renewed Focus on Natural Resource Development

- Increased activity in the natural resource exploration and development industries is good for the state on many fronts. With an increase in activity comes an expectation that the state will provide the necessary data to facilitate that development. DGGS welcomes this challenge and will be doing everything possible to meet the needs of this renewed focus.
- Our effort to provide critical geologic data to these entities will be tested as more and more end-users of our products demand quicker and more comprehensive response. The main challenge will arise from a static state budget and our ability to plan for the rapidly changing needs of the resource development community, and to gather the required field information in the face of rising operating costs.
- Spikes in the exploration cycle also create a situation where high-paying private-sector jobs become abundant, and opportunities for experienced geoscientists become commonplace. The state will need to stay diligent in order to keep our best and brightest employees.
- DGGS must continue developing and optimizing its data acquisition programs and work to discover new and more efficient ways to disseminate the information to the groups that need it.

Infrastructure Projects and Public Safety

- Development of Alaska's vast resources requires access to world markets. Providing geologic data for infrastructure maintenance and development will remain a key challenge for DGGS.

- The Alaska Gasline Inducement Act (AGIA) pipeline will require comprehensive information about construction materials and geologic hazards data to allow timely and safe design and development. DGGS is currently acquiring those data, but will need to accelerate the current pace to supply the needed maps and information.
- Large projects that will develop Alaska's huge natural resource base and sustain the State's economy require baseline data and hazards analysis so that permitting can take place in a reasonable timeframe and the environment can be properly protected. Unfortunately, most areas have only minimal data and little of the detailed geologic mapping that will be necessary to undertake these activities.
- Continued arctic warming will undoubtedly increase maintenance requirements on many of Alaska's current roads and transportation corridors. Identifying geologic hazards and areas prone to failure will be necessary to mitigate this change. Increased materials requirements will likewise strain Department of Transportation and Public Facilities' (DOT/PF) ability to address this issue. DGGS will work with other state agencies to provide modern analytical techniques for this work.
- Population continues to expand in some areas of the state, and those regions (like Wasilla) have essentially no baseline data on which to base zoning efforts and restrictions. Likewise, many areas where resource development is expanding lack the most rudimentary baseline data on things such as groundwater, geologic hazards, and resource abundance.
- **DGGS will be challenged to provide geologic information for infrastructure, human, and economic development, as well as transitioning our hydrocarbon-based economy. All construction in the state requires a complete analysis of the inherent geologic risks that are commonplace but poorly understood in most areas of Alaska.**

Changes in local energy supply and consumption

- A complete, or even partial, re-tooling of the state's domestic energy supply is not a trivial exercise. Providing the investment necessary to make changes is a first important step; however, there must also be oversight and monitoring of projects to avoid the substantial mistakes of the past. The Alaska Energy Authority has completed the first three rounds of the renewable energy grant program, which is working to develop alternate forms of energy in all corners of the state. DGGS will continue to be intimately involved in reviewing the proposals for resource existence, methodology, and data review. DNR will be tasked with the substantial job of regulating and permitting the hundreds of projects that have the real potential to significantly impact the state's natural resources.
- Sustained high energy prices and the current push to curtail carbon-based fuel use could have a significant impact on the economies of rural Alaska and threaten the viability of rural infrastructure.
- Many remote areas of the state lack sufficient geologic information on potential alternate forms of energy such as shallow natural gas, coal, geothermal, and conventional gas that will be necessary bridge fuels as the state and local governments grapple with increasing energy cost and decreasing availability.
- Misinformation about viable alternate energy sources is rampant and many expensive mistakes can be avoided by getting accurate information in the hands of the local governments and decision makers.
- **DGGS will be challenged to provide pertinent and timely data on numerous fronts, and addresse the occurrence of locally available energy sources. DGGS will continue to strive and make data available to those that need it and move Alaska toward a more secure energy future.**

Response to data needs for adaptation to a changing arctic climate

- Alaska will be a national focal point over the coming years, for indications and impacts of climate change. DGGS's ability to provide reliable, unbiased data for the development and evaluation of emerging policy and statute changes will be very important for achieving reasonable, long-range planning and mitigation. We will continue to collect geologic and hazards data needed to help mitigate and adapt to the changing environment, and make that data available to the public.
- Geologic information will be needed in a number of key climate-related mitigation efforts. Most importantly, these data will be required in areas of coastal development and critical infrastructure where ground settlement from thawing permafrost, increased erosion and landslide hazards, and changes in hydrologic systems (both surface and subsurface aquifers) will be prevalent.
- Historically, the state has relied on site-specific hazards analyses related to ongoing development or permit approval. The recognition of significant change across the arctic will require that regional

baseline data be gathered and made available. Continued population growth and development in Alaska will continue to encroach on areas with heightened geohazard risk.
- Because of the nearly ubiquitous need for modern geologic mapping and data in impacted areas of the state, DGGS will be tasked with acquiring geologic data, producing maps, and identifying risks (information that can be used in both short-term and long-term planning). In some cases it will be critical to have this data available in crisis situations.
- DGGS will work with many other agencies (with a wide range of mandates) in a coordinated effort so that the most important needs are addressed, and redundancy is minimized.
- **The key challenge will be in the prioritization of the areas, as there is much more need for data than personnel and funding to acquire it.**

DGGS FY2011 PROGRAM

PROGRAM FOCUS

DGGS develops its strategic programs and project schedule through consultation with the many users of geologic information—state and federal agencies, the Alaska State Legislature, the federal Congressional delegation, professionals in the private sector, academia, and individual Alaskans. Their input to DGGS programs comes through the Alaska Geologic Mapping Advisory Board, liaison activities of the Director, and personal contact between DGGS staff and the above groups.

The FY2011 DGGS program focuses on projects designed to foster the creation of future Alaska natural-resource jobs and revenue and to mitigate adverse effects of geologic hazards. For the foreseeable future, much of the economy will continue to depend on developing the state's natural resources. Within that future, energy and mineral resources constitute a major portion of the state's wealth. Mitigating the effects of geologic hazards helps preserve public safety and private investments by fostering sound design and construction practices. Both resource development and hazard risk mitigation depend heavily on the availability of reliable geologic information.

The role of DGGS in state revenue generation and the maintenance of Alaska's economy is strategic. DGGS provides objective geologic data and information used by in-state, national, and international mineral and energy companies, construction companies, air carriers, other DNR agencies, Department of Commerce, Community & Economic Development, Department of Transportation & Public Facilities, Division of Homeland Security & Emergency Management, and the Federal Emergency Management Agency. DGGS geologists provide geological and geophysical information to assist mineral prospectors, oil and gas explorationists, and others to explore for, discover, and develop Alaska's subsurface resources. DGGS is a central repository of information on Alaska geologic resources and a primary source of information for mitigating geologic hazard risks. To focus attention on Alaska's subsurface resource potential and geologic hazards, DGGS makes the state's geologic information available on statewide, national, and international levels. Through its Geologic Materials Center in Eagle River, DGGS also provides access to physical geologic samples collected by private companies and government agencies.

Minerals Data and Information Rescue in Alaska (MDIRA) Program

Downsizing of federal and state agencies in Alaska during the late '80s and early '90s placed at risk an extensive body of geological, geochemical, mineral, and mineral-development data that had been collected by federal, state, and private organizations over the past century. These data are archived in various locations offering various levels of storage capacity, quality, and accessibility. The budget shortfalls for federal and state archival functions created a need to develop aggressive plans for assembling, maintaining, and most importantly, creating value from this data legacy. For the purpose of this effort, "at risk data" is defined as any geologic data or voucher samples existing in substandard storage sites or in a mode in which data may be subject to irretrievable loss or degradation, or may be unavailable to meet the needs of its intended users. Beginning in 1998, a liaison committee comprising representatives from the Alaska Miners Association, Alaska Native corporations, University of Alaska, Alaska Department of Natural Resources, and independent mining industry consultants guided the implementation of the Alaska minerals data rescue efforts through a federally funded program entitled Minerals Data and Information Rescue in Alaska (MDIRA). DGGS projects supported in whole or in part by this program have been undertaken by the Mineral Resources and Geologic Communications sections. Although primary MDIRA funding for DGGS ended in early FY2010, in FY11 DGGS received a final allocation of remaining funds, which is being used to complete four ongoing MDIRA-related projects. In the FY2011 Program Summaries that follow, these projects are indicated by an asterisk (*). Information compiled through MDIRA-supported projects is available at www.akgeology.info/.

FY2011 DIVISION EXPENSE BUDGET
(estimated expenses in thousands of dollars)

Program	General Fund	CIP	Federal	Interagency & Program Receipts	Total
Energy Resources	$858	$106	$201	$299	$1,463
Mineral Resources	$1,519	$281	$53	$5	$1,858
Engineering Geology	$356	$499	$561	$1,737	$3,154
Volcanology	$0	$0	$1,434	$11	$1,445
Geologic Communications	$929	$0	$0	$15	$944
Geologic Materials Center	$278	$119	$25	$50	$472
Administrative Services	$411	$0	$0	$2	$413
Seismic Hazards Safety Commission	$10	$0	$0	$0	$10
Total by funding source	$4,361	$1,005	$2,274	$2,119	$9,759

PROGRAM SUMMARIES

STATE GEOLOGIST/DIRECTOR

The Director's Office provides leadership and coordination for the activities of the Division through the State Geologist/Director, Division Operations Manager, and administrative staff.

OBJECTIVES

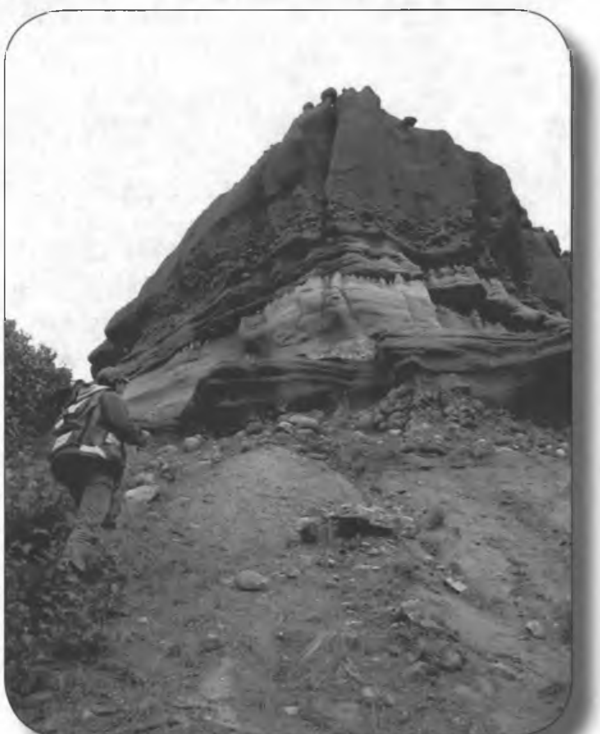
1. Provide executive leadership for the Geological Development component of DNR's program budget and act as liaison between the Division and the DNR Commissioner's Office, other state agencies, Legislature, Governor's Office, and local, federal, and private entities.
2. Stimulate exploration, discovery, and development of the geologic resources of the state through implementation of detailed geological and geophysical surveys as prescribed by AS §41.08.
3. Provide geologic information to mitigate the adverse effects of natural geologic hazards.
4. Provide secure archival storage and efficient public access to the state's growing legacy of geologic information, and energy- and minerals-related reference cores and samples.

TASKS

- Prepare annual Division funding plan including Alaska General Fund base budget, Capital Improvement Project budget, interagency programs, and federal initiatives.
- Inform Alaska state legislators, Governor's Office, Alaska Congressional delegation, and the public about the DGGS geologic program and its significance.
- Focus the Division's geologic expertise on addressing Alaska's highest priority needs for geologic information.

ENERGY RESOURCES

The Statewide Energy Resource Assessment program produces new geologic information about the state's oil, natural gas, coal, and geothermal resources. As both State and national oil and gas reserves continue to decline, and associated price volatility becomes the norm, it will become exceedingly important to identify new energy resources in the state to help offset declining conventional reserves and state income. An additional short-term need that must be addressed is identifying affordable energy resources that can be economically developed for smaller local markets. As a consequence, there is a continual need for acquisition and dissemination of fundamental geologic data using modern technology that will enable industry and local governments to better focus exploration efforts on prospective areas beyond the currently producing fields. Recent DGGS stratigraphic studies and geologic mapping in the central and eastern North Slope are stimulating exploration interest in the Brooks Range foothills. This underexplored frontier province appears to be dominantly gas-prone and has the potential to yield additional reserves for the proposed natural gas pipeline. In late FY2010, DGGS resumed stratigraphic studies in the Umiat region south and southeast of the Colville River in the Umiat Quadrangle of the central Brooks Range foothills. This area encompasses approximately 700 square miles straddling the proposed road corridor between Umiat and the Dalton Highway, and includes stratigraphic and structural elements important to understanding the oil and gas potential of Alaska's North Slope.



Predicted gas deliverability shortfalls in the south-central Alaska market have resulted in a significant increase in exploration interest in Cook Inlet Basin. With this new interest the exploration focus has shifted from permeable sandstones in structural traps to gas in tight (low porosity and permeability) sandstone formations and stratigraphic plays. To stimulate sustained exploration interest, DGGS initiated a multi-year study of this basin in FY2007, providing relevant high-quality data to help evaluate resource potential of tight formations and stratigraphic traps. This project focuses on building a robust model of the basin's stratigraphy to help predict the distribution of potential sandstone reservoirs and to provide a better understanding of parameters controlling reservoir quality and producibility. In FY2010 DGGS resumed stratigraphic and structural studies along the northwestern margin of the basin, in the Tyonek Quadrangle. This area includes some of the same rock formations that produce oil and gas in nearby fields such as Beluga, North Cook Inlet, and Granite Point. Features studied in outcrop are important for developing new techniques that will allow the productive life of these fields to be extended and help in the recognition of stratigraphic traps and reservoirs in tight formations. In late FY2010 DGGS resumed stratigraphic and structural studies on the western side of lower Cook Inlet, across from Ninilchik and Anchor Point. This area includes exposures of rocks known to be the source of most, if not all, of the oil and some gas produced from fields in upper Cook Inlet. Information obtained from these stratigraphic units provides important keys to understanding the remaining petroleum potential in the basin.

Many sedimentary basins in Alaska have geological characteristics that are conducive to hosting natural gas, including unconventional gas. However, most of these basins are so poorly known that we do not have a realistic understanding of their gas potential. For example, the geology of the Susitna basin suggests that it could host natural gas in quantities that could be produced for in-state use. In 2010 DGGS initiated a multi-year study of the natural gas potential of this basin and is currently compiling available data and planning fieldwork for the 2011 season. Information obtained from this project will add to the database of publicly available information on the petroleum geology of this basin, which will help stimulate private-sector exploration activity.

DGGS is collaborating with the Alaska Division of Oil and Gas on a study of the potential for deep rock formations to sequester carbon dioxide (CO_2). Publicly available coal data and existing coal mapping are being used to produce a derivative map showing the distribution of deep coal seams that are available for sequestration.

The Statewide Energy Resource Assessment program also is collecting new coal quality and stratigraphic data and working to implement a comprehensive statewide coal resource data file as part of an integrated DGGS geologic data management system.

DGGS is participating in a multi-agency effort to inventory Alaska's known energy resources. This project includes development of a user-friendly, web-based interactive map to display the location, type, and, where applicable, a risk-weighted quantity estimate of energy resources known to be available in a given area or at a specific site. In addition to this effort, DGGS is currently reviewing available information on potential geology-based energy resources for use by rural communities. This work will summarize available relevant information, identify areas of the state where additional information is needed to better understand the true resource potential, and will be incorporated into the web-based interactive map. The reporting function for this project was recently transferred to the Alaska Energy Authority.

The numerous elements of the Statewide Energy Resource Assessment program are financed from a mixture of sources: General Fund, Industry Receipts, Federal Receipts, and Capital Improvement Project funding.

OBJECTIVES

1. Encourage active private-sector oil and gas exploration on the North Slope outside the Prudhoe Bay–Kuparuk field areas.
2. Collect and publish new geologic data to stimulate renewed, successful exploration for hydrocarbons in the Cook Inlet Basin.
3. Collect and publish new geologic data to stimulate exploration for natural gas in the Susitna basin.
4. Provide a map showing the distribution of deep coal seams potentially available to sequester CO_2.
5. Provide DNR, other state agencies, and the public with authoritative information relating to the energy resources of the state so that rational policy and investment decisions can be made.

FY2011 ENERGY RESOURCES PROJECTS

Detailed project summaries for the following energy resources projects appear in the section Project Summaries—FY2011:

In addition to the above projects, the Energy Resources Section performs the following tasks:

- Provide written evaluations of mineable coal potential for lease areas in response to requests from Division of Mining, Land and Water.
- Respond to verbal requests from other state agencies, federal agencies, industry, local government, and the public for information on energy-related geologic framework and oil, gas, and coal resource data.

MINERAL RESOURCES

The minerals industry has been a significant and steadfast partner in the economic well-being of Alaska since the late 1800s. In more recent times, global demand for strategic minerals is at an all-time high and Alaska's mineral reserves will play a significant role in helping to meet that rising demand. The mineral industry, however, has historically been reluctant to commit significant company resources to exploration without sufficient understanding of the geologic framework of their areas of interest. For this reason, and to support responsible stewardship of Alaska's mineral endowment, DGGS conducts geological and geophysical surveys of the most prospective Alaska lands that are open to mineral and other geologic resource development.

Alaska has an accessible state land endowment of more than 100 million acres, much of it selected under the Statehood Act because of perceived potential to host mineral wealth. Currently the overwhelming majority of these lands are not geologically or geophysically surveyed at a sufficiently detailed level, nor with the focus needed, to optimize mineral discovery and development. Recently, a DNR/DGGS program of integrated geological and geophysical mapping has been effective in attracting new private-sector mineral investment capital to Alaska. Projects of the Mineral Resources Section are designed to produce, on a prioritized schedule, the critical new surveys and reports needed to sustain Alaska's mineral industry investments and provide management agencies with information needed to formulate rational management policy.

The Mineral Resources Section also shares responsibilities with the Geologic Communications Section in the Division-wide task of continuing the implementation of a publicly accessible, comprehensive, on-line computerized Alaska geologic information database developed through the Minerals Data and Information Rescue in Alaska (MDIRA) program.

The numerous elements of the Mineral Resources Section are financed from a mixture of sources: General Fund base budget, Capital Improvements Project funding, and Federal Receipts.

OBJECTIVES

1. Catalyze increased mineral resource exploration in Alaska.
2. Provide DNR, other state agencies, and the public with unbiased, authoritative information on the geologic framework and mineral resources of the state to support rational land policy and investment decisions.
3. Provide, in cooperation with the Department of Commerce, Community and Economic Development, an accurate annual statistical and descriptive summary of the status of Alaska's mineral industry.

FY2011 MINERAL RESOURCES PROJECTS

Detailed project summaries for the following Mineral Resources projects appear in the section *Project Summaries—FY2011:*

Airborne geophysical/geological mineral inventory program: Bedrock geologic mapping of the northern Fairbanks mining district, Circle Quadrangle, Alaska – p. 48

Airborne geophysical/geological mineral inventory program: Bedrock geologic mapping in the Council–Big Hurrah–Bluff area, Seward Peninsula, Alaska – p. 49

Bedrock geology and mineral-resource assessment along the proposed Gas Pipeline Corridor from Delta Junction to the Canada border – p. 50

Annual Alaska mineral industry report – p. 51

*Alaska geological and geophysical map index – p. 52

*Geochronologic database for Alaska – p. 53

*MDIRA-supported project (see p. 16)

In addition to the above projects, the Mineral Resources Section performs the following tasks:

- DGGS Mineral Resource geologists provide timely responses to verbal and written requests for mineral information from other state and federal agencies, local government, industry, and the general public.
- Provide authoritative briefings about the status of Alaska's mineral industry, state support for mineral-resource ventures, and recently acquired geophysical and geological data at professional mineral industry conventions and trade shows, and in professional journals.

ENGINEERING GEOLOGY

The Engineering Geology program addresses major engineering-geology and geologic-hazard issues that affect the public safety and economic well-being in developing areas of Alaska. DGGS conducts engineering-geologic mapping to determine the distribution and character of surficial deposits, their suitability for foundations, susceptibility to erosion, earthquakes and landslides, and other geologic hazards. Geologic evaluations of areas subject to major hazards like floods, earthquakes, volcanic eruptions, tsunamis, and landslides help to forecast the likelihood of future major events and the severity of hazards associated with them. In addition to General Funds, some elements of the Engineering Geology program are partially or largely financed through Federal and interagency receipts.

In many areas, the state lacks the fundamental geologic data needed to guide the proper development and implementation of building codes, land-use zoning, right-of-way siting, and contingency planning for adverse natural hazard events. Loss of life and damage to infrastructure and buildings can be reduced through informed construction practices, land-use planning, building-code application, and emergency preparedness. However, economics and practicality dictate that mitigation measures be implemented first where risk is highest. Because hazards are not uniformly distributed, engineering-geologic and hazard maps become the first source of information about where damage is likely to be greatest and, therefore, where mitigation efforts should be concentrated. These maps are critical for emergency planning and the allocation of emergency-response resources prior to an adverse event.

The type of surficial-geologic mapping conducted for purposes of identifying geologic hazards and locating sources of construction materials is also of benefit for locating placer-mineral deposits. For this reason, engineering-geology personnel often participate in teams with DGGS's mineral-resources geologists to map areas of interest for minerals exploration.

A major continuing program headed by the Engineering Geology section but also involving members of the Mineral Resources section is the geologic mapping and hazards evaluation of the proposed natural gas pipeline corridor from Delta Junction to the Canada border. The purpose of this multi-year project is to provide detailed geologic information for a 12-mile-wide corridor on which to base alignment decisions, engineering design, permitting, and planning for future development along the Alaska Highway. Following acquisition of high-resolution airborne geophysical data in 2006, DGGS began collecting field data from Delta Junction eastward. Fieldwork was largely complete by 2010, with a minor amount of additional field assessment anticipated in 2011 and final reports and maps to be published in 2011 and 2012.

A significant effort of the Engineering Geology section in the past has been in support of MapTEACH (Mapping Technology Experiences with Alaska's Community Heritage), a field-based geoscience outreach program for middle- and high-school students in rural Alaska that emphasizes hands-on experience with geoscience and spatial technology in conjunction with traditional activities. The project came to the end of its original National Science Foundation funding in April 2008 and was adopted by the University of Alaska Geography program as its flagship K–12 outreach program. DGGS continues to be involved in a limited capacity with MapTEACH activities to enhance community understanding of landscape processes and natural hazards in rural Alaska, and to foster appreciation of state-of-the-art technology tools and datasets that can be applied to informed community planning and decision making.

Major new projects have been developed in response to the overwhelming need for baseline geologic mapping and natural hazards evaluations in and near communities that are being affected by severe erosion and flooding problems, some of which are likely to be exacerbated by climate change. Thawing permafrost and possible sea level changes are also a growing concern for many Alaskan communities. DGGS recognizes the importance of reliable scientific information to help the state and its communities prepare for potential emergency situations resulting from geologic hazards, including those that are affected or amplified by climate change. DGGS will perform geologic studies to identify high-risk areas where proactive mitigation efforts will be needed and useful, as well as evaluating proposed relocation sites for communities faced with the immediate need to move to a safer location. Additionally, new DGGS expertise in the field of neotectonics (active faulting) will be dedicated to identifying and understanding active faults and earthquake hazards in developing areas of the state.

OBJECTIVES

1. Help mitigate risks to public safety and health by providing information on geologic hazards as they affect human activity.
2. Provide geologic information to help lower the costs of construction design and improve planning to mitigate consequences arising from hazardous natural geologic events and conditions.
3. Provide reliable engineering-geologic data for informed land-use decisions by the government and private sector.
4. Identify sources of sand, gravel, rip-rap, stone, and other geologic construction materials required to create the infrastructure, roads, and other land-based transportation corridor improvements necessary to support expanded development of natural resources and other local economic activities in Alaska.
5. Identify potential sources of placer minerals in conjunction with minerals resources mapping projects.

FY2011 ENGINEERING GEOLOGY PROJECTS

Detailed project summaries for the following Engineering Geology projects appear in the section *Project Summaries—FY2011:*

In addition to the above projects, the Engineering Geology section performs the following tasks:

- Produce written evaluations of potential hazards in areas of oil exploration leases, land disposals, permit applications, etc., and respond to verbal

requests for information from other state agencies, local government, and the general public.

- As part of the Alaska Coastal Management Program, conduct reviews of district coastal management plans, Coastal Policy Questionnaires, and consistency applications to determine compliance with the program's natural hazards standards (11 AAC 112.210).
- When appropriate, conduct post-event hazard evaluations in response to unexpected major geologic events (for example, earthquakes and landslides), providing timely information dispersal to the public via electronic as well as traditional methods, and providing event and continuing hazard information to appropriate emergency management agencies.

VOLCANOLOGY

The Volcanology program of DGGS works as part of an interagency consortium to mitigate hazards from Alaska volcanoes. The consortium is the Alaska Volcano Observatory (AVO), formed by Memorandum of Understanding in 1988. AVO cooperators are DGGS, the U.S. Geological Survey (USGS), and the University of Alaska Fairbanks Geophysical Institute (UAF/GI). The Director established Volcanology as a separate section of DGGS in early 2007.

AVO studies volcanoes to increase understanding of hazards at particular volcanoes and how volcanoes work in general; monitors volcanoes using seismology, geodesy, satellite remote sensing, field studies, and local observers; and provides timely and accurate warning of increasing unrest and eruptions to emergency management agencies, other government entities, the private sector, and the public. The majority of Alaska's 52 historically active volcanoes are remote from human settlements, but all underlie the heavily traveled north Pacific passenger and cargo air routes between North America and Asia; thus the aviation sector is an important recipient of AVO monitoring and reporting. The vulnerability of local infrastructure to active volcanoes was illustrated by the near-flooding of the Drift River Oil Terminal by lahars (volcanic mudflows) generated on three separate occasions during the spring 2009 eruption of Redoubt volcano. In addition, important transportation hubs at Cold Bay, Unalaska/Dutch Harbor, and Adak are all downwind from nearby active volcanoes, and construction will begin this spring on a ~4,500-foot airstrip 15 miles downwind from Akutan volcano.

The three component agencies of AVO (DGGS, USGS, UAF/GI) each bring particular strengths to the observatory, while sharing general expertise in volcanology. Among these agencies, DGGS has the primary AVO mandate for baseline geologic mapping and the state's mandate for hazards studies. DGGS's administrative flexibility has allowed us to build and maintain the AVO website, serving a large database of descriptive material about volcanoes, providing a cutting-edge system for intra-observatory communication and data sharing, and providing notices of eruptions and unrest to users in public, private, and government sectors. The database and information dissemination tools built around the database have emerged as the most powerful such tool among volcano observatories worldwide, and portions of the software designed and written at DGGS are in use at other U.S. volcano observatories. Particular strengths of the USGS are the federal hazards mandate and direct ties with federal agencies. UAF/GI brings a research mandate and access to technological resources (such as satellite data downlink centers) beyond the financial capability of other AVO partners. All agencies have fundamental expertise in the many scientific and technical disciplines that comprise volcanology.

Funds for DGGS participation in AVO come from cooperative agreements with the USGS. The majority of these funds in turn come from the USGS Volcano Hazards Program base budget. In the past, the remainder has come to USGS as specially mandated congressional programs through other agencies in other departments, such as Transportation and Defense. The loss of these designated funds has negatively impacted AVO's ability to maintain volcano-monitoring networks. The continuing impact to AVO will be significant if replacement funds are not secured. The outcome of the federal budget process is unknown, and difficult to predict.

OBJECTIVES

1. Help mitigate risks to public safety and health by providing information on volcanic hazards as they affect human activity.
2. Represent the State of Alaska's interests within the multiagency Alaska Volcano Observatory.
3. Develop and maintain the Alaska Volcano Observatory website as a primary communications vehicle to deliver information about Alaska's volcanoes to the public and provide internal communications and data exchange among AVO personnel.

4. Provide comprehensive information on Alaska volcanoes, including past history and current activity, to the general public, agencies, and volcanologists worldwide.

FY2011 VOLCANOLOGY PROJECTS

Detailed project summaries for the following Volcanology projects appear in the section *Project Summaries—FY2011:*

In addition to the above projects, the Volcanology Section performs the following tasks:

- Assist AVO in volcano monitoring. AVO monitors volcanoes using short-period seismometers, broadband seismometers, continuous telemetered GPS, satellite imagery, gas measurements, web cameras, and local observer reports. AVO maintains seismic networks on about 30 active volcanoes (up from four in the mid 1990s), and monitors more than 100 volcanoes twice daily by satellite. While not a primary DGGS activity, DGGS assists in volcano monitoring when needed during eruption events.
- Provide advanced GIS expertise to all component agencies in AVO. This includes producing base maps in areas where 1:63,360-scale topographic maps do not exist, retrieving and georegistering maps from discontinued map series, and producing a variety of other georegistered data products. DGGS also provides expertise in finalizing and troubleshooting GIS-based map publications using standard GIS techniques for numerous projects in all AVO component agencies. DGGS is currently leading the effort in AVO to make a web-accessible catalog of GIS resources.
- Provide helicopter and fixed-wing airplane logistics. DGGS manages helicopter charter procurement for all major AVO projects, and fixed-wing charter for volcanic gas measurement flights. Consolidating all the contracting in a single agency results in significant budgetary and logistic efficiencies.
- Perform geochemical data procurement and archiving, coordinating geochemical analyses, and maintaining the archive of those data. These data share rigid inter-project quality controls, making the combined dataset a major resource for researchers and adding substantially to the value of the data from individual geologic mapping projects.
- Represent DGGS to CUSVO/NVEWS. DGGS is one of the charter members of the Consortium of U.S. Volcano Observatories (CUSVO), which provides coordination among the five volcano observatories in the United States. The National Volcano Early Warning System (NVEWS) is a major emerging initiative of CUSVO; the DGGS project leader serves on the NVEWS steering committee.
- Provide information on geothermal resources to state and federal agencies, the private sector, and the public.

GEOLOGIC COMMUNICATIONS

The Geologic Communications Section provides a variety of services that make Alaska geologic and earth science information readily available to the public, private industry, government, and academia. Some team members work to publish reports and maps; some maintain and upgrade the division's Digital Geologic Database; some maintain and improve the DGGS website; and others ensure the entire division has a network and computer equipment that helps staff do their jobs.

The section's publications specialists edit, design, publish, and distribute technical and summary reports and maps generated by the Division's technical projects about Alaska's geologic resources and hazards. The maps and reports released with the help of this group are the state's primary means for widely disseminating detailed information and data relating to Alaska's subsurface mineral and energy wealth, geologic construction materials, and geologic hazards. These printed or digital-format documents and datasets focus attention on Alaska's most geologically prospective and useful lands and are the authoritative geologic basis for many of the state's resource-related land-policy decisions. They also encourage geologic exploration investment leading to resource discoveries and subsequent major capital investments. Timely availability of geologic information from DGGS is a significant factor in stimulating Alaska's economy and mitigating the adverse effects of geologic hazards.

The section's geologic information center ensures that information is delivered to the public on a wide range of topics including mineral and energy resources, prospecting, earthquakes, volcanoes, and permafrost. It assists customers in understanding geologic and geophysical maps, and manages sales and inventories of geologic reports, maps, and digital data. Additionally, the information center prepares displays and represents the division at geologic conferences and events. The section produces this annual report summarizing division activities and accomplishments; publishes twice-yearly newsletters to communicate division progress and advertise recent publications; designs, edits, and produces technical and educational geologic maps and reports in printed and digital formats; manages the DGGS library so that reports (by DGGS and other agencies) are available for geologic staff use; and participates in outreach activities such as classroom presentations, science fair judging, and helping teachers plan earth science units.

The division's digital geologic database project (Geologic & Earth Resources Information Library of Alaska – GERILA) has three primary objectives: (1) maintain this spatially referenced geologic database system in a centralized data and information architecture with networked data access for new DGGS geologic data; (2) create a functional, map-based on-line system that allows the public to find and identify the type and geographic locations of geologic data available from DGGS and then view or download the selected data along with national-standard metadata (www.dggs.alaska.gov/pubs/); and (3) cooperatively integrate DGGS data with data from other agencies through a multi-agency website (www.akgeology.info/).

The Geologic Communications section provides computer hardware and software and Geographic Information System (GIS) service and support to DGGS staff, and streamlines information delivery to the public. The section developed the division's website and began extensive use of the Internet in FY1998 to increase the availability of the Division's information and to provide state and worldwide access to the information about the geology of Alaska. These efforts developed into a major project to establish, maintain, and enhance a state–federal, multi-agency, Internet-accessible Alaska geologic database management system. Federal funding supported an extensive effort to scan, convert to digital format, and post the entire pre-digital DGGS collection of publications on our website. The U.S. Geological Survey provided additional funds to do the same for all pre-digital Alaska-related USGS publications and make them available via the DGGS website. Recent additions to the DGGS website include the Alaska minerals-related publications of the U.S. Bureau of Land Management (formerly U.S. Bureau of Mines), and publications produced by the University of Alaska Fairbanks Mineral Industry Research Laboratory (MIRL).

The Geologic Communications Section is supported by the General Fund, Program Receipts from publication sales, and Federal Receipts.

OBJECTIVES

1. Disseminate new, accurate, unbiased, Division-generated data on Alaska's geology, as well as selected pertinent data from other sources, to DNR policy and regulatory groups, to the public at large, and to all other interested parties, within one year of its acquisition.
2. Preserve and manage the data and knowledge generated by the Division's special and ongoing projects in an organized, readily retrievable, and reproducible form consistent with pertinent professional standards and documented with national-standard metadata.
3. Enhance public awareness of Alaska's prospective mineral and energy resources and geologic hazards.

FY2011 GEOLOGIC COMMUNICATIONS PROJECTS

Detailed project summaries for the following Geologic Communications projects appear in the section *Project Summaries—FY2011:*

*MDIRA-supported project (see p. 16)

GEOLOGIC MATERIALS CENTER

The Alaska Geologic Materials Center (GMC) in Eagle River archives and provides public access to non-proprietary oil, gas, and coal drill cores and drill-cutting samples, rock cores from mineral properties, and processed ore, oil, gas, coal, and source-rock samples. These samples are used by government and private-sector geoscientists to improve the odds of finding new oil, gas, and mineral deposits that will maintain the flow of state revenues and provide in-state employment. The Geologic Materials Center Project is supported by the General Fund budget and in-kind contributions from industry. Additional financial support is received annually from the Alaska Oil & Gas Conservation Commission. The private sector contributes the cost of delivering all new samples, sample preparation and analyses, sample logs, and data logs, and occasionally donates storage containers and/or shelving.

The holdings of the GMC are a continually growing asset that is compounding in value over time at little cost to the state. The GMC facility is staffed by two Division geologists, a Natural Resource Technician, a contract geologist, three student interns, and several volunteers. The GMC has formal cooperative agreements with the U.S. Geological Survey, the U.S. Bureau of Ocean Energy Management, Regulation and Enforcement, and U.S. Bureau of Land Management to house and control their geologic materials from Alaska. A voluntary 14-member board advises the curator and DGGS on matters pertaining to the GMC.

With federal funding and through a Reimbursable Services Agreement with the Department of Transportation & Public Facilities, DGGS recently completed a concept study for construction of a new materials center to replace the existing GMC. The sample collection long ago exceeded available warehouse space, with the overflow now occupying 60 unheated tractor-trailer type portable storage containers. Limited space and unsuitable site conditions preclude significant expansion at the existing site in Eagle River. DGGS is negotiating a proposed new site in Anchorage and is now looking for sources of funding to finance the project. The concept study report is available on the GMC web page. DGGS has begun the design and engineering for a new facility with support of state Capital Improvement Project (CIP) funds. This work is being conducted by a private engineering firm contracted by the Department of Transportation & Public Facilities.

OBJECTIVES

1. Encourage responsible resource development and in-state employment opportunities by increasing accessibility to representative geologic samples and information pertaining to oil, gas, and mineral exploration.
2. Advance the knowledge of the geology and resources in Alaska's structural basins favorable for oil or gas discovery.
3. Advance the knowledge of Alaska's mineral potential by making available representative samples of ores and drill cores from mineral deposits throughout the state.

A detailed project description for the Geologic Materials Center appears in the section Project Summaries–FY2011 (p. 81).

ADMINISTRATIVE SERVICES

The Administrative Services group provides financial control and administrative support for all other projects in the Geological Development component including: securing lowest costs for goods and services; maintaining, and when necessary, procuring vehicles for fieldwork; coordinating travel arrangements and appropriate paperwork to minimize travel expenses and field party subsistence costs; administering and monitoring grants and contracts; tracking and reporting project expenditures to ensure cost containment within budget for all projects; mail/courier services; assistance in personnel matters; and any other support necessary to increase efficiency or savings in acquiring and disseminating knowledge of the geology of Alaska.

OBJECTIVE

1. Facilitate the efficient administration of DGGS programs and projects.

TASKS

- Monitor grants and contracts (Federal, Interagency, and Program Receipts) to ensure deliverables are produced on schedule and within budget; ensure expenses are timely and properly billed against grants and contracts and receipts are collected promptly.
- Provide accurate, timely reporting of project expenditures and current balances; encourage prudent money management.
- Provide accurate, timely processing of employee timesheets, invoices, procurement records, and other documentation required by the State; ensure strict adherence to State archiving requirements.
- Minimize the cost of transportation to and from the field by coordinating personnel travel and supply shipments.
- Coordinate Division vehicle use to minimize requests for reimbursement for personal vehicle mileage.
- Make travel arrangements and complete travel authorizations to ensure use of the lowest-cost travel options.
- Assist staff with personnel matters; inform staff about changes in personnel rules or benefits and ensure that all personnel paperwork complies with applicable rules and regulations. Estimate future personnel salaries and benefits to assist management in making human resource decisions necessary to efficiently accomplish the division's mission.

EMPLOYEE HIGHLIGHTS

~ ~ ~ WELCOME ~ ~ ~

Rebecca-Ellen Farrell started working with DGGS in June 2010 as a geologist in the Engineering Geology section. She is working on the Alaska Quaternary Fault and Fold Database, which will be incorporated into the U.S. Geological Survey's national database of active faults and folds.

Originally from Pennsylvania, Rebecca-Ellen earned her B.A. in Geology from Smith College in 2004. Feeling drawn to Alaska, she moved to Juneau for two years. To continue her studies, she relocated to Vancouver, B.C., where she earned her M.S. in Geological Sciences (Volcanology) from the University of British Columbia in May 2010. Her thesis work focused on the Neogene Chilcotin basalts, located in Chasm Provincial Park, central British Columbia. Her favorite things to do while working in the Chasm canyon included stratigraphic logging, facies analysis, sampling for geochronology, traversing, and drawing cross-sections, while at the same time observing lots of California Big Horned Sheep. Using physical volcanology, she reconstructed the emplacement history by defining the volcanic facies architecture for the Chasm canyon.

Outside of the office, Rebecca-Ellen enjoys speedskating, cycling, yoga, and hiking about in the Interior.

Patricia (Trish) Gallagher joined DGGS as a Geologist in October 2010. She grew up in the foothills of Colorado and moved to Alaska to attend the University of Alaska Fairbanks. She graduated in May 2009 with a bachelor's degree in geology. From 2008 to 2009, while completing her geology degree at UAF, Trish was a student intern for the Engineering Geology section at DGGS. Her primary responsibilities were to use GIS and graphics programs to edit maps as part of the Gas Pipeline Corridor Geologic Hazards and Mapping Project. After graduating, Trish has continued working with DGGS as a non-permanent geologist, where she is involved with work on the Gas Pipeline Corridor Project .

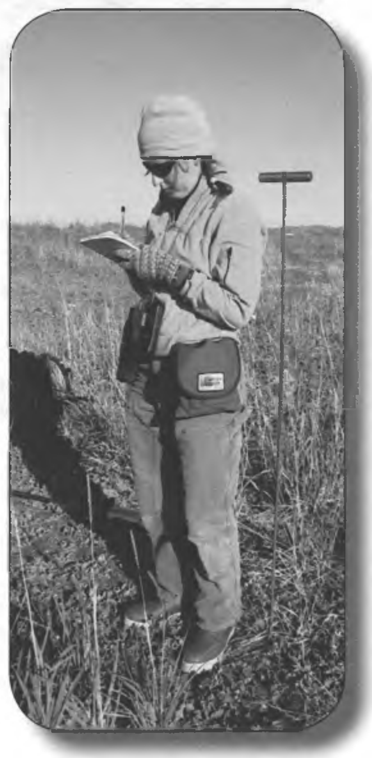
Trish managed the field database and assisted with field logistics in addition to doing GIS and graphics work for the Gas Pipeline Corridor Geologic Hazards and Mapping Project. As a non-permanent geologist she supports multiple Mineral Resources Section projects with field operational support, computer and field data Access database management and input, post-field sample management, data analysis, and ArcGIS data-layer construction.

When not at work, Trish loves to ride horses, bake and decorate cakes, fish, spend time outdoors, and spoil her lovable husky, Aedan.

Gerry Griesel joined the Mineral Resources section at DGGS in June 2010. He was born in Calgary, Alberta, and spent his first seven years in rural southeastern British Columbia before moving to Washington state in 1985. He earned his B.S. in Geology from Western Washington University (WWU) in 2001. While at WWU he developed an affinity for doing field work in the North Cascade Mountains of Washington and British Columbia. Following his undergraduate degree he worked with Washington State Department of Natural Resources on geologic mapping projects and as a Teaching Assistant for WWU field classes. Gerry returned to WWU in 2004 to earn his Master's degree in Geology. His research focused on the complex structural evolution and tectonic history of the North Cascades.

After graduate school, Gerry worked for two years on various projects in the Basin and Range province of North America. In 2008 he worked for a small gold exploration company mapping high-angle structures related to a hot-spring-style epithermal gold system in the Albion range of southeastern Idaho. He spent the following year with AltaRock Energy, one of only a few companies in North America that are actively seeking to develop engineered geothermal systems (EGS). He was the lead geologist in charge of identifying the most suitable targets for potential EGS development across a broad area of southeastern Oregon and northern California. He had begun working with another small gold company in Nevada in early 2010 before accepting the position with DGGS.

When he is not at work, Gerry's interests include snowboarding (shout out to Mt. Baker Ski Area!), backpacking, camping, barbeque, sports (Go Seahawks! Go Mariners!), and live music. He and his wife Michelle celebrated the birth of their first child, Baker Maxwell Griesel, who arrived December 10, 2010. They are both new to Alaska, and are looking forward to learning some new hobbies, such as canoeing, fishing, shooting, and cross-country skiing.



Nicole Kinsman is making a gradual transition into her position as the new coastal geologist with the Engineering Geology Section of DGGS. She arrived in Fairbanks in June 2010 and stepped right into the field, investigating coastal hazards in and around Kivalina. Nicole expects to return to DGGS in January 2011 upon wrapping up her Ph.D. in Earth Sciences at the University of California, Santa Cruz.

Nicole hails from upstate New York, where her initial exposure to coastal erosion arose maintaining a cement seawall with her grandfather on the glacial till bluffs of Lake Ontario. She attended Colgate University and received her B.A. in Geology with a thesis on the stable isotope geochemistry of metamorphic fluids. Thanks to a coastal geomorphology class at the University of Wollongong, Australia, Nicole reconciled her long-standing interests in both ocean science and geology and moved to California to pursue a career in the coastal sciences.

In California, Nicole worked closely with the Department of Boating and Waterways to improve regional coastal management by inventorying coastal engineering structures (for example, groins) and documenting local knowledge of the shoreline's response to anthropogenic modification. Her doctoral research is focused on the influence of engineered littoral barriers on sandy beaches, and coastal cliff morphology. She has also been contracted by the U.S. Geological Survey to conduct coastal sediment transport and shoreline change studies in southern California. Nicole's research interests encompass a wide range of topics from coastal landform evolution to human-induced coastal modifications and coastal hazards.

Nicole is very excited about relocating to Alaska and cannot wait to explore the state's impressive geology, both at work and in her free time. When she is not hiking or counting sand grains, Nicole enjoys canoeing, sewing, carpentry, and aviation.

David Mauel began working as geologist with the Energy Resources Section's bedrock mapping team in June 2010 and was out doing fieldwork on the North Slope by his fourth day on the job. Dave was born and raised in the small town of Oconomowoc, Wisconsin. After high school, he attended the University of Wisconsin Oshkosh and earned his B.S. in Geology. He then left his fellow cheeseheads and moved to the desert southwest, where he worked as a geologist for ASARCO at the Ray Mine, a large porphyry copper deposit in east-central Arizona.

Following a downturn in the mineral industry, Dave returned to school, where he focused on the study of basin analysis and sedimentary tectonics. In 2008 he earned his master's degree from New Mexico State University. His graduate research utilized stratigraphy, sedimentology, geochronology, and structural analysis to improve understanding of a Late Jurassic rift basin in Sonora, Mexico, which underwent its greatest subsidence concurrently with the initial opening of the Gulf of Mexico and breakup of Pangean supercontinent. While attending New Mexico State, Dave also taught in middle school science classrooms several days a week for two years as a National Science Foundation GK-12 Fellow. As part of this program, he designed and implemented inquiry-based modules intended to foster critical thinking skills in the students.

Although Dave's geological interests lie primarily in basin analysis and tectonics, he remains interested in Alaska's mineral deposits. It was while working on various copper, gold, and nickel explorations programs in the minerals industry from 2005 to 2010 that Dave was introduced to Alaska's geology and natural wonders. As a result, he remains interested in learning more about the geology of Alaska's many deposit types, in addition to its rich mining history.

Dave is looking forward to his first Fairbanks winter, particularly the opportunity to try out the local cross-country skiing trails. In his spare time, he enjoys hiking, reading, playing guitar, and traveling.

~ ~ ~ GOODBYE ~ ~ ~

ALFRED (FRED) STURMANN retired from his position as DGGS's Geographic Information System (GIS) Manager and Cartographer at the end of August 2010. In his career at DGGS, which spanned nearly 30 years, "state-of-the-art mapmaking" evolved from a painstaking, hand-scribed method that frequently involved years of handwork to produce one geologic map sheet, to lightning-speed digital production of maps, from start to finish in possibly a month or less. Fred won one national and 12 statewide awards for cartographic design over the years.

In one of his final projects before retirement, Fred rewrote the DGGS Geologic Cartography Manual, addressing the digital process and incorporating the tips and suggestions he had so that all future mapmakers at the survey could benefit from it.

Fred and Erna like to sail their small sailboat on Alaska's lakes or ocean or go on extended kayaking tours. They like to hike and ski, and enjoy camping in the mountains. Alfred enjoys making furniture of the Arts & Crafts period.

We wish the best for Fred and his family as he works on completing his new house and plans a trip to Austria to visit family there.

Happy Sailing, Fred and Erna!

PROJECT SUMMARIES—FY2011

Alaska faces the challenge of growing a healthy economy from its natural resources while protecting an environmental legacy that is the envy of many. The Department of Natural Resources' Division of Geological & Geophysical Surveys is an integral partner in the team of state agencies that strive to meet this challenge. The output from our projects provides the fundamental earth-science information required to guide critical policy decisions, encourage exploration investment, mitigate the effects of geologic hazards, and improve the quality of life for all Alaskans.

The overviews of the following 48 projects that DGGS is pursuing in FY2011 span the scope of our legislative mission statement.

Each of these projects is making a positive difference for Alaska. Many are implemented through various cooperative agreements with other state and federal agencies, universities, in-house project teams, and contracts. We leverage state General Funds through these arrange-ments so that the Division's work provides the greatest possible benefit from the public's investment.

Energy Resources

Mineral Resources

**MDIRA-supported project (see p. 16)*

Engineering Geology

Volcanology

Geologic Communications

Geologic Materials Center

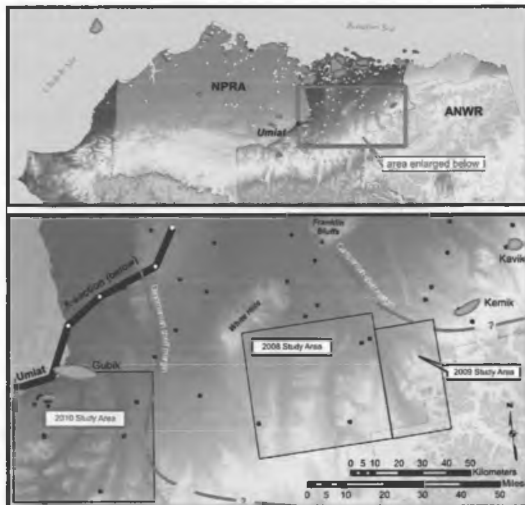
**MDIRA-supported project (see p. 16)*

BROOKS RANGE FOOTHILLS & NORTH SLOPE PROGRAM

Alaska's North Slope remains one of the most promising onshore oil and gas provinces in all of North America. The Division of Geological & Geophysical Surveys (DGGS) continues its leadership role in furthering the geologic understanding of this petroleum system, primarily through investigations of rocks exposed in the foothills of the northern Brooks Range. This program was developed in response to the need for high quality, publicly available geologic data to stimulate exploration for hydrocarbons in northern Alaska. The cost of this program is shared by major and independent oil and gas companies. While directed by DGGS, this research effort is a multi-agency collaboration that includes the Alaska Division of Oil & Gas (DOG), the United States Geological Survey (USGS), the University of Alaska, and others.

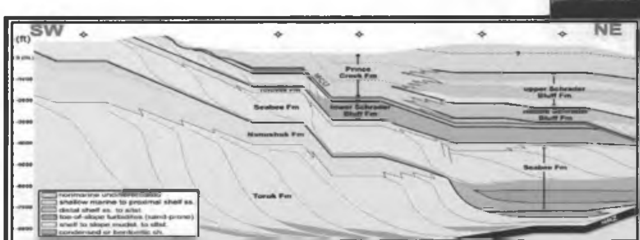
Our work over the last several years has focused on State lands in the central North Slope where we can tie surface geologic observations with the higher density and quality of subsurface data (wells and seismic). During the 2010 field season, the program shifted westward to the Umiat area (fig. 1), a region that has undergone significant exploration activity in recent years. We conducted reconnaissance mapping in anticipation of a multi-year project in the area. In addition we continued our emphasis on key reservoir and source rock intervals, providing new constraints on the depositional history and correlation of units. Our stratigraphic work focused particularly on potential reservoir rocks of the Tuluvak and Schrader Bluff Formations, and included the discovery of an oil-stained interval in the uppermost Seabee Formation. These detailed outcrop observations are being integrated with available subsurface data to arrive at an improved understanding of how this hydrocarbon-rich basin evolved.

During the spring of 2010, we organized a successful two-day DNR Technical Review Meeting in Anchorage to summarize our recent work and share interim results relevant to oil and gas exploration. Much of the work presented at this meeting will be published through DGGS in the upcoming year, including several geologic maps (see p. 35) and a collection of papers summarizing topical structural and stratigraphic studies.



Location map of northern Alaska and expanded view of state lands of the east-central North Slope. Cross section is simplified from Decker (2007).

Oil-stained sandstone of the upper Seabee Formation discovered during 2010 fieldwork along the Anaktuvuk River.



Decker, P.L., 2007, Brookian sequence stratigraphic correlations, Umiat Field to Milne Point Field, west-central North Slope, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2007-2, 19 p., 1 sheet

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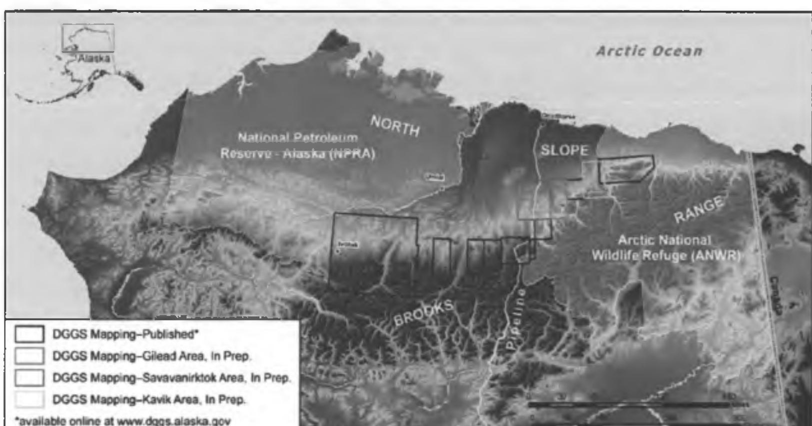
GEOLOGIC MAPPING IN THE GILEAD CREEK AREA

Petroleum production in northern Alaska has long contributed to the State's economic security and provides many jobs for Alaskans. However, an increasingly diminished throughput in the Trans-Alaska Pipeline System and uncertainty regarding construction of a major natural gas pipeline provide sustained impetus for the Alaska Division of Geological & Geophysical Surveys (DGGS) to continue generating publicly available geologic information. DGGS regularly conducts detailed geologic mapping in the North Slope foothills to improve our understanding of the State's energy resources and promote continued exploration investment by industry. These geologic maps are often consulted by industry in their efforts to determine oil and gas prospectivity, particularly farther north where bedrock exposures are typically obscured by an extensive mantle of Quaternary deposits and tundra.

During summer 2009, we collaborated with the Alaska Division of Oil and Gas and University of Alaska Fairbanks to map ~500 square miles in the Gilead Creek area of the east-central North Slope (see map). This map area lies immediately adjacent to other recent DGGS map projects and furthers one of our program's long-term goals of publishing exceptionally detailed, 1:63,360-scale geologic maps of the entire foothills region.

The Gilead Creek area lies in a unique structural position within the foothills, spanning the transition from thin-skinned deformation of Cretaceous–Tertiary Brookian sediments in the west to higher relief, basement involved structures in the east. This transition exposes at the surface critical stratigraphic relationships that are otherwise only known via subsurface data.

Key observations from our mapping and stratigraphic work include new insights into the mid-Cretaceous Gilead succession, a >850-meter-thick, sand-rich, locally petroliferous package of sediment gravity flow deposits—likely recording basin-axis sedimentation in a toe-of-slope environment—that may have prospective subsurface equivalents to the west (see photo; bed "a" is 3.5 meters thick). Additionally, we recognized two mappable units within the distal Upper Cretaceous Hue Shale that are regionally separated by an intervening tongue of sand-prone Seabee Formation; the latter formation—stratigraphically encased by excellent source-rock facies of the Hue Shale—commonly exhibits a strong hydrocarbon odor.



A digitally drafted geologic map of the Gilead area was prepared during winter 2009–10 and presented to industry, government, and academia participants at the Alaska Department of Natural Resources-led Technical Review Conference in Anchorage (April 2010). We anticipate the final map will be published as a Report of Investigations available through the DGGS website in 2011. This work is funded by the State of Alaska and industry receipts.

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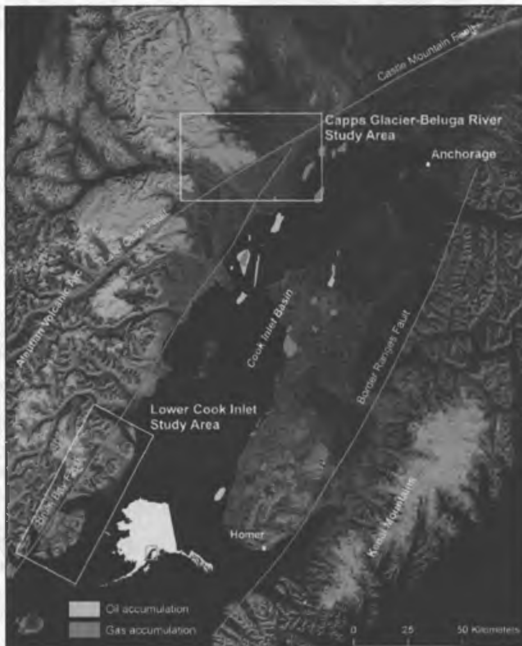
COOK INLET GEOLOGY AND HYDROCARBON POTENTIAL

Increasing demand and predicted deliverability shortfalls for Cook Inlet gas to south-central Alaska customers pose a serious threat to the region's economy. These factors make it an ideal time to promote new exploration investment in the Cook Inlet region. The Alaska Division of Geological & Geophysical Surveys (DGGS) is responding to this challenge by leading a multi-year, multi-agency program of relevant applied geologic research designed to provide high-quality data to the geologic community and public policy makers. This program is a collaborative effort between DGGS, the Alaska Division of Oil and Gas (DOG), the University of Alaska Fairbanks, and the U.S. Geological Survey.

Historically, Cook Inlet exploration has focused on the search for large fold structures with four-way closure (analogous to an inverted bowl). Now that nearly all large structures have been found and tested, the exploration focus is gradually shifting to subtle stratigraphic traps and reservoirs in low porosity and permeability formations. Successful exploration for these plays requires detailed knowledge of potential reservoir geometries, geologic factors controlling these geometries, and geologic controls on reservoir producibility. The initial goal of this program is to improve understanding of potential reservoir geometries, reservoir quality, and their geologic controls.



During 2010 DGGS and DOG continued documenting the geometry of potential reservoir sand bodies in Tertiary- and Mesozoic-age sandstones in the Capps Glacier–Beluga River region west of Anchorage and along the west side of lower Cook Inlet, due west of Anchor Point (see satellite image). Work in the former area focused on documenting alluvial fan and gravelly river deposits along the western basin margin. Detailed stratigraphic and structural studies by our group have demonstrated these rocks were deposited during a period of active faulting and volcanic activity (see inset photo), both of which dramatically affected sand body geometries and reservoir quality. Work in the latter area focused on documenting sand body geometries, reservoir quality, and petroleum source rock potential of Upper Jurassic through Lower Cretaceous age marine rocks in coastal exposures. Oil-stained Cretaceous-age sandstones were sampled for geochemical analysis. Oil extracted from these sandstones will provide valuable information on petroleum source rocks known to underlie much of the basin. Important additional components of this program include bedrock geologic mapping in the Tyonek Quadrangle (see p. 37), a study currently underway to document the subsidence history of upper Cook Inlet, and a subsurface mapping effort aimed at delineating the distribution of petroleum source rocks relative to thick accumulations of potential reservoir sandstones.

This project is funded by the State of Alaska, Apache Corporation, and the U.S. Geological Survey STATEMAP and Energy programs. Results of this work have been documented in a series of publications available from the DGGS website (www.dggs.alaska.gov). Additional publications will be released as they become available.

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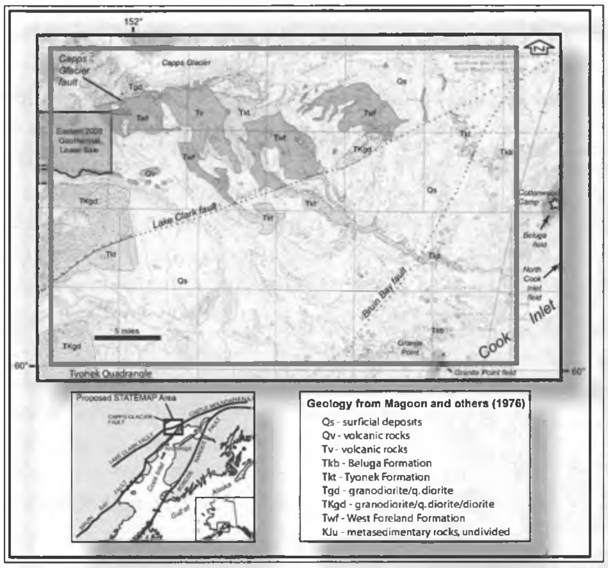
GEOLOGIC MAPPING IN THE TYONEK–CAPPS GLACIER AREA

Gas production from Cook Inlet basin has contributed significantly to Alaska's economy by providing inexpensive natural gas for industrial use, electric power generation, home heating fuel, and job creation for south-central Alaska. Rising demand, predicted deliverability shortfalls, and volatility in commodity prices underscore the need for discovery of additional gas reserves in Cook Inlet. Despite the growing need and significant remaining gas potential, exploration interest in the basin remains weak. The Division of Geological & Geophysical Surveys (DGGS) is responding by pursuing a program in the basin focused on understanding the potential for stratigraphic traps and gas reservoirs in low porosity and permeability (tight) formations (p. 36). This program includes detailed geologic mapping of areas where outcrop relations are complex, poorly understood, and important for understanding the potential for gas reservoirs in stratigraphic traps and tight formations.



During the summer of 2010, DGGS completed 1:63,360-scale geologic mapping of nearly 475 square miles in the Tyonek Quadrangle, southeast of the Lake Clark fault between Blockade Glacier and Olson Creek (inset map). This work was a continuation of similar mapping performed in 2009 of the region northwest of the Lake Clark fault. The final published product will be a new 1:63,360-scale geologic map encompassing approximately 875 square miles along the northwestern margin of Cook Inlet basin, and an accompanying report. A more thorough geologic understanding of this area is important because it includes some of the best exposures of Tertiary Cook Inlet basin strata (inset picture), some of which serve as reservoirs in the nearby Beluga, North Cook Inlet, and Granite Point fields. Available geologic mapping in the area either predates modern stratigraphic nomenclature used in the basin, or lacks structural details necessary for reconstructing the geologic history of the region. Each is critical for understanding controls on reservoir geometries and quality required to assess the potential for stratigraphic traps and reservoirs in tight formations. Our mapping has unraveled complex stratigraphic and structural relationships and represents a major step forward in understanding the geologic evolution of the northwestern margin of the basin, including formation of the previously mentioned oil and gas fields. Concurrent with bedrock mapping, new 1:63,360-scale mapping of the surficial geology has led to improved understanding of the glacial history of the region and its sand and gravel resources. Preliminary analysis of shallow-faulting related seismic hazards that represent potential threats to nearby population centers and petroleum production infrastructure has been performed as part of this project as well. Our work in this area will help spur exploration interest and investment in Cook Inlet basin.

Preliminary 2009 and 2010 mapping was completed with partial funding from the U.S. Geological Survey's STATEMAP program and a preliminary map of the entire project area will be submitted to the USGS in spring 2011. Preliminary results from related stratigraphic and structural studies will be published as DGGS reports by early 2011.

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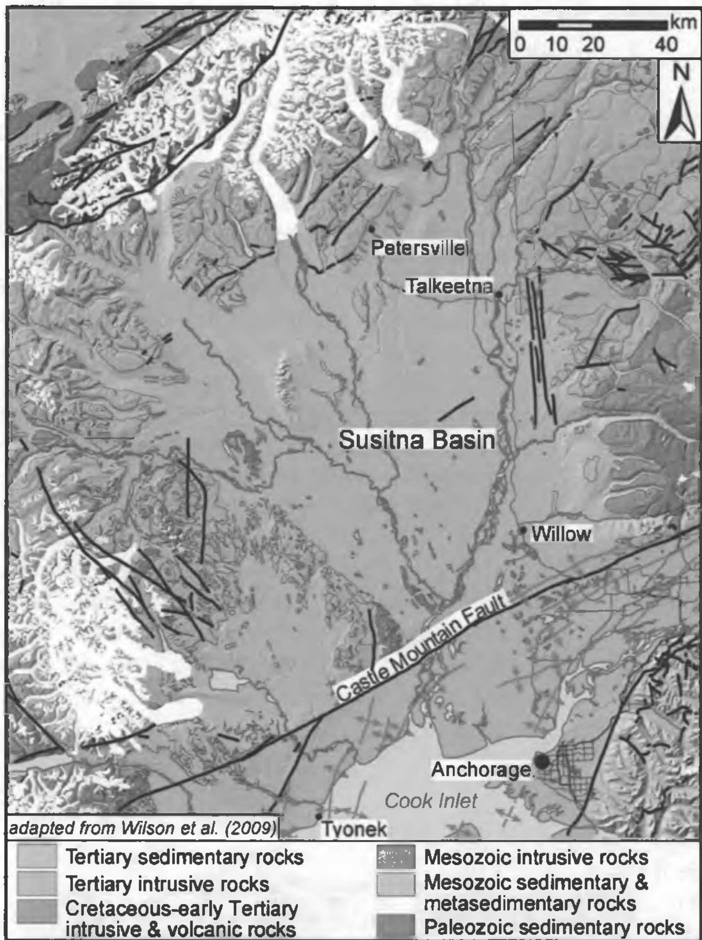
GEOLOGY AND NATURAL GAS POTENTIAL OF THE SUSITNA BASIN

The geology of the Susitna basin suggests it might include producible volumes of natural gas, but a lack of data hinders realistic assessment of this potential resource. The Division of Geological & Geophysical Surveys (DGGS) is responding to this challenge by leading a multi-agency investigation of the natural gas potential (including unconventional gas) of the basin for in-state use. Considering its proximity to the state's most populous region, the Susitna basin project is especially timely as Alaska faces significant energy challenges that threaten the state's economic future. This project, funded by the State of Alaska, will provide relevant geologic data in the public domain to help spur private-sector investment in the basin.

The Susitna basin is poorly understood even though available data suggest it has significant natural gas potential. The basin is bounded by rugged, mountainous topography on the east, west, and north sides and the Castle Mountain fault on the south side (see inset map). The Castle Mountain fault separates the basin from the geologically better known Cook Inlet basin, which includes significant proven oil and gas resources. The Susitna basin includes some of the same coal-bearing rock formations that have supplied large quantities of gas in producing Cook Inlet fields. Outcrops of the coal-bearing Tyonek and Sterling formations are known from widely scattered locations throughout the basin and a few exploration wells have also penetrated these same coal-bearing units. This information suggests the presence of large structures that could have provided the uplift required to facilitate migration of biogenic gas to porous and permeable reservoirs—a mechanism recognized as critical in the formation of Cook Inlet gas accumulations. While these stratigraphic and structural elements are present in the basin, they are so poorly known that realistic evaluation of gas potential is not possible.



DGGS is currently compiling and evaluating available data and planning fieldwork in the basin during the 2011 field season. Fieldwork will focus on developing a better understanding of gas source rocks (coal) and structures that could have resulted in uplift and desorption of gas from coal-bearing strata. Results of this work will be documented in a series of publications available from the DGGS website (www.dggs.alaska.gov).

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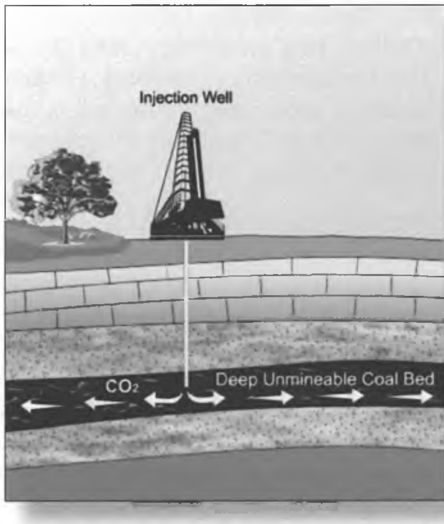
REFINING ESTIMATES FOR ALASKA COAL SEAM CARBON SEQUESTRATION

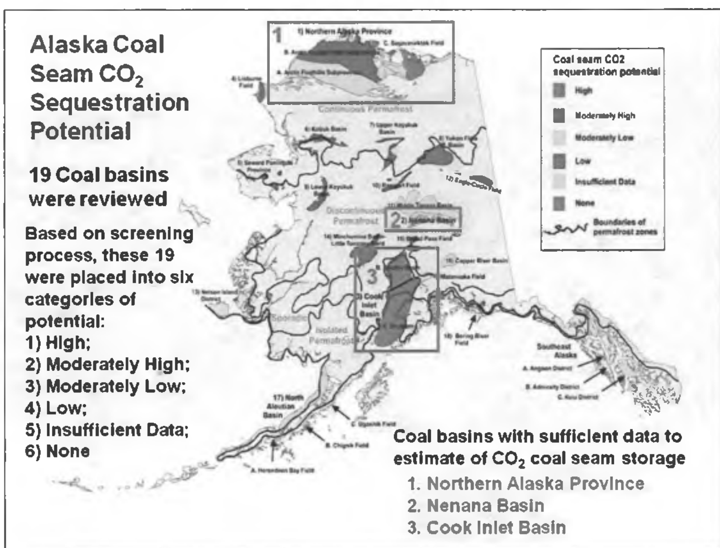
Carbon dioxide (CO_2) capture and storage technologies could play a critical role in mitigating the impact of fossil-fuel-based electricity generation on greenhouse gas buildup. Nearly one-third of the carbon emissions in the U.S. come from power plants. Geologic sequestration of CO_2 generated from fossil fuel combustion may be a viable method to reduce the amount of greenhouse gas emissions. In the subsurface, coal seams often contain gases such as methane. The gas is held in pores on the surface of the coal and in fractures in the seams. If CO_2 is injected into a coal seam it displaces the methane, and can remain stored within the seam, provided the coal is never disturbed. Tests have shown that the adsorption rate for CO_2 is approximately twice that of methane. Sequestering CO_2 in coal beds has several advantages. For example, CO_2 injection can enhance methane production from coal beds.



The West Coast Regional Carbon Sequestration Partnership (WESTCARB) is identifying and validating carbon sequestration opportunities in California, the surrounding states of Arizona, Nevada, Oregon, Washington, Alaska, and the Canada Province of British Columbia. Findings from the first phase of WESTCARB's regional characterization of geologic formations and managed land suitable for long-term CO_2 storage (known as 'sinks') indicated a lack of data in many key areas. The Alaska Division of Geological & Geophysical Surveys reviewed and refined the coal estimates for storage of CO_2 in deep, unmineable coal seams as the second task under a larger project, Alaska Geologic Carbon Sequestration Potential Estimate: Screening Saline Basins and Refining Coal Estimates, conducted by the Alaska Division of Oil & Gas.

Nineteen Alaska coal basins were reviewed and, through a screening process, were placed into six categories of potential: (1) High; (2) Moderately High; (3) Moderately Low; (4) Low; (5) Insufficient Data; and (6) None. The following main attributes were used in the screening process: • Basin Age, • Depositional Environment, • Structural Setting, • Rank of Coal, • Net Coal Thickness, • Coal Volume, • Coal Quality data, • CBM Data, • Infrastructure, • Type of Permafrost, and • Depth of Permafrost. Three coal basins were determined to have sufficient and reliable subsurface and coal-quality data to make reasonable estimates of CO_2 coal seam storage capacity and are in proximity to existing or potential future infrastructure: (1) Northern Alaska Province, (2) Nenana Basin, and (3) Cook Inlet Basin.

Our study indicates that the coal-seam CO_2 potential storage capacity of Alaska unmineable coal is about 49 gigatons (Gt), which is about 41 percent less than the preliminary estimated volume of 119 Gt CO_2 storage capacity for coal seams. The major difference between our study and the previous study is the result of assessing the presence, extent, and effect of permafrost on permeability of coal seams, and hence its storage capacity. The effective permeability of coal in permafrost is near zero. Therefore, producing methane gas from coal seams in the permafrost zone and storing CO_2 in these same seams is unlikely. Storage of CO_2 in the North Slope region can only be considered in thick coal seams beneath the base of the permafrost that can extend to depths of more than 660 m. This resulted in our much lower estimate of coal seam CO_2 storage capacity of 5.83 Gt than the 98 Gt reported in earlier estimates. Our estimate of 43 Gt CO_2 coal seam storage capacity for the Cook Inlet region was about twice the earlier estimate (21 Gt) because our review of available coal resources indicated 1,570 billion short tons of coal present and we used a CO_2:CH4 ratio of 7:1 rather than the 1,290 billion short tons of coal and 3:1 $CO_2:CH_4$ ratio used in the earlier study.



The final technical report on refinements to coal seam storage of CO_2 for Alaska will be submitted to WESTCARB in April 2010.

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ALASKA COAL DATABASE – NATIONAL COAL RESOURCE DATABASE SYSTEM

The long-term goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) participation in the U.S. Geological Survey's (USGS) National Coal Resource Database System (NCRDS) cooperative program is to record all known coal occurrences in Alaska and archive the information in a single, readily accessible database available at the USGS Web site, http://energy.er.usgs.gov/products/databases/USCoal/. The NCRDS program is funded by USGS through a multi-year proposal process with final reporting at the end of each funding period.

Alaska's coal resources make up about half of the United States' coal-resource base and approximately one-sixth of the total world-resource base. Total identified Alaska coal resources (all ranks) amount to only about 160 billion short tons, yet hypothetical and speculative resources are as high as 5.5 trillion short tons. During the course of gathering information to expand the NCRDS database for Alaska, we recognized the need to collect new coal samples and current stratigraphic data for previously described occurrences. Sometimes a coal occurrence described in older literature is poorly located and the description is either inaccurate or inadequate for a proper resource assessment. The most frequent problems we have encountered are unverified coal seams and coal sample locations, suspect coal quality analyses, and insufficient stratigraphic control.

"Nenana Basin"—Bonnifield project. Aerial view (toward east) of coal-bearing Usibelli Group (likely Healy Creek Formation) in Red Mountain Creek.

FY2010 was the final year of a five-year NCRDS project to collect new data for the Alaska Peninsula, North Slope, Kenai Peninsula–Cook Inlet, and the Nenana Basin as adjunct to ongoing DGGS projects in these regions. Detailed coal stratigraphic and coal quality studies are rarely conducted as part of these larger projects and the proposed work will augment the non-coal data collection, field activities, and reporting. During 2009, we augmented an ongoing oil-and-gas-related study of Cook Inlet that included coal seams in the Capps Glacier area and completed work on coal samples collected during the 2008 eastern Bonnifield Mining District mapping. Additionally, we received the data analyzed by the USGS laboratory as part of the supplementary NCRDS study examining the chemical nature (major-, minor-, and trace-element and mineralogical composition) of the feed coal, fly ash, and bottom ash at the Fairbanks, Alaska, power plant. Sample localities, coal seam characteristics, coal quality, and point-source data will be placed into the Alaska coal resource portion of the NCRDS, with a final report summarizing these data for release in spring 2011.

Cook Inlet—Capps coal bed, Capps Creek (Tyonek Formation).

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STATE GEOLOGICAL SURVEY CONTRIBUTIONS TO THE NATIONAL GEOTHERMAL DATA SYSTEM

The National Geothermal Data System (NGDS) is a U.S. Department of Energy-funded distributed national network of databases and data sites that collectively form a system for the acquisition, management, and maintenance of geothermal and related data. The NGDS website address is: www.geothermaldata.org/

NGDS National Geothermal Data System

Much of the risk of geothermal energy development is associated with exploring for, confirming, and characterizing the available geothermal resources. The overriding purpose of the NGDS is to help mitigate this risk by serving as a central repository for geothermal and relevant related data as well as a link to distributed data sources. By helping with the process of assessing and categorizing the nation's geothermal resources, providing strategies and tools for financial risk assessment, and by consolidating all geothermal data through a publicly accessible data system, the NGDS will support research, stimulate public interest, promote market acceptance and investment, and in turn support the growth of the geothermal industry.

The Alaska Division of Geological & Geophysical Surveys (DGGS) is contributing Alaskan geothermal data to the NGDS as part of a three-year national effort called the State Geological Survey Contributions to NGDS Data Development, Collection and Maintenance that was proposed through the Association of American State Geologists and is being administered by the Arizona Geological Survey. As part of this three-year project that began in 2010, DGGS will compile available hydrothermal, developed geothermal systems, geothermal well data, and heat flow data for input into the NGDS.

Google Earth image of Dutch Harbor—Unalaska with active Makushin volcano in the background. View toward the west.

Hydrothermal data: Digital data from 111 thermal springs and wells statewide including location, water chemistry (some sites), flow rate (some sites), and physical site description. The 111 sites are in the geothermal portion of the Alaska Energy Inventory database.

Developed Geothermal Systems: Chena Hot Springs (Interior Alaska) generates 400 kw of power from a moderate temperature geothermal ORC power plant and has drilled 18 wells to depths of 1,000 feet. Temperatures recorded are up to 80°C (176°F). Data includes water chemistry, permeability, and flow rates.

Geothermal well data: The 1980 drilling at Makushin volcano (see photo) yielded 7,585.5 feet of drill core from six exploratory geothermal wells. Associated data include alteration and fluid inclusion studies. Some of these data are in digital format, but most are not. If geothermal energy were successfully developed at Makushin, it could provide electrical power to the nearby towns of Unalaska and Dutch Harbor.

Heat flow data: There are 1,400 wells oil and gas wells statewide for which temperature logs are available. These data will be evaluated for temperature profile and formation temperatures. The data set includes bottom hole temperature (BHT) data from 278 oil and gas exploration wells that have previously been collected and corrected, from Alaska's North Slope (252 wells) and other basins (26 wells). An additional 1,800 wells from the Prudhoe Bay area and 974 wells from the Cook Inlet area remain to be compiled, data corrected for time since circulation, BHT determined, and interpreted for heat flow.

By the completion of this three-year project, the compiled Alaska geothermal data along with associated metadata will be placed into the NGDS and available for public and governmental use.

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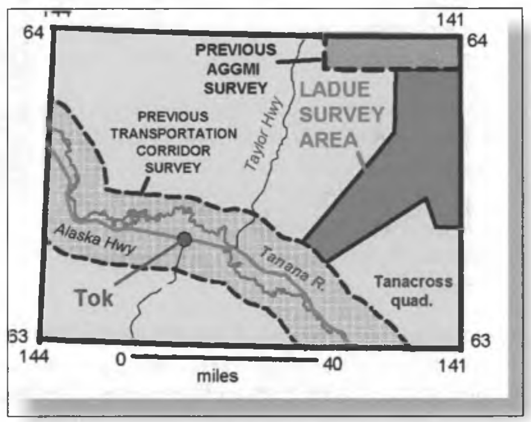
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE LADUE AREA, FORTYMILE MINING DISTRICT, EASTERN ALASKA

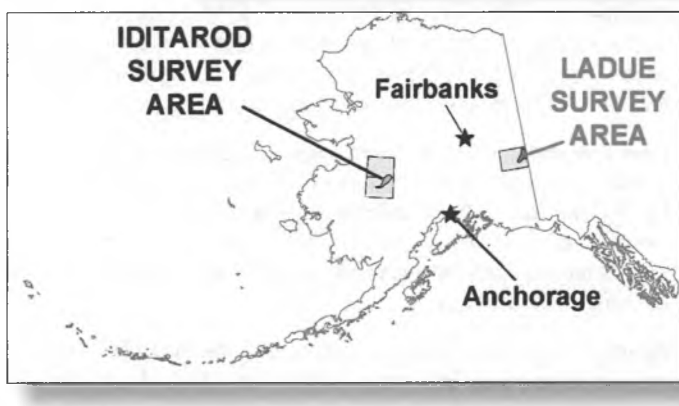
The Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is a multi-year investment to expand the knowledge base of Alaska's mineral resources and catalyze private-sector mineral development. The project seeks to delineate mineral zones on Alaska state lands that: (1) have major economic value; (2) can be developed in the short term to provide high-quality jobs for Alaska; and (3) will provide economic diversification to help offset the loss of Prudhoe Bay oil revenue. Candidate lands for this project are identified based on existing geologic knowledge, land ownership, and responses to solicitations for nominations from Alaska's geologic community. Products resulting from these surveys generally include: (1) 1:63,360-scale aeromagnetic and airborne-electromagnetic maps; (2) 1:63,360-scale geologic maps; and (3) various other geological, geochemical, and geophysical data compilations. As a result of this program, millions of dollars of venture capital have been spent in the local economies of the surveyed mining districts and adjacent areas in direct response to the new geologic knowledge provided by the surveys.

Through the AGGMI program, DGGS is acquiring airborne-geophysical data for the Ladue and Iditarod areas (see p. 43) in FY11. The 730-square-mile Ladue survey tract, about 25 miles east of Tok, is all State land and is part of the Fortymile mining district, the oldest placer gold camp in Alaska. More than 500,000 ounces of placer gold have been produced from the district. Like much of the Yukon–Tanana Uplands, the Ladue survey area is underlain by Paleozoic and older (?) deformed and regionally metamorphosed rocks, and consists of quartzite, schist, gneiss, marble, greenstone, amphibolite, and orthogneiss. Cretaceous- to Tertiary-age igneous rocks of mafic, intermediate, and granitic composition intruded the metamorphosed rocks. The survey area contains large, low-grade copper–molybdenum ± gold(?) porphyry deposits, plutonic-related lode gold prospects, and prospects with anomalous lead and zinc concentrations. The survey area has the potential for hosting emerald deposits similar to the Tsa Da Glisza property in Yukon, Canada, and for metamorphic/orogenic lode gold deposits similar to those of the historic Klondike Gold District in Yukon, Canada, and the Napoleon deposit just northeast of Chicken, Alaska.



Airborne-geophysical surveys enable users to delineate regional structures, and identify metamorphic–stratigraphic lithologies and plutonic rock types based on their geophysical characteristics. Follow-up geologic mapping tests geophysical anomalies and interpretations, and provides detailed documentation of the types, locations, and spatial distribution of metamorphic and plutonic rocks and structural features. By completing an integrated geophysical–geological mineral inventory study, new zones of mineralization may be identified, and extrapolation of some of the information into surrounding areas may be appropriate.

Geophysical information being acquired for the Ladue area includes aeromagnetic and electromagnetic data. Maps and digital data will be released as DGGS Geophysical Reports in mid-winter 2011. A second publication, containing a project report, interpretation, and electromagnetic anomalies, will be released in summer 2011. DGGS believes these data will lead to a better understanding of the geologic framework of the area and will stimulate increased mineral exploration investment within the survey boundary and the surrounding area.



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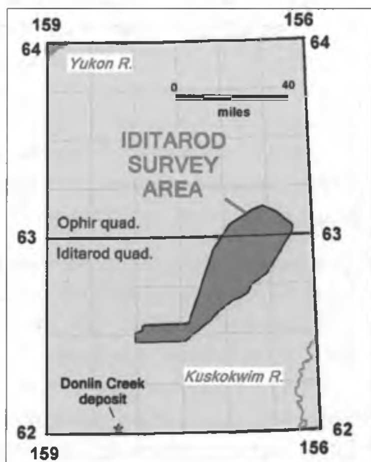
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE IDITAROD AREA, IDITAROD, INNOKO, AND MCGRATH MINING DISTRICTS, WESTERN ALASKA

The Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is a multi-year investment to expand the knowledge base of Alaska's mineral resources and catalyze private-sector mineral development. The project seeks to delineate mineral zones on Alaska state lands that: (1) have major economic value; (2) can be developed in the short term to provide high-quality jobs for Alaska; and (3) will provide economic diversification to help offset the loss of Prudhoe Bay oil revenue. Candidate lands for this project are identified based on existing geologic knowledge, land ownership, and responses to solicitations for nominations from Alaska's geologic community. Products resulting from these surveys generally include: (1) 1:63,360-scale aeromagnetic and airborne-electromagnetic maps; (2) 1:63,360-scale geologic maps; and (3) various other geological, geochemical, and geophysical data compilations. As a result of this program, millions of dollars of venture capital have been spent in the local economies of the surveyed mining districts and adjacent areas in direct response to the new geologic knowledge provided by the surveys.

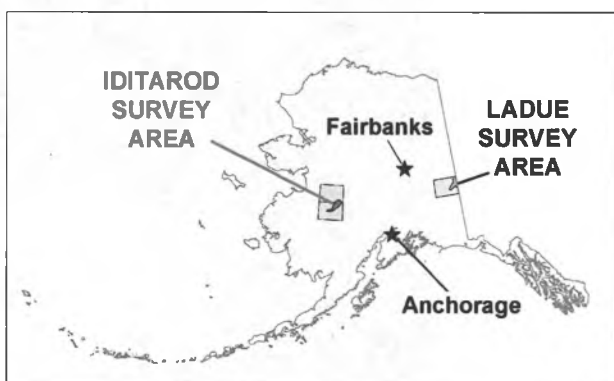
Through the AGGMI program, DGGS is acquiring airborne-geophysical data in for the Iditarod and Ladue areas (see p. 42) in FY11. The 850-square-mile Iditarod survey tract is about 20 miles west of McGrath and 240 miles northwest of Anchorage. The survey area consists primarily of State land, with a small amount of Federal and Native land. Most of the survey area is part of the Iditarod–Innoko mining districts, which have produced more than 2.3 million ounces of gold; only 3,000 ounces of this production has been from lode sources. The discovery of more than 30 million ounces of gold associated with a Late Cretaceous dike swarm at the Donlin Creek deposit, about 30 miles southwest of the survey area, has kept mining activity high in the region.

Like the Donlin Creek area, most of the survey area is composed of the Upper Cretaceous Kuskokwim Group, a flysch sequence consisting of interbedded sandstone and shale. Most plutons have quartz monzonitic to monzonitic compositions and are calc-alkaline. Mineralization is thought to be contemporaneous with plutonism at several localities in the region. Besides plutonic-related gold deposits, other lode potential in the survey area includes mesothermal and epithermal deposits that contain mercury, tungsten, silver, antimony, and tin.



Airborne-geophysical surveys enable users to delineate regional structures, and identify metamorphic–stratigraphic lithologies and plutonic rock types based on their geophysical characteristics. Follow-up geologic mapping tests geophysical anomalies and interpretations, and provides detailed documentation of the types, locations, and spatial distribution of metamorphic and plutonic rocks and structural features. By completing an integrated geophysical–geological mineral inventory study, new zones of mineralization may be identified, and extrapolation of some of the information into surrounding areas may be appropriate.

Geophysical information being acquired for the Iditarod area includes aeromagnetic and electromagnetic data. Maps and digital data will be released as DGGS Geophysical Reports in mid-winter 2011. A second publication, containing a project report, interpretation, and electromagnetic anomalies, will be released in summer 2011. DGGS believes these data will lead to a better understanding of the geologic framework of the area and will stimulate increased mineral exploration investment within the survey boundary and the surrounding area.



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AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PRGRAM: GEOLOGIC MAPPING IN THE EASTERN MORAN AREA, TANANA AND MELOZITNA QUADRANGLES, ALASKA

Historic and active placer mines in the Melozitna mining district, which encompasses the Moran area, have produced more than 12,000 ounces of gold and an undetermined amount of tin, yet little is understood about the source of the placer metals or the few gold and polymetallic lode occurrences in the area. To encourage renewed industry exploration for mineral deposits in this region, and to provide geologic data for State and local land-use management, the Alaska Division of Geological & Geophysical Surveys (DGGS) in 2010 released the 653-square-mile Moran airborne-geophysical survey (pink area, fig. 1) as part of the State-funded Airborne Geophysical/Geological Mineral Inventory program. The Moran survey area is 150 miles west of Fairbanks in the eastern Kokrines Hills, on the north side of the Yukon River. In summer 2011, DGGS will conduct fieldwork to geologically map approximately 300 square miles in the eastern Moran area (outlined in red, fig. 1). The remainder of the geophysical survey will be mapped in 2012. Interim data reports and a preliminary interpretive map will be published in 2011 and 2012. A final set of 1:63,360-scale bedrock-, surficial- and comprehensive-geologic maps of the combined map areas will be published in 2013. This mapping project will be funded primarily by State General Funds, with supplemental funding through the Federal STATEMAP program.

Currently, only reconnaissance-level, 1:250,000-scale geologic maps are available for the Moran area; DGGS's new geophysical data indicate this area is much more complex than shown on these maps. DGGS's detailed, 1:63,360-scale geologic mapping and geologic investigations in this region will: (1) field check geophysical anomalies and patterns, (2) identify the location, type, and character of bedrock and surficial geologic units, and (3) determine the location and kinematics of structural features. This detailed geologic framework will allow us to develop models for the area's gold and polymetallic lode prospects, and explain the distribution and metal content of local placer deposits. In addition, the preferred route of the Western Alaska Access Planning Study for the proposed road to Nome along the Yukon River corridor transects the eastern Moran map area (yellow-orange line, fig. 1). Current geologic mapping is insufficient to evaluate geologic-engineering challenges of infrastructure development in the area. Geologic hazards are also of concern, and include the Kaltag fault, which crosses the southern edge of the map area. Although the fault is potentially active, the recent displacement history of the fault and its associated seismic hazards have not been evaluated. As DGGS's work progresses, preliminary results will be presented in public venues, allowing timely access to the new information on the Moran area's geology, mineral resources, and geologic hazards.

The primary objective of the eastern Moran project is to map the geology in sufficient detail to inform State and local land-use decisions and to guide mineral industry exploration efforts. The timing of this project coincides with renewed mineral-industry interest in underexplored gold districts and in high-tech and strategic metals. Because economic or infrastructure development could potentially conflict with other land uses, the availability of DGGS's detailed geologic, mineral-resource, and hazard assessments is important for long-range planning. Providing this baseline geologic framework will help State and local planners balance the need for resource and infrastructure development with other land-management strategies.

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AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: BEDROCK GEOLOGIC MAPPING IN THE TOLOVANA MINING DISTRICT, LIVENGOOD QUADRANGLE, ALASKA

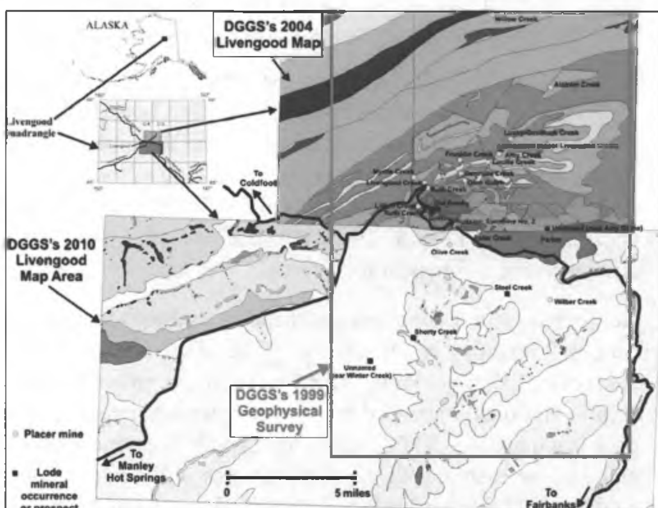
Historic and active placer mines have produced more than 500,000 ounces of placer gold in the Livengood area. To encourage renewed industry exploration for additional mineral deposits in this region, and to provide geologic data for State and local land-use management, the Alaska Division of Geological & Geophysical Surveys (DGGS) has conducted a series of geophysical and geological investigations in the area. This work is part of the Airborne Geophysical/Geological Mineral Inventory (AGGMI) program, supported by State of Alaska General Funds. DGGS released a 123-square-mile airborne-geophysical survey of the Livengood area in 1999. In 2004, DGGS published a geologic map and associated geologic report for an area that includes the northern portion of the 1999 geophysical survey (fig. 1). Subsequent mineral industry exploration in this map area resulted in the discovery of an estimated 19-million-ounce gold deposit at Money Knob. DGGS returned to the area in June 2010 to conduct geologic mapping and sampling of the southern portion of the 1999 geophysical survey and surrounding area (fig. 1). A geochemical report was published in November 2010, and a 1:50,000-scale bedrock-geologic map will be published in 2011.

The purpose of DGGS's mapping is to provide geologic context for known lode and placer deposits and occurrences, and to evaluate the area's mineral-resource potential. Wilber Creek is the only creek in the 2010 map area with known placer gold production. Its gold compositions are similar to placer gold of the Livengood area, but the area's present morphology suggests the gold is derived from the 2010 map area. The only known significant lode mineralization occurs west–northwest of Wilber Creek at the Shorty Creek prospect.

Rocks in the northern and northwestern portions of the 2010 map area belong to the Livengood Terrane and include: the Ordovician Livengood Dome Chert, overlying Amy Creek unit, Cambrian ophiolite suite, and Devonian Cascaden unit. DGGS work has refined both the location and the nature of the contacts between these units. The Lower Cretaceous Wilber Creek unit of the Manley Terrane dominates the bulk of the southern map area, and it is in fault contact with the Livengood Terrane.

Felsic igneous rocks, with variable textures and compositions, range in size from thin dikes to small plutons and are typically quite altered. DGGS studies distinguished Devonian volcanic rocks, and four groups of presumed Cretaceous intrusive rocks. Group I is compositionally variable, scattered across the map area, and not associated with mineralization. Group II comprises the Cascaden Ridge pluton, is compositionally similar compared to gold-related Money Knob dikes, and is spatially associated with Devonian volcanic rocks that act as the host rock in the Money Knob system. Group III is compositionally similar to gold-related Money Knob dikes, and mostly located in the Wilber Creek drainage. Placer gold found in Wilber Creek may be derived from these dikes. Group IV is similar in composition and age to the Tolovana Hot Springs pluton (65 Ma), and is associated with the high Ag–Bi–Sn and locally anomalous Au mineralization of the Shorty Creek lode prospect.

To fulfill the goals of this project, age information will be obtained for group II and III felsic intrusive rocks to determine if their similarity to the Money Knob dikes is temporal as well as compositional. The relative age of high-angle structures to hydrothermal alteration in the Cambrian ophiolite and Wilber Creek unit are still unknown. Faulting emplaced the Wilber Creek unit from an unknown source area, but from how far and when in relation to the Money Knob gold system? These issues will be addressed in the next year, along with conducting petrography, further geochemical analyses, and completion of the geologic map.



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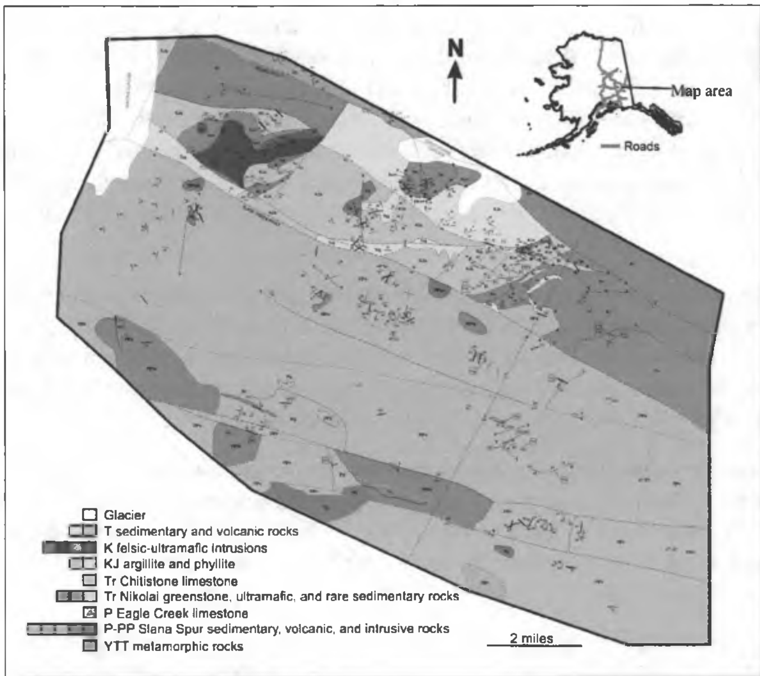
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: BEDROCK GEOLOGIC MAPPING OF THE SLATE CREEK AREA, MT. HAYES QUADRANGLE, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys (DGGS) released a 442-square-mile airborne geophysical survey, including magnetic and electromagnetic data, for the Slate Creek–Slana River area in the northern Chistochina mining district in early 2009. DGGS conducted geologic mapping of about 113 square miles in the western Slate Creek portion of the geophysical survey tract during July 2009 (fig. 1). This mapping project is funded primarily by State CIP funds, with supplementary Federal STATEMAP funding. The geophysical survey and Slate Creek mapping project are part of DGGS's Airborne Geophysical/Geological Mineral Inventory program, a special multi-year investment by the State of Alaska to expand Alaska's geologic and mineral resources knowledge base, catalyze future private-sector mineral exploration and development, and guide state planning.



The Slate Creek study area is in the southern foothills of the Alaska Range, about 140 miles southeast of Fairbanks and 20 miles east of Paxson. Approximately 183,000 ounces of placer gold have been mined from the region since 1898, with most production from the historic Slate Creek subdistrict. The map area comprises one active placer gold mine, 64 inactive placer gold occurrences and mines (with minor platinum-group metals [PGM]), and 29 metallic lode occurrences. There are no significant known lode gold occurrences to explain the extensive placers. Gold chemical data suggest the placers are sourced from transported and reworked auriferous Tertiary gravels instead of from the local gold-bearing bedrock. The Mentasta–Slana area also hosts many plutonic-related skarn, replacement, and vein–gossan occurrences as well as potential porphyry(?) copper–gold lode prospects and 'Alaska-type' PGM lode occurrences associated with Cretaceous mafic–ultramafic rocks.

A portion of the main strand of the Denali Fault System (DFS), which ruptured in 2002 (with an associated magnitude 7.9 earthquake), is included in and bounds the northern edge of the study area. DGGS is identifying, determining orientations, and characterizing the kinematics of active and inactive faults along the DFS and subsidiary faults to provide a better understanding of the regional stress regime. The results of a paleoseismic trench study across the 2002 rupture trace of the Denali fault are contained in a Preliminary Interpretive Report presently under review at DGGS. These data are necessary for subsequent assessment of earthquake hazards to critical infrastructure and population centers.

New geologic mapping and neotectonic studies, incorporating interpretations of DGGS's airborne geophysical data, will lead to a better understanding of the region's geologic framework, provide data on recent fault movement essential to geologic hazard assessments, provide geologic-resource data critical to land-use decisions, and help to stimulate increased mineral exploration investment within this belt of rocks. Products will be a series of geologic maps at 1:50,000 scale, and reports containing geological, geochemical, and geophysical data. Geologic maps of the Slate Creek–Slana River area will be completed in 2011. Surficial-geologic mapping performed in conjunction with this project is described separately (p. 62).

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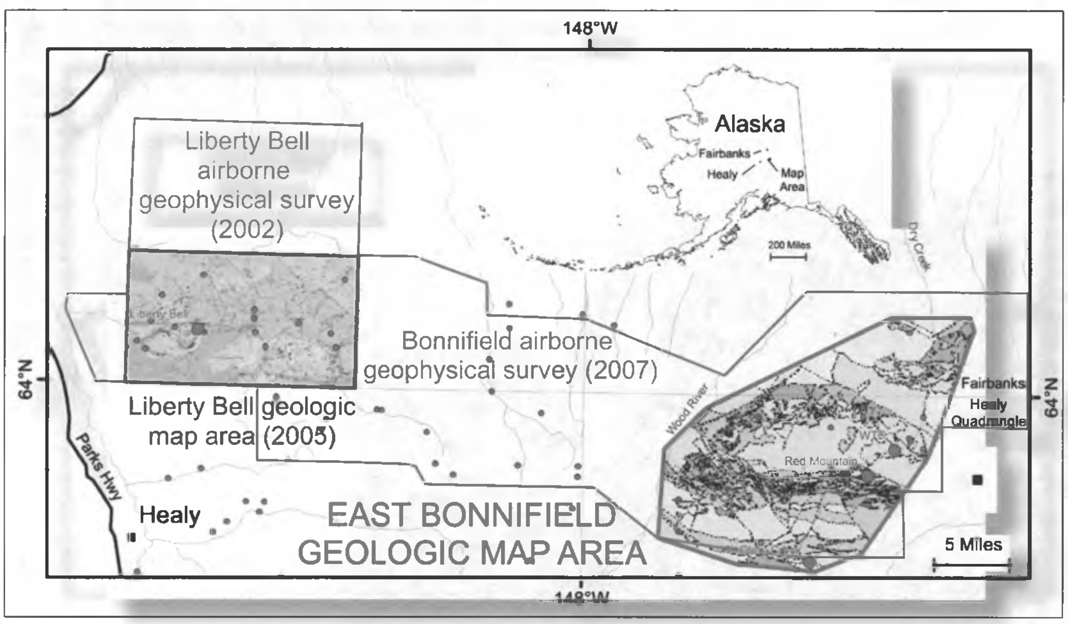
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: GEOLOGIC MAPPING IN THE EASTERN BONNIFIELD MINING DISTRICT, HEALY AND FAIRBANKS QUADRANGLES, ALASKA

Historic and active placer mines in the Bonnifield mining district have produced more than 86,000 ounces of gold; the region also contains numerous significant polymetallic volcanogenic massive sulfide (VMS) and gold–polymetallic pluton-related lode occurrences. To encourage renewed industry exploration for mineral deposits in this region, and to provide geologic data for State and local land-use management, in 2007 the Alaska Division of Geological & Geophysical Surveys (DGGS) released a 613-square-mile airborne-geophysical survey for the eastern two-thirds of the area outlined in magenta (fig. 1) as part of the State-funded Airborne Geophysical/Geological Mineral Inventory program. In summer 2008, DGGS conducted fieldwork to geologically map an approximately 200-square-mile area in the eastern Bonnifield mining district (area outlined in red; fig. 1). A geochemical data report was published in 2009, and 1:50,000-scale bedrock- and comprehensive-geologic maps will be published in 2011. This project is funded primarily by State Capital Improvement Project (CIP) funds, with supplemental funding from the U.S. Geological Survey through the Federal STATEMAP program.

The eastern Bonnifield map area is 60 miles south of Fairbanks in the northern foothills of the Alaska Range. The map area contains significant mineral occurrences, most notably the WTF and Dry Creek VMS prospects, which contain drill-inferred resources of copper, lead, zinc, silver, and gold. Lithologic and structural relationships and interpretations depicted on 50-year-old published geologic maps are not supported by our summer 2008 investigations. DGGS's new geologic map incorporates interpretations of our Bonnifield airborne geophysical survey data, aerial photographs, donated industry data, and our 2008 field observations and new scientific analytical data. Our work documents many sets of newly discovered inactive faults and one potentially active fault, and presents a revised stratigraphic section based on actual lithologic units instead of grouped rock packages.

The primary objective of the eastern Bonnifield project is to map the geology of the area in sufficient detail to facilitate wise State and local land-use decisions and to guide mineral industry exploration efforts. The timing of this project coincides with renewed mineral-industry interest in exploration for volcanogenic massive sulfide deposits including those in the eastern Bonnifield mining district; exploration activity in Alaska in general is near an all-time high. Because economic development could potentially conflict with other land uses, the availability of DGGS's detailed geologic, resource, and reconnaissance hazard assessments is important for long-range planning. Providing a basic geologic framework and an inventory of potentially mineralized areas will help State and local planners balance the need for resource development with other land-management strategies. Geologic maps and data produced by this project will also serve as a framework for further scientific studies and increased regional understanding of this tectonically active area, which is 21 miles north of the Denali fault.



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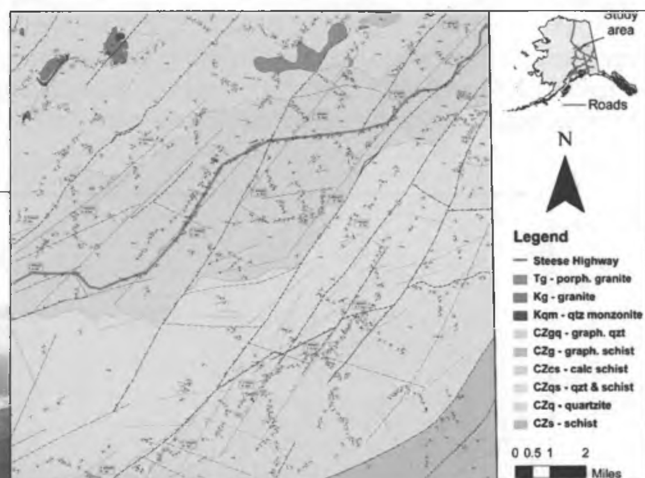
ALASKA GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: BEDROCK GEOLOGIC MAPPING OF THE NORTHERN FAIRBANKS MINING DISTRICT, CIRCLE QUADRANGLE, ALASKA

In summer 2007, the Alaska Division of Geological & Geophysical Surveys (DGGS) conducted 189 square miles of geologic mapping northeast of Fairbanks, covering the central portion of DGGS's 404-square-mile northeast Fairbanks airborne magnetic and electromagnetic geophysical surveys released in January 2006. The mapping project is funded primarily by DGGS's Airborne Geophysical/Geological Mineral Inventory program, an annual investment by the State of Alaska to expand Alaska's geologic- and mineral-resources knowledge base, catalyze future private-sector mineral exploration and development, and guide state planning. Additional support is from the federal STATEMAP program.

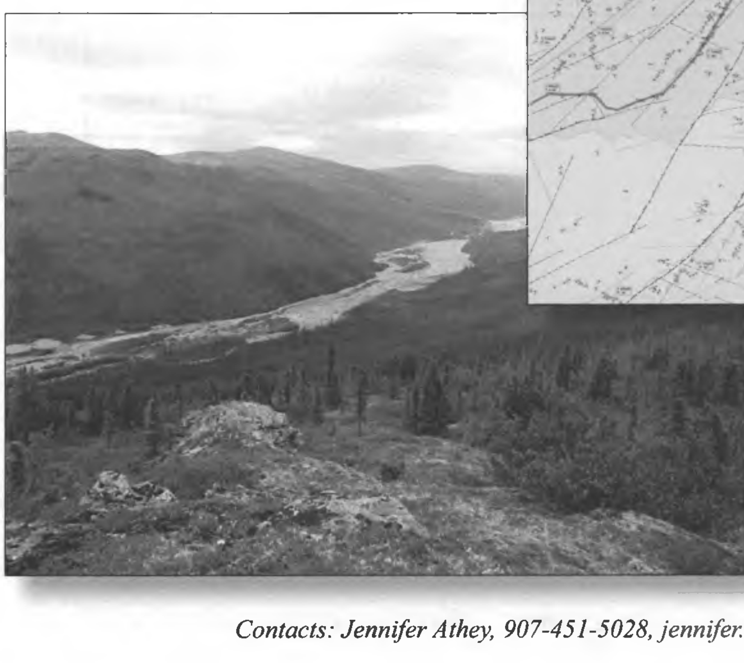
The Steese Highway bisects the study area from highway mileposts 66 to 85. Good access from the highway, placer mining roads, and a few trails, in addition to nearby power from the high-voltage power lines of the Fort Knox gold mine 25 miles to the southwest, would facilitate possible mineral development. The map area lies in a northeast-oriented trend of plutonic-related gold mineralization between the central and southwestern Fairbanks and Circle mining districts. The Fairbanks mining district has the largest historic gold production in Alaska, with nearly 12.9 million troy ounces of gold produced as of 2007. Three placer mines (two active) and one lode gold prospect are present in the northeast Fairbanks map area. Placer gold is spatially associated with monzogranite and quartz monzonite plugs, dikes, and sills. The distribution of paystreaks within the placers and paucity of mineralization within the intrusions suggest some of the gold may be structurally controlled. In 2007, DGGS identified arsenopyrite–pyrite–quartz veins and boxworks and semi-massive stibnite–quartz veins proximal to the intrusive suite.

In addition to geologic mapping, DGGS conducted a rock and stream-sediment geochemical study instrumental in the Alaska Division of Mining, Land & Water's decision to relocate a portion of the proposed Mount Ryan Remote Recreational Cabin Sites Staking Area to an area with lower perceived mineral potential. Because land open to settlement is usually closed to mineral exploration and development, knowledge of an area's mineral potential is crucial to decisions about whether to retain that land for subsurface users. These geochemical data were published in January 2008.

DGGS's geologic mapping incorporates interpretations of our airborne geophysical data, and will provide: (1) a better understanding of the lithologic, metamorphic, and tectonic framework of Interior Alaska; (2) baseline geologic-materials and hazards data for future infrastructure and residential construction, and current maintenance of the Steese Highway; (3) geologic-resource data critical to land-use decisions; and (4) geologic knowledge that will help encourage mineral exploration investment in the northern section of the Fairbanks mining district. A series of 1:50,000-scale geologic maps and associated scientific studies for this project will be completed in 2011. Surficial-geologic mapping performed in conjunction with this project is described separately (p. 65).



Draft bedrock geologic map.



View, looking north, of the Faith Creek gold placer.

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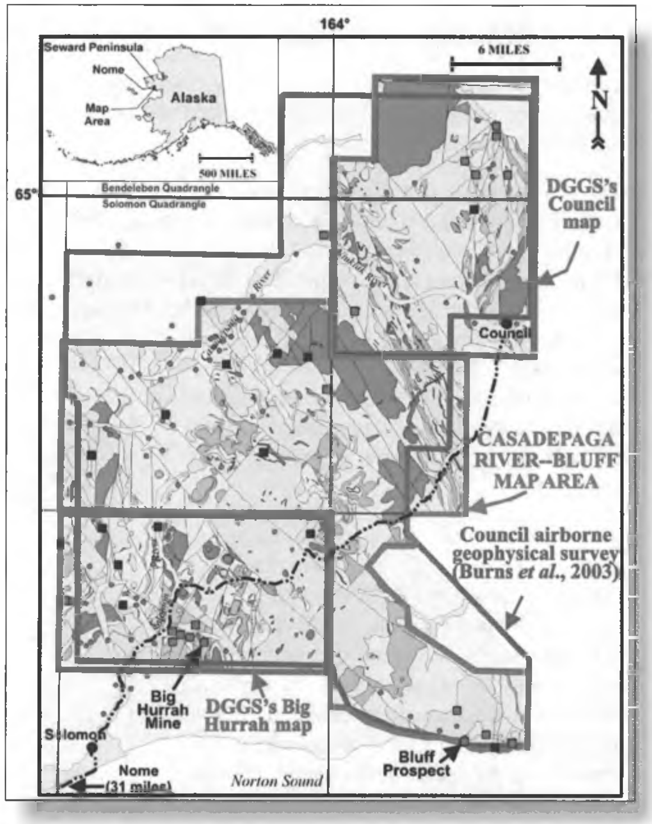
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: BEDROCK GEOLOGIC MAPPING IN THE COUNCIL–BIG HURRAH–BLUFF AREA, SEWARD PENINSULA, ALASKA

More than 1 million ounces of placer gold have been extracted from the Solomon–Council area of Alaska's Seward Peninsula during the past century, but gold production has declined in recent decades. To encourage renewed industry exploration for lode gold and base-metal deposits in this region, and to provide geologic data for land-use management, in 2003 the Alaska Division of Geological & Geophysical Surveys (DGGS) released airborne-geophysical surveys for the area outlined in purple (fig. 1). These surveys are part of the Airborne Geophysical/Geological Mineral Inventory (AGGMI) program, supported by State Capital Improvement Project (CIP) funds. In 2004, DGGS conducted 1:50,000-scale geologic mapping and geochemical sampling in the Big Hurrah and Council areas (green outline, fig. 1).



In 2006, DGGS extended this mapping into the Casadepaga River–Bluff area (red outline, fig. 1), and will produce a combined map and a geologic report of the entire project area in 2011. A geochemical report for the 2006 map area was released in October 2007. This part of the project is primarily supported by the State CIP-funded AGGMI program, and was partially supported in 2007 by the Federal STATEMAP program. The purpose of DGGS's mapping is to provide geologic context for known lode gold and base-metal deposits and occurrences, and evaluate the area's mineral-resource potential. The Casadepaga River–Bluff map area contains the Bluff lode gold prospect, and covers the headwaters of the Casadepaga River, known for its rich placer gold deposits. The lode sources of this placer gold have not yet been identified.

The Casadepaga River–Bluff area is underlain by Proterozoic to Lower Paleozoic metasedimentary and metaigneous rocks of the Nome Group, including the Solomon Schist, Mixed Unit, Casadepaga Schist, and undifferentiated marble. DGGS's recent detailed geologic mapping defines the internal metamorphic stratigraphy of these rock units, and is revealing new relationships between units as well. Efforts to determine their depositional ages are in progress. Stratigraphic relationships and depositional-age data are essential for evaluating the economic potential of the Nome Group for hosting base-metal sulfide deposits.

In the Casadepaga River–Bluff area, DGGS's geologic mapping and associated studies have documented the location, geochemistry, age, distribution, orientation, and regional structural controls on the area's gold-bearing quartz vein systems. To help predict where additional veins may be located, it is important to determine the timing of gold-vein formation relative to structural features, metamorphic events, and igneous intrusions. Our preliminary work indicates that Nome Group rocks underwent high-pressure blueschist-facies metamorphism ~200 million years ago, and were later partially overprinted by a greenschist-facies mineral assemblage. Rare, extension-related alkalic intrusions of Cretaceous to Quaternary age are scattered throughout the map areas, but are not spatially associated with gold-bearing quartz veins. These veins yield 40Ar/39Ar adularia and white mica ages of ~105 to 115 Ma. Hydrothermal kaolinite, cinnabar, and adularia indicate epithermal-style mineralization on the southern Seward Peninsula, as well as the more widely distributed, gold-bearing veins of possible orogenic or extensional origin.

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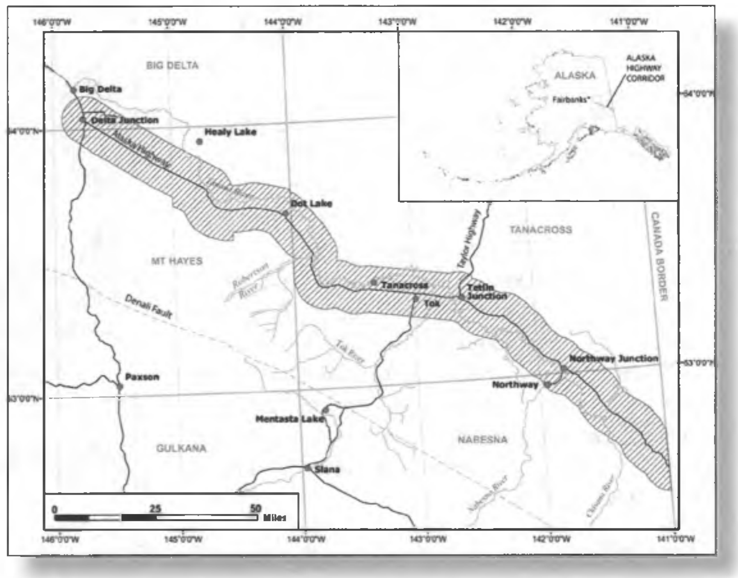
BEDROCK GEOLOGY & MINERAL-RESOURCE ASSESSMENT ALONG THE PROPOSED GAS PIPELINE CORRIDOR FROM DELTA JUNCTION TO THE CANADA BORDER

The Alaska Highway is the primary land transportation route to interior Alaska from the contiguous United States, and is likely to become the locus of increasing development, especially if the proposed natural gas pipeline or Alaska Railroad extension are constructed along this route. Despite the corridor's strategic location, relatively little geologic and geotechnical work has been published along its length. This multi-year project, primarily supported by State Capital Improvement Project (CIP) funds, will provide a framework of geologic data upon which engineering, design, and resource decisions may be evaluated for future development between Delta Junction and the Canada border. In 2006, as the first phase of this project, DGGS collected, interpreted, and published airborne geophysical data for a 16-mile-wide corridor centered on the Alaska Highway. The second phase of the project consists of mapping bedrock and surficial geology and evaluating geologic hazards and resources. The surficial-geology and geologic hazards parts of the project are described separately.

The bedrock portion of the project includes 1:63,360-scale bedrock geologic mapping and mineral-resource assessment work. In 2006 and 2007, DGGS conducted geologic fieldwork between Delta Junction and Dot Lake, in 2008 between Dot Lake and Tetlin Junction, in 2009 between Tetlin Junction and the Canada border, and in 2010 final field checking from Delta Junction to the border. The 2008 portion of the corridor is particularly significant because of its close proximity to the active Denali fault, approximately 25 miles to the southwest in the Alaska Range. DGGS determined the location and kinematics of many smaller-scale, potentially active faults related to the Denali fault system within the corridor, and this data will provide a better understanding of the history and potential impacts of these faults.



The bedrock maps incorporate interpretations of DGGS's airborne magnetic and resistivity data, field data, and various scientific analytical data. The geophysical data are particularly valuable for interpreting the geology in areas covered by surficial deposits or vegetation. Preliminary results from 2009 fieldwork show a continuation of geologic relationships determined by 2006–2008 fieldwork, along with new features and interpretations. Numerous plutonic rock suites were defined; these plutons intruded amphibolite-facies metasedimentary and metaigneous rocks similar to those elsewhere in the Yukon–Tanana Upland, as well as a suite of greenschist-facies metasedimentary rocks and metamorphosed mafic intrusions, which likely correlate with similar units directly across the border in Canada.

These rocks have undergone several ductile to brittle deformation and faulting events. High-grade contractional ductile deformation affects rock units as young as Mississippian. Normal faulting, accommodating east–west extension, affects rock units as young as Late Cretaceous. Overprinting all of this is a complex system of younger strike-slip, reverse, and oblique faults that have affected all of the rock units. These structures accommodate overall north–south contraction with a component of right-lateral slip, similar to deformation on the Denali fault. The latest structures may have been active during the Late Cenozoic, shown by their alignment with major topographic changes, and there are similar-azimuth lineations in young sedimentary units on aerial photographs and in DGGS's airborne-geophysical data. In addition, there is evidence of Quaternary-age faulting along the northern front of the Alaska Range.

DGGS is also evaluating the mineral-resource potential of bedrock units by sampling and analyzing altered rocks to provide baseline geochemical data for use by State land managers and mineral exploration companies. Geochemical analyses for 2006–2010 fieldwork will be published in 2011. Bedrock geologic maps for the 2006–2009 corridor segments will be published in 2011; funding for this planned work consists of FY2010 CIP funding and State General Funds.

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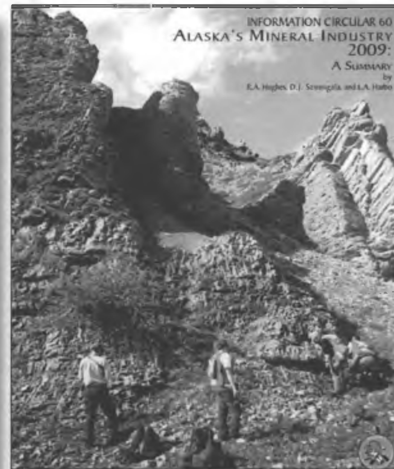
ANNUAL ALASKA MINERAL INDUSTRY REPORT



Alaska Statute 41.08 charges the Division of Geological & Geophysical Surveys (DGGS) to *"determine the potential of Alaska land for production of metals, minerals, fuels, and geothermal resources"; "conduct such other surveys and investigations as will advance knowledge of the geology of Alaska"; and "print and publish an annual report and such other special and topical reports and maps as may be desirable for the benefit of the state."* To meet part of this goal, we gather, verify, collate, and supply statistics and summary observations about Alaska's mineral industry and release this information in a timely manner to the public in the format of an annual mineral industry report, an interim summary, and public presentations. This project supplies information to the mineral industry, provides the State and the public with valuable data pertaining to the health of Alaska's mineral industry, and fosters a better understanding of the significance of the mineral industry to Alaska's private sector and government.

The annual Alaska mineral industry report is a key source of information about exploration, development, and production of Alaska's mineral resources. Statewide and international circulation of the report and its findings at professional mineral industry conventions and trade shows, at chambers of commerce and other organizations' meetings, and in professional journals informs the general public, local and international mineral industry, and local, state, federal, and international government agencies about current activities within Alaska's mineral industry. The report serves as a barometer for the mineral industry's status in any given year and provides unbiased, authoritative information compiled in a consistent format from year to year. Government personnel rely on the report as an essential tool for formulating public policy affecting resource and land management.

The 2009 Alaska mineral industry report, released in December 2010, summarizes information provided through replies to questionnaires mailed by DGGS, phone interviews, press releases, and other information sources. The 2009 cumulative value of Alaska's mineral industry, the sum of exploration, development, and production values, was $2.966 billion, $204.2 million lower than 2008's value of $3.171 billion. This was the fourth consecutive year that the cumulative value topped $2 billion and the 14th straight year that Alaska's mineral industry topped $1 billion. Exploration expenditures for 2009 were $180 million, approximately one-third of the United States total, but a 48 percent drop from the record $347.3 million expended on exploration in 2008. Development expenditures amounted to $330.8 million, down 17 percent from the $396.2 million spent in 2008; and the value of mineral production was $2,455.6 million, with production volumes of most metals increasing from 2008 amounts. Alaska's mineral industry value will likely increase in 2010 due to improving metal prices and new mines starting production in 2010.

The annual mineral industry report has been published for 28 consecutive years as a cooperative venture between the Department of Natural Resources' (DNR) Division of Geological & Geophysical Surveys, and the Office of Economic Development (OED) in the Department of Commerce, Community & Economic Development (DCED). A summary of the 2010 Alaska mineral industry activities will be released by February 2011. The 2010 Alaska mineral industry report will be released by early November 2011.

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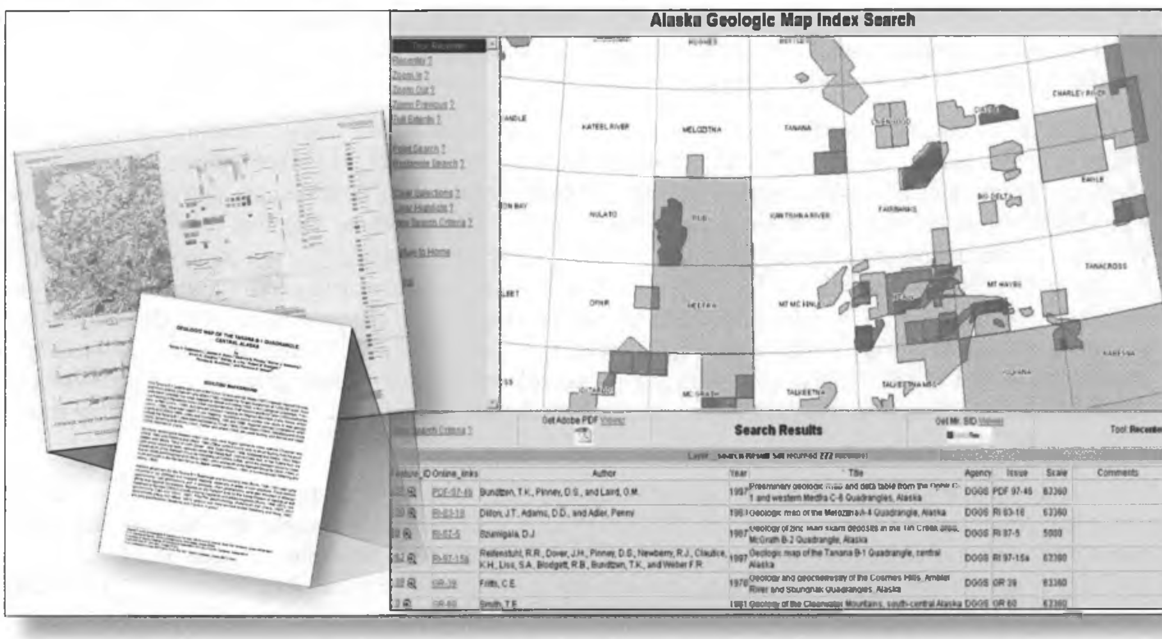
ALASKA GEOLOGICAL AND GEOPHYSICAL MAP INDEX

In 2003 the Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS) and Land Records Information Section (LRIS; now Information Resource Management) released the first version of a Web application that will ultimately provide the locations and outlines of Alaska geologic maps from all government agencies in a single, interactive, Internet-accessible location. The "Alaska Geology Map Index" site (http:maps.akgeology.info/) currently contains about 300 citations and outlines for DGGS-authored geologic maps. About 900 additional U.S. Geological Survey (USGS) and DGGS geologic map outlines and associated bibliographic references have been compiled and are being categorized and checked for errors. The 1,200 outlines will be uploaded into DGGS's central Oracle database during 2010 and 2011. DGGS intends to add outlines for remaining geologic maps by DGGS, U.S. Geological Survey (USGS), U.S. Bureau of Mines (BOM), and U.S. Bureau of Land Management (BLM), and geophysical maps by DGGS and other agencies in future years.

Currently, no up-to-date geographic index of Alaska geologic maps exists. Internet access to the current status of geological and geophysical maps of Alaska will make it easier for the public and government agencies to more quickly find the maps they need to make informed resource- and land-management decisions. The categorized database provides an effective means of searching for maps of particular interest. For example, geologic hazard-related maps will be harvested from the Map Index database to help create the comprehensive map-based interface, "Online Guide to Geologic Hazards in Alaska." This project is described separately under the Alaska Coastal Management Program.

DGGS anticipates upgrading the Map Index interface to a fully integrated map- and text-based search application based on real-time data served from DGGS's central Oracle database. The user will be able to: (1) retrieve subsets of map outlines based on map categories (bedrock geology, surficial geology, resources–metals–lode, hazards–permafrost, etc.) or metadata (scale, publishing organization, publication date, etc.); (2) view the results in an interactive map interface and listing; and (3) re-query the results by either a text search or map selection. The interface will also provide links to downloadable digital reports and maps for each citation, where available. Some of these functions are available at this time, but the capability of the interface, number of maps available, and currency of the data will be greatly improved.

The project was initiated with funding from the Federal Minerals Data and Information Rescue in Alaska (MDIRA) program and is now supported by State General Funds. The primary objective of the MDIRA program was to ensure that all available Alaska minerals-related data are preserved in a safe and readily accessible format for all potential users. DGGS is applying for additional support from the National Geological & Geophysical Data Preservation Program of USGS.



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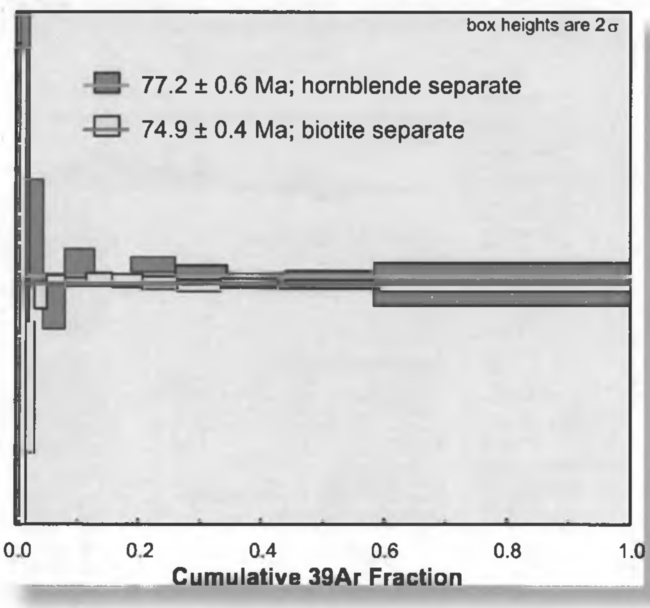
GEOCHRONOLOGIC DATABASE FOR ALASKA

In 2005, the Alaska Division of Geological & Geophysical Surveys (DGGS) initiated development of a comprehensive geochronologic database for Alaska. The geochronologic database contains summary interpretive and detailed analytical data and associated information for all available radiometric ages of rocks and minerals in Alaska. The objective of this project is to expand the most-current existing compilations of radiometric data and to make this age information widely accessible to private industry, academia, and government. This project was initially funded through the Federal Minerals Data and Information Rescue in Alaska (MDIRA) program and in 2010 was supported by State General Funds and the National Geological and Geophysical Data Preservation Program (NGGDPP). The primary objective of the MDIRA program is to ensure that all available Alaska minerals data are securely archived in perpetuity and in a format readily accessible by all potential users. Information on mineral resources is important for management policy decisions in both the public and private sectors. Increased use of high-quality data should lead to better economic, legislative, and environmental decisions.

The compilation includes information for all available U-Pb, K-Ar, $^{40}Ar/^{39}Ar$, and Rb-Sr ages of Alaska samples. Radiometric ages are compiled from both published and unpublished sources. Essential basic supporting information that is currently not easily accessible was harvested from original publications, student theses, industry records, and laboratory archives. This detailed information includes raw analytical data, standards, constants used in calculations, analytical laboratory, analyst, sample preparation and processing steps, sampling agency and geologist, and sample context and descriptions. To date, more than 4,925 age records have been compiled.

In 2009, DGGS loaded the compiled geochronologic data into its central Oracle database. In 2010, DGGS created a beta-version Web Feature Service (WFS) containing age sample locations, basic metadata, and references to the appropriate original publications that were harvested by the National Digital Catalog (http:datapreservation.usgs.gov/catalog.shtml). WFS data are served online in real time directly from DGGS's Digital Geologic Database described on p. 73 and are importable into Geographic Information Systems (GIS) software. Current efforts include documentation of data fields, creation of record-level metadata, and development of a WFS-type data release with instructions for GIS users. In 2011, DGGS anticipates upgrading the WFS with summary age data and publishing a report of all summary geochronologic data in the central database. The final stage of the geochronology project will be to make these data fully accessible via an interactive, map- and text-based search application on DGGS's website and through a link on the MDIRA website (http:akgeology.info). DGGS's central database will serve as a repository for future Alaska radiometric data and provide an authoritative, up-to-date, digital source of this important geologic information.



Age spectra plot generated from detailed $^{40}Ar/^{39}Ar$ age data stored in the geochronologic database.

Table 1. Example summary table information for an $^{40}Ar/^{39}Ar$ sample.

Analytical Method	Sample Number	Latitude	Longitude	Estimated Location Error	Age	Lithology	Dated Material	Age Interpretation	Age Type	Citation	Link
40Ar/39Ar	1999JS59A	62.3	-149.13	100	77.2 ± .6 Ma	quartz diorite	mineral separate: hornblende	igneous crystallization	plateau	PIR 2002-4	http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=7144
40Ar/39Ar	1999JS59A	62.3	-149.13	100	74.9 ± .4 Ma	quartz diorite	mineral separate: biotite	igneous crystallization	plateau	PIR 2002-4	http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=citation&ID=7144

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ALASKA COASTAL MANAGEMENT PROGRAM: NATURAL HAZARDS

DGGS provides support to Alaska Coastal Management Program (ACMP) personnel and coastal district planners regarding natural hazard issues. DGGS responsibilities include: reviewing natural hazard aspects of proposed coastal projects during the consistency review process; recommending state designation of hazard areas during consistency reviews when needed; providing support to coastal district planners in revising coastal management plans; par-ticipating in district teleconferences; and periodically reviewing regulatory and planning documents regarding natural hazards issues.

A lack of basic field data and baseline information on geologic hazards in Alaska makes it difficult for coastal districts and the State to implement the ACMP natural hazard standard (11 AAC 112.210). Coastal districts often do not have the scientific information needed to designate natural hazard areas in their district plans for the purpose of ensuring that coastal development adequately mitigates the risks of the hazards. During consistency review for a proposed project, the State can, under the standard, designate a natural hazard area so that hazards risks may be addressed in the review. DGGS assists DNR in development of the background information and formal designation of the hazard area.

The DGGS website provides access to the online "Guide to Geologic Hazards in Alaska," a bibliographic database with links to scanned maps and documents published by DGGS and the U.S. Geological Survey (USGS) that contain information relevant to hazard identification in Alaska: www.dggs.alaska.gov/geohazards . The guide is served from DGGS's publications database and is searchable by coastal district. In 2009, DGGS was awarded ACMP Enhancement Grant Program (EGP) funding to update the guide and make it more user-friendly to coastal district planners, ACMP, and project applicants. The revised online guide is facilitating delivery of new geologic hazard maps and reports planned by DGGS under the Coastal Impact Assistance Program (CIAP; described on p. 56) and recommended by the Climate Change Cabinet's Immediate Action Workgroup. DGGS has been awarded additional EGP funding in 2010 to expand this project. The upgraded Guide to Geologic Hazards in Alaska will act as a resiliency tool, providing districts centralized data that can support proposed natural hazards designations and policies, planning, and federal reporting on natural hazards. The upgrade plan includes incorporating the geographic extents of published hazards data (collected in part from the DGGS Map Index project [described on p. 52]), to develop a functional prototype of an interactive geologic-hazards bibliography map- and text-based search interface using a GoogleMaps-type application.

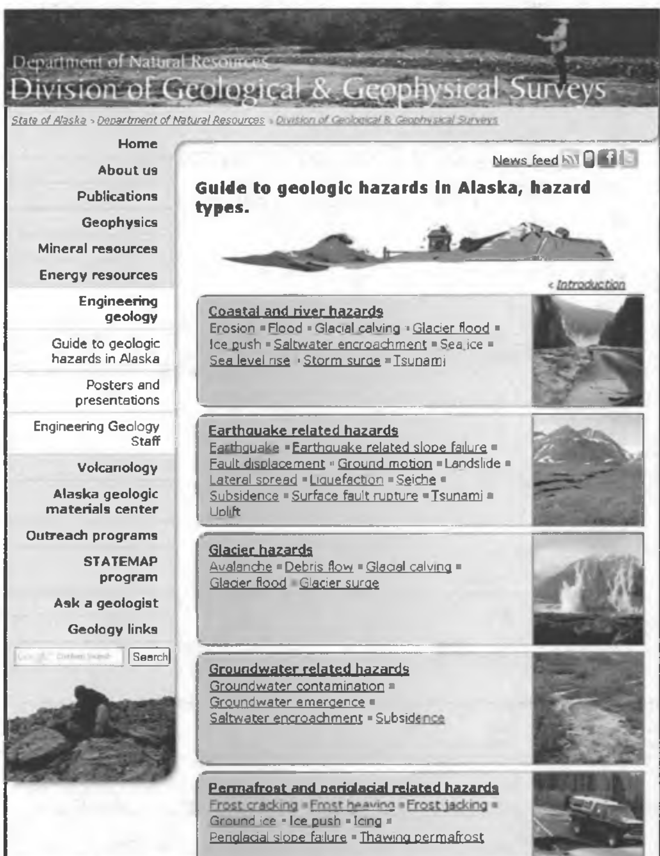

Figure 1. The DGGS online "Guide to Geologic Hazards in Alaska" has been updated to include relevant new published information and internet sites as well as to provide expanded information about the types of geologic hazards present in Alaska. The guide will also be enhanced by the addition of a searchable map interface that will allow users to more easily identify bibliographic resources available for their area of interest.

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ASSESSMENTS OF GEOLOGIC HAZARDS ASSOCIATED WITH CLIMATE CHANGE

Studies have shown clearly that high-latitude regions are experiencing the impacts of a sustained and amplified climate-warming trend. Alaska's high-latitude location makes it particularly sensitive to the effects of climate change, which can include the modification or enhancement of natural geomorphic processes. These modifications could increase the magnitude and frequency of some kinds of geologic hazards (such as erosion, flooding, slope instability, and thawing permafrost) and, if not properly addressed, have a direct effect on Alaska communities and infrastructure, as well as on the livelihoods and lifestyles of Alaskans (fig. 1). The State can help preserve the integrity of its infrastructure and the health and safety of Alaska's people by being prepared for potential emergency situations resulting from geologic hazards that are caused or amplified by climate change. A critical first step is to perform the necessary sound science to identify high-risk areas where proactive mitigation efforts will be needed and useful, and areas where design structure and proper, informed planning can alleviate the need for future mitigation.

The Division of Geological & Geophysical Surveys' (DGGS) Climate Change Hazards Program has been developed to rigorously assess geologic hazards associated with climate change and publish information that will be used for proactive planning, hazard mitigation, and emergency response in high-risk communities and developing areas. DGGS is accomplishing this by collecting the necessary field data to assess geologic hazards and publish peer-reviewed surficial-geologic and geologic-hazards maps and reports of high-risk communities and infrastructure in Alaska. We are completing these assessments at local and/or regional scales as needed to address specific local problems and to understand and evaluate the larger geologic context. This effort is a collaboration with relevant outside organizations including the Immediate Action Work Group of the Governor's Subcabinet on Climate Change, University of Alaska, Federal Emergency Management Agency, Alaska Division of Homeland Security & Emergency Management, Alaska Division of Coastal & Ocean Management, Alaska Department of Commerce, Community and Economic Development, U.S. Geological Survey, and U.S. Army Corps of Engineers, and will provide valuable information to allow planners and design engineers to minimize the economic impacts and public safety risks associated with geologic hazards.

DGGS scientists conducted field-based geologic hazards assessments and mapping in and around the communities of Kivalina and Koyukuk during summer 2010, and expect to complete the first products of this project in FY2011. The geologic-hazards and surficial-geologic maps will be published in digital GIS format in conformance with national standards and will delineate areas where potential natural hazards such as erosion, slope instability, flooding, and thawing permafrost should be considered at a more detailed level to fully evaluate risk for any given use. The maps will also help evaluate proposed relocation sites for communities that must move to avoid irreparable damage, and identify potential sources for construction materials. Reports describing the geology and hazards will accompany the maps.

The Climate Change Hazards Program is funded by the State of Alaska as a Capital Improvement Project (CIP).

Figure 1. Permafrost cellar near the Wulik River, northwestern Alaska. Warming temperatures and thawing permafrost can flood permafrost cellars and threaten food supplies in some villages in rural Alaska. Natural processes, such as thawing permafrost, are likely to be modified by climate change.

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GEOHAZARD EVALUATION AND GEOLOGIC MAPPING FOR COASTAL COMMUNITIES

Approximately 6,600 miles of Alaska's coastline and many low-lying areas along the state's rivers are subject to severe flooding and erosion. The United States General Accounting Office (GAO; now the U.S. Government Accountability Office) reported in 2004 that flooding and erosion affects 184 out of 213 (86 percent) Alaska Native villages, and most of these are coastal communities (fig. 1). Many of the problems are long-standing, although some studies indicate that increased flooding and erosion are being caused in part by changing climate. These findings were reinforced in 2006, when the U.S. Army Corps of Engineers determined that the coastal villages of Kivalina, Newtok, and Shishmaref have only 10–15 years left in their current locations before being irretrievably lost to erosion if countermeasures are not implemented. The Immediate Action Work Group (IAWG) of the Governor's Subcabinet on Climate Change made a series of recommendations in 2009 that represent an intensive collaborative effort undertaken in an open public forum to address the immediate needs of the state, with a specific focus on six communities in peril: Newtok, Shishmaref, Kivalina, Koyukuk, Unalakleet, and Shaktoolik (fig. 2). Four of the top six at-risk villages are located on the coast.

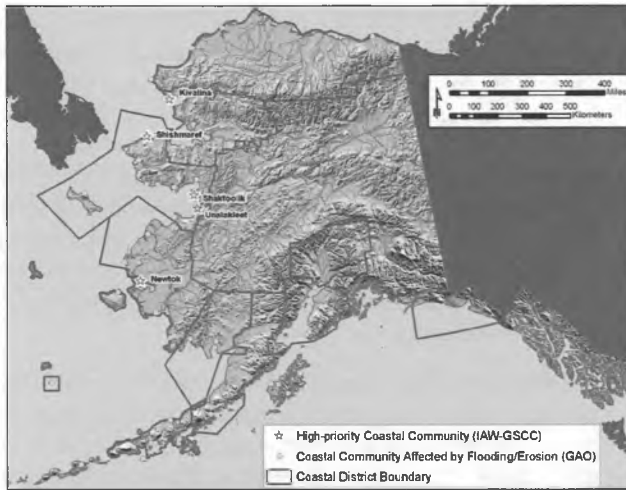

Figure 1. Map showing the distribution of Alaskan communities at risk for coastal flooding and erosion.

Figure 2. The village of Kivalina, northwestern Alaska. The engineered rock barrier is designed to help protect the town against coastal erosion.

In response to these issues, the Division of Geological & Geophysical Surveys (DGGS) has initiated a program of coastal community geohazards evaluation and geologic mapping in support of community and district planning. External support for this effort comes from the federal Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE; formerly the U.S. Minerals Management Service, MMS) as part of the Coastal Impact Assistance Program (CIAP). In 2010, DGGS hired a new staff geologist specializing in coastal hazards and began to collect the necessary field data to produce and publish surficial and engineering-geologic/hazards maps of Alaska coastal communities, prioritized in consultation with the IAWG, Alaska Division of Community and Regional Affairs, Alaska Coastal Management Program staff, U.S. Army Corps of Engineers (COE), and affected coastal districts. Kivalina was selected as the pilot community for DGGS's first mapping efforts, leveraging federal STATEMAP and state CIP funds to enhance the scope of the project. The maps produced by this program will identify local natural hazards and other geologic factors that must be considered in the siting, design, construction, and operations of development projects to ensure protection of human life, property, and the coastal environment. Maps may include proposed relocation sites in response to the severe coastal erosion problems now facing various Alaskan communities. Mapping will be completed at local and/or regional scales as needed to address specific local problems and to understand and evaluate the larger geologic context of the area. The engineering-geologic/hazards maps will be published in GIS format with standard metadata and will delineate areas where natural hazards such as erosion, slope instability, active faults, flooding, and earthquake effects should be considered at a more detailed level to fully evaluate construction risk and to ensure that the coastal areas are not damaged by planned and proposed development. Project work will be coordinated with current U.S. Geological Survey coastal studies to ensure there is no duplication of effort. DGGS expects to complete the geohazard evaluation and hazard mapping for Kivalina in FY2011 and two or more communities in each of the following three years. Target communities for FY2011 mapping are likely to include Shaktoolik and Unalakleet.

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GEOLOGIC MAPPING AND HAZARDS EVALUATION IN AND NEAR KIVALINA, NORTHWEST ALASKA

Approximately 10,600 kilometers of Alaska's coastline and many low-lying areas along the state's rivers are subject to severe flooding and erosion. The United States General Accounting Office (GAO; now the U.S. Government Accountability Office) reported in 2004 that flooding and erosion affects 184 out of 213 (86 percent of) Alaska Native villages. These findings were reinforced by subsequent studies, conducted by the U.S Army Corps of Engineers (2006) and the Immediate Action Workgroup of the Alaska Governor's Subcabinet on Climate Change (2008), that identified Kivalina as among the most imperiled communities in Alaska due to climate-change phenomena and therefore in most need of immediate actions to prevent loss of life and property.

The Alaska Division of Geological & Geophysical Surveys (DGGS) has statutory responsibility to perform the necessary sound science to identify high-risk areas where proactive mitigation efforts will be needed and useful. Alaska's Geologic Mapping Advisory Board (GMAB) endorsed DGGS's choice of Kivalina (fig. 1) as a project to be funded by the U.S. Geological Survey's STATEMAP program in order to map surficial geology and assess geologic materials and natural hazards in support of informed community planning.

The objectives of the 2010 Kivalina STATEMAP project are: (1) Map the surficial geology in sufficient detail to develop comprehensive lithologic unit descriptions and a geomorphic framework that can be used to understand the active earth processes affecting the village of Kivalina and the surrounding area, and map the bedrock geology at a reconnaissance level sufficient to evaluate the lithologies for general engineering and materials characteristics; (2) Develop information matrices and derive maps that describe the general engineering properties of bedrock and unconsolidated geologic units in the map area; and (3) Identify and map potential geologic hazards, including the coastal zone and areas of flooding, erosion, thawing permafrost, and slope instability (fig. 2).

DGGS scientists completed fieldwork in the Kivalina STATEMAP area in July 2010 and are analyzing data and generating map products. Final products will be published in 2011 and include a report and maps describing the geologic setting and natural hazards of the study area. These new data will be critical to community planners as they develop and administer their plans in the context of major undertakings ranging from construction of engineered protective structures to possible relocation of the entire village.

Federal STATEMAP funding for this project is matched by state Capital Improvement Project (CIP) funds through DGGS's Climate Change Hazards program. Supplementary funds are from the U.S. Minerals Management Service (MMS) as part of the Coastal Impact Assistance Program (CIAP).

Figure 1. Map showing location of the Kivalina study area.

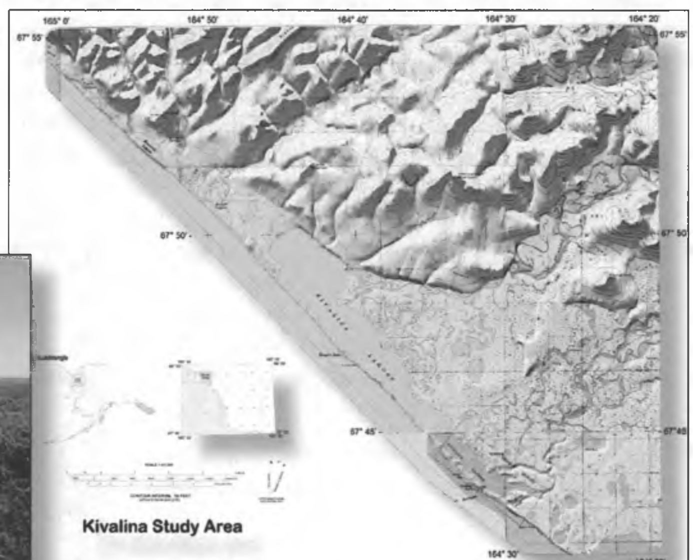

Figure 2. Thermokarst and drainage system development near Kivalina, Alaska.

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GEOLOGY, GEOHAZARDS, AND RESOURCES ALONG THE PROPOSED GAS PIPELINE CORRIDOR, ALASKA HIGHWAY, FROM DELTA JUNCTION TO THE CANADA BORDER

In preparation for the proposed Alaska natural gas pipeline, the Alaska Division of Geological & Geophysical Surveys (DGGS) is continuing work on a multi-year project to evaluate the geology, geohazards, and material resources between Delta Junction and the Canada border along a 12-mile-wide corridor centered along the Alaska Highway (fig. 1). Information obtained as a result of this study has been utilized for time-critical alignment, engineering, design and permitting decisions. Published materials from each of three segments along this route will include reports describing surficial geology, permafrost, bedrock geology, and potentially active faults. Each report, with the exception of the one describing potentially active faults, will be accompanied by 1:63,360-scale geologic maps. An engineering-geologic map and associated descriptive table will also be published as a derivative product from each surficial-geologic map. The bedrock mapping portion of this project is described separately (see p. 50). All maps are being made available as digital GIS files with accompanying metadata.

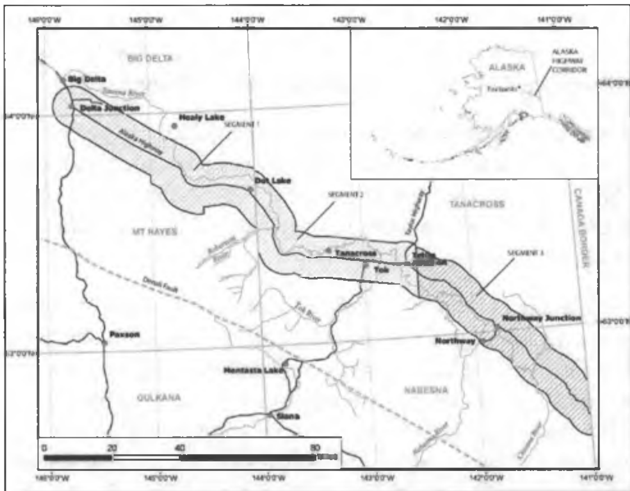

Figure 1. Location of the three segments of the study area.

For corridor Segment 2, between Dot Lake and Tetlin Junction, products in 2010 include a report on potentially active faults, a report and associated maps describing permafrost, and engineering-geologic maps with descriptive tables. DGGS is also currently engaged in report writing and map preparation for the third segment of the corridor between Tetlin Junction and the Canada border. We anticipate publication of the surficial-geologic map and report for Segment 2 in the fall of 2010 and all Segment 3 maps and reports by the fall of 2011.

DGGS personnel and contractors conducted field work during the summer and fall of 2010 to address additional questions arising from evaluation of previous years' results and to collect more data for completing a final compilation report that will include revised GIS maps for the entire corridor. Fieldwork included refining the permafrost, surficial- and engineering-geologic mapping and assessing areas along the Alaska Highway that are undergoing active slope failures (fig. 2). Additionally, we evaluated a paleoseismic trench along a lineament south of Alaska Highway milepost 1338 for evidence of recent fault activity. Information from field investigations was used in posters presented in fall 2010 at meetings of the Geological Society of America and the American Geophysical Union. During 2011, we will perform minor final fieldwork to resolve remaining geologic issues and to inspect any significant newly identified features that become apparent from high-resolution LiDAR (Light Detection and Ranging) data being collected in the entire proposed pipeline corridor (described separately; see p. xx). We anticipate completing the final compilation maps and report by winter 2012.

The Gas Pipeline Corridor Project is funded by the State of Alaska as a Capital Improvement Project (CIP).

Figure 2. Cracking of road surface resulting from active slope movement along the Alaska Highway near milepost 1272.

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LIDAR ACQUISITION FOR GEOLOGIC HAZARD EVALUATION

LiDAR (Light Detection and Ranging) has proven to be a highly useful form of remotely sensed data for identification and characterization of potentially active faults and many other surficial-geologic landforms and hazards, especially in areas of heavy vegetative cover where access may be difficult and other forms of remotely sensed data are ineffective. Because of its documented effectiveness as a tool for evaluating geology and geologic hazards, the Alaska Division of Geological & Geophysical Surveys (DGGS), with support from the Alaska Gas Pipeline Office and the Office of the Federal Coordinator, contracted Watershed Sciences, Inc. to acquire high-resolution LiDAR data (8 pulses per square meter) for an area of 1,578,504 acres beginning in the fall of 2010.

LiDAR acquisition areas (fig. 1) consist of: (1) contiguous 1-mile-width coverage over existing infrastructure along the entire length of the proposed natural gas pipeline corridor from Prudhoe Bay to the Canada border (following the Alaska Highway) and from Delta Junction to Valdez; (2) half-mile-wide coverage of existing primary pipeline-support roads where outside the main corridor; and (3) expanded areas of coverage along these corridors where data are needed for evaluation of active faults, slope instability, and other hazards.

The LiDAR data will serve multiple purposes, but will be primarily used to evaluate active faulting, slope instability, thaw settlement, erosion, and other engineering constraints along the proposed pipeline routes, and to provide a base layer for the state–federal GIS database that will be used to evaluate permit applications and construction plans.

Watershed Sciences, Inc., began work in mid September and was able to collect data for 128,221 acres, or about 22 percent of the total survey area, before the onset of snow prevented further acquisition. Data were collected for most of the targeted area between Delta Junction and the Canada border as well as between Delta Junction and Paxson. Remaining data collection will take place in the spring and summer of 2011, with anticipated completion by August 2011. Data delivery to DGGS will be staged beginning in early 2011. After quality control and analysis, data, including bare earth Digital Elevation Models (DEM's), will be made available to the public via the DGGS web page.

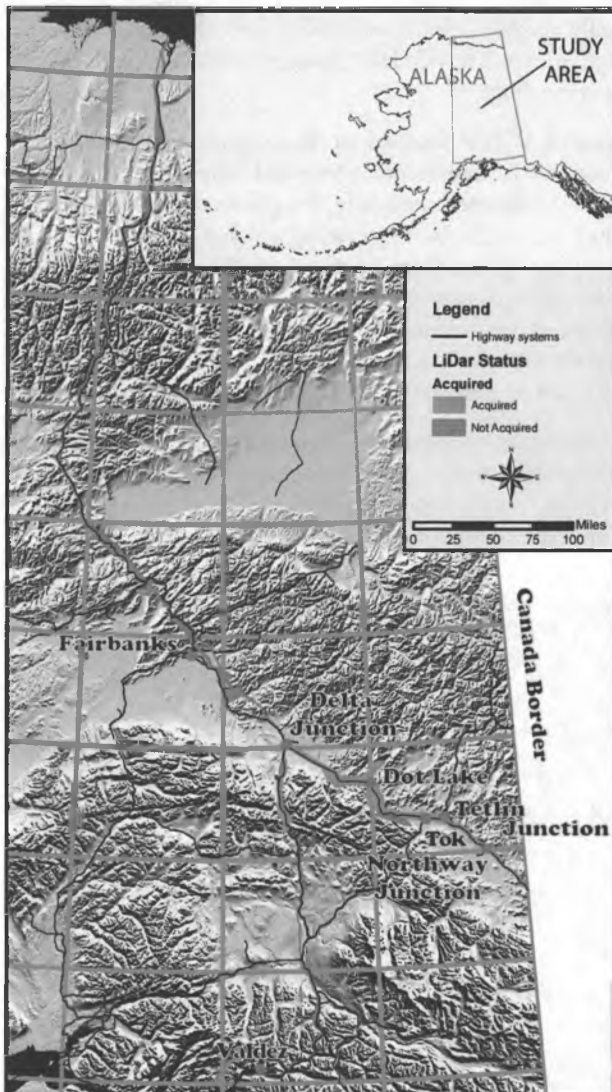

Figure 1. Map showing LiDAR acquisition areas.

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MapTEACH

The Alaska Division of Geological & Geophysical Surveys (DGGS) continues to participate in MapTEACH (Mapping Technology Experiences with Alaska's Community Heritage), an education-outreach program that targets geospatial technology skills for rural Alaska students (fig. 1). This program is a continuation of what was originally a multi-year NSF-funded collaborative project by DGGS and is now an important part of the University of Alaska Integrated Geography Program, which has embraced it as their "flagship K–12 outreach program." MapTEACH emphasizes hands-on experience with spatial technology (GPS, GIS, and remote sensing imagery in a local landscape-landform context) in conjunction with traditional activities. Working directly with geologists and local landscape experts, participants are presented with a chance to authentically emulate scientific data collection and mapping activities at a novice level, using real data in a real-world setting.

Figure 1. The MapTEACH website offers curriculum resources and other helpful information about the program to teachers wishing to explore place-based education in Alaska. The program was originally named "Mapping Technology Experiences with Alaska's Cultural Heritage," but "Cultural" has been replaced by "Community" to reflect the broader context into which MapTEACH has grown.

MapTEACH is founded on the integration of three focus areas: Geoscience, geospatial technology, and local landscape knowledge. Program materials are built on a menu-based model in which users (teachers) can select those portions of the curriculum that are most useful for their classroom objectives. When implementing the full range of MapTEACH curriculum, students and teachers interact in field settings with Native Elders, traditions-based community leaders, and professional geologists from DGGS and the University of Alaska.

Introducing students to geoscience and geospatial technology in culturally responsive and stimulating classroom and field settings will enhance community understanding of landscape processes and natural hazards in rural Alaska. It will also foster appreciation of state-of-the-art technology tools and data sets that can be applied to informed community planning and decision making.

MapTEACH is currently working with the Yukon–Koyukuk and Yukon Flats school districts to train science and geography teachers in the use of the MapTEACH curriculum (fig. 2). Class implementation projects to date have included an erosion study in Huslia, re-clearing and mapping an abandoned nature trail in Ruby, mapping Native place names in Koyukuk and Nulato, and mapping a road trip from Manley Hot Springs to Seward.

Figure 2. A Fort Yukon teacher prepares to core a tree on a MapTEACH field trip. Teacher training workshops were held in Fairbanks for teachers from the Yukon–Koyukuk and Yukon Flats school districts in which they learned about permafrost effects on landscape and vegetation, and gained experience in digital mapping using GPS units, GIS and GoogleEarth.

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QUATERNARY FAULT AND FOLD DATABASE

The Division of Geological & Geophysical Surveys (DGGS) is continuing collaborative efforts with the U.S. Geological Survey (USGS) to develop a Quaternary fault and fold database for the State of Alaska (fig. 1). Partial funding for GIS support has been provided by the Federal Office of Emergency Management (FEMA) in a grant to DGGS. The on-line resource will be of great utility to the earthquake engineering community, the insurance industry, scientific researchers, and the general public, and will contribute to the established database of active faults for the nation. Although Alaska is one of the most seismically active states, information on Quaternary tectonics is sparse. The November 3, 2002, magnitude 7.9 Denali fault earthquake and a large scarp in the vicinity of Anchorage along the Castle Mountain fault attest to the importance of information related to the location of past and future earthquakes. When completed, the database will also help identify gaps and problems in the existing information as a means of prioritizing future field investigations to identify, map, and describe Quaternary faults and folds.

DGGS is digitizing a GIS database of fault traces and fold axes (with associated attributes and in compliance with national guidelines) from 1:250,000-scale published data . In some cases, where more detailed maps are available, faults are digitized at a scale of 1:63,360. In support of the database, DGGS has completed a comprehensive literature search for published materials on Quaternary faults and folds and is in the process of creating text-based descriptions for individual structures. The descriptions summarize pertinent data such as geographic information, geomorphic expression, length, average strike, sense of movement, age of faulted surficial deposits, existing paleoseismological studies, and a list of references. The database will be incorporated into the existing USGS Quaternary fault and fold database, which provides users with a powerful user-friendly map interface linked to the available data.

We have completed digital mapping of eight major structures, including the Denali, Castle Mountain, Queen Charlotte–Fairweather, Iditarod–Nixon, Kaltag, Bendeleben, Patton Bay, and Hanning Bay faults. Fault digitizing will next concentrate on the Northern Alaska Range Foothills Fold and Thrust Belt and the southern Yakutat collision zone. Given the number of faults and lack of information on many structures, the complete dataset will take years to complete. Therefore, DGGS is concentrating efforts along structures that pose the greatest seismic hazards and/or have potential to impact planned and likely future development in the state. Our initial effort will serve as a platform up which to add additional information as new faults are discovered and future detailed studies are performed. Ultimately, the database will provide a comprehensive resource for seismic hazard assessment and regional policy planning.

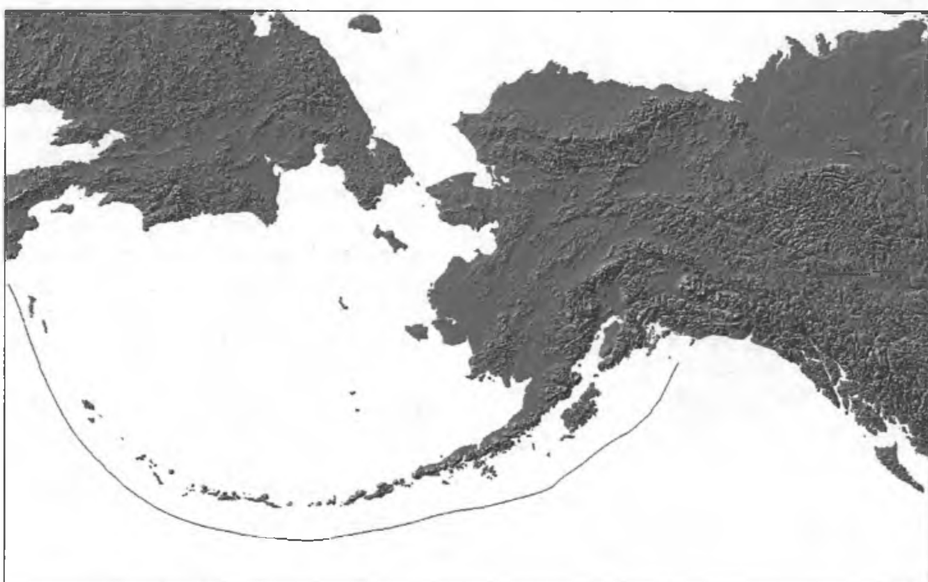

Figure 1. Digital shaded relief map of Alaska showing faults already digitized as part of the DGGS/USGS Quaternary fault and fold database project.

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SURFICIAL-GEOLOGIC AND NEOTECTONIC MAPPING OF THE SLATE CREEK AREA, MT. HAYES QUADRANGLE, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys (DGGS) conducted surficial-geologic and neotectonic mapping of about 113 square miles of the Chistochina geophysical survey tract during July 2009. This mapping project was primarily funded by State capital project funds, with supplementary Federal STATEMAP funding from the U.S. Geological Survey (USGS). The Slate Creek study area is located in the southern foothills of the Alaska Range about 140 miles southeast of Fairbanks and 20 miles east of Paxson (fig. 1). The 1,240-mile-long (2,000-kilometer-long) right-lateral Denali fault bounds the northern margin of the map area and was the source of the Mw 7.9 Denali fault earthquake on November 3, 2002, that caused significant damage to transportation corridors and many communities, as well as impacting the Trans-Alaska Pipeline. To identify and study evidence for past earthquakes along the Denali fault in this area, DGGS, in conjunction with the USGS, initiated a paleoseismic trench study as part of this project.

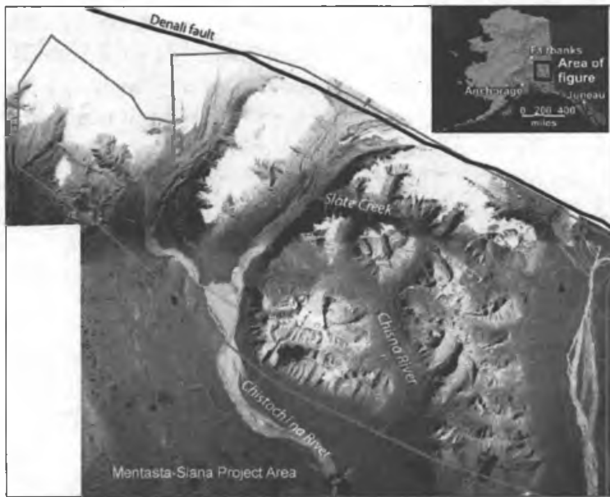

Figure 1. Location map of Slate Creek area, showing approximate trace of the Denali fault.

During Pleistocene time, the map area was inundated by ice that was part of an extensive system of alpine glaciers and ice caps of the Alaska Range that coalesced with the Cordilleran Ice Sheet and reached all the way to the Gulf of Alaska. The map area was also extensively glaciated during late Wisconsin time, with ice reaching up to 30 miles (50 kilometers) from the rangefront at its maximum extent 25,000–20,000 years ago. Glacially-oversteepened slopes and comparatively recent loss of ice buttresses, possibly combined with proximity to the Denali fault and its attendant seismicity, have resulted in numerous landslides. Three trenches were hand dug on the 2002 rupture trace of the Denali fault. Six faults were identified on one trench, all of which break the entire stratigraphic section to the surface and thus indicate rupture during the 2002 event. The other two trenches suggest the occurrence of at least two paleoearthquakes.

Figure 2. Draft surficial-geologic map of the Mentasta–Slate Creek area. Green = Pleistocene glacial deposits; purple = Holocene glacial deposits; orange = colluvial deposits; yellow = alluvial deposits; gray = bedrock.

New surficial-geologic mapping (fig. 2) will lead to a better understanding of the region's Quaternary geologic framework and provide geologic-resource and -hazards data critical to land-use decisions. Paleoearthquake chronology data developed in collaboration with our USGS colleagues are being compared to paleoseismic histories determined at other sites along the central and eastern Denali fault, and will ultimately be used to develop earthquake recurrence models for south-central Alaska. This information will also contribute to Alaska's Quaternary Fault and Fold Database (QFF project, described separately). Products of the Slate Creek project anticipated by late 2011 include a report and a geologic map (1:50,000 scale) describing surficial-geologic deposits. A Report of Investigations (RI) summarizing the results of the paleoseismic investigation has been reviewed internally by the USGS and will be finalized in Spring 2011. Bedrock mapping performed in conjunction with this project is described separately.

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SURFICIAL-GEOLOGIC AND NEOTECTONIC MAPPING OF THE TYONEK AREA, WESTERN COOK INLET, ALASKA

In conjunction with the 2010 Tyonek STATEMAP project (described separately), the Division of Geological & Geophysical Surveys (DGGS) is undertaking surficial-geologic mapping and neotectonic investigation on the western side of Cook Inlet (fig. 1). The map area straddles the northwestern margin of Cook Inlet basin and encompasses about 875 square miles (2,266 square kilometers) of State and Native corporation land. The Lake Clark fault is a right oblique reverse fault that extends ~105 miles (~170 kilometers) northeast from Lake Clark in the western Alaska Range to the northern Cook Inlet forearc basin. Post Eocene right lateral and north-side-up vertical displacements of 16 miles (26 kilometers) and 1,640–3,280 feet (500–1,000 meters), respectively, are well documented. Details about the fault's Quaternary history are limited to only a few observations.

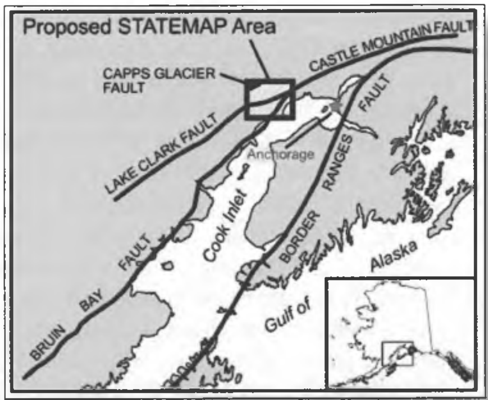

Figure 1. Location map of Tyonek area.

Glacial, volcanic, and mass-movement deposits dominate the Tyonek landscape (fig. 2). During the last major glaciation, the map area was invaded by the massive Cordilleran Ice Sheet, which spread eastward into the Cook Inlet trough from sources in the southern Alaska Range to the west and north. Following the maximum ice extent about 23,000 years ago, the glacier complex thinned and ice from individual lobes fluctuated as it deposited glacial and glacioestuarine material that is now preserved in the coastal lowland area of northwestern Cook Inlet. Volcanism centered on the Mt. Spurr complex temporarily dammed the valley of Chakachatna River, producing massive flooding in the southwestern part of the map area. Massive landslides displace bedrock and Quaternary sediments in the uplands and valley walls of incised streams, and the volcanic plateau in the northwestern map area is being dismantled by complex landslides along the eastern and western margins. Our neotectonic investigation places broad constraints on the recency of activity along the Lake Clark fault. The results indicate that the eastern part of the fault is characterized by a relatively low rate of activity and has been tectonically quiescent since at least 21,000 years ago.

New geologic mapping will lead to a better understanding of the region's geologic framework and provide geologic-resource and -hazards data critical to land-use decisions. The neotectonic data are important for seismic hazards assessments related to petroleum production infrastructure and potential future coal resource and hydroelectric power development, as well as seismic safety of the greater Anchorage metropolitan area. The results of the neotectonic study will ultimately be incorporated into the Alaska Quaternary Fault and Fold database (see p. 61). Final products of the Tyonek project will include two reports and a geologic map at 1:63,360 scale. The neotectonics report is presently in review and expected to be completed in Spring 2011. A map and report describing the surficial geology will be completed by late 2011. Bedrock geologic mapping performed in conjunction with this project is described separately.

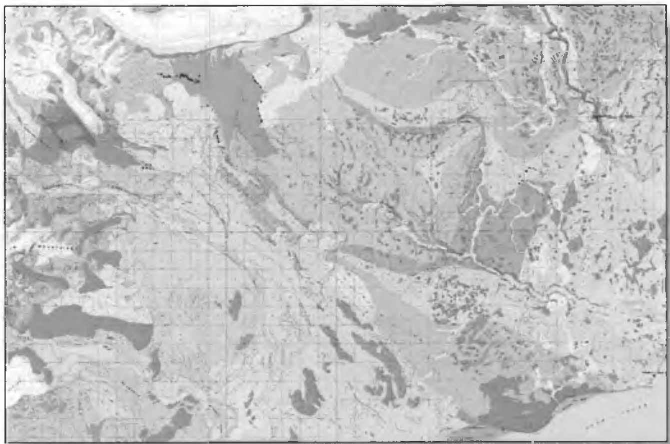

Figure 2. Draft surficial-geologic map of the Tyonek area. Green = glacial deposits; yellow = alluvial deposits; blue = glacioestuarine deposits; tan = landslides; and dark pink = volcanic deposits.

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SURFICIAL GEOLOGY IN THE SAGAVANIRKTOK QUADRANGLE, NORTH SLOPE ALASKA

In 2010 the Alaska Division of Geological & Geophysical Surveys (DGGS) continued compiling surficial-geologic maps of a 1,212-square-mile area straddling the Dalton Highway in the northern Brooks Range foothills in the Sagavanirktok B-3, B-4, B-5, A-3, A-4 and A-5 quadrangles at a scale of 1:50,000 (fig. 1). Mapping in this area will provide crucial baseline geologic data for assessing potential geologic hazards such as permafrost thawing, slope creep, and flooding, which could impact existing infrastructure in the area, including the Trans Alaska Pipeline (TAPS) and Dalton Highway, both of which are vitally important to Alaska's economy. Information from these mapping efforts can also be useful for assessing the rate and severity of landscape change, an important consideration in infrastructure development in arctic regions where such information is limited. Future development such as resource exploration and construction of a natural gas pipeline will depend on having good quality geologic and hazards data upon which to base decisions.

Figure 1. Area of mapping.

Many of the surficial deposits in the area are related to Itkillik (late Pleistocene), Sagavanirktok (middle Pleistocene), and Anaktuvik (early Pleistocene) glacial advances moving northward out of the Brooks Range along major drainages. Deposits from the Anaktuvuk advance have been extensively modified by colluvial and periglacial processes (fig. 2) and are characterized by broad, gently sloping surfaces. The younger Itkillik and Sagavanirktok deposits, although somewhat modified by slope processes, retain more primary glacial morphology and tend to have steeper slopes (fig. 2). In general, the northern and western portions of the study area are characterized by thermokarst and other features associated with extensive permafrost development (fig. 3).

Figure 2. Oblique, south-facing photo of Sagavanirktok River and Anaktuvuk River drifts. Sagavanirktok River drift retains some primary glacial morphology, and Anaktuvuk River drift is characterized by broad, gently sloping surfaces extensively modified by colluvial and periglacial processes.

We anticipate that a reconnaissance map of the entire area and a more detailed map of 377 square miles in the central portion of the area along TAPS will be completed in 2011. This project has been conducted in conjunction with the DGGS Energy Section as part of their continuing work along the northern foothills of the Brooks Range. Preliminary results were part of a combined bedrock–surficial geologic map presented at the Alaska Geological Society Conference in 2009 and a map submitted to the U.S. Geological Survey in fulfillment of STATEMAP reporting requirements that same year.

Figure 3. Oblique photo showing polygonal ground associated with extensive permafrost development.

The Sagavanirktok mapping project is funded by State of Alaska General Funds and the Federal STATEMAP program.

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SURFICIAL GEOLOGY OF THE NORTHERN FAIRBANKS MINING DISTRICT, CIRCLE QUADRANGLE, NORTHEAST FAIRBANKS GEOPHYSICAL SURVEY TRACT

In summer 2007, the Division of Geological & Geophysical Surveys (DGGS) conducted about 189 square miles of geologic mapping straddling the Steese Highway, about 50 miles northeast of Fairbanks, covering the central portion of DGGS's 404-square-mile Northeast Fairbanks airborne magnetic and electromagnetic geophysical survey area. The mapping project was funded primarily by DGGS's Airborne Geophysical/Geological Mineral Inventory program, a special multi-year capital-project investment by the State of Alaska to expand Alaska's geologic and mineral resources knowledge base, catalyze future private-sector mineral exploration and development, and guide state planning. Other funding sources included the U.S. Geological Survey's STATEMAP program and the State's General Fund.

The Engineering Geology Section of DGGS mapped the surficial geology of the area to understand the genesis of the landscape in which placer gold deposits have accumulated (fig. 1). Glacial deposits are prominent in the northwestern portion of the field area, where large granite erratics can be traced many kilometers downvalley from sources in the high peaks of the Mt. Prindle area. Extensive gravel-capped high-level terraces are preserved along the Chatanika River, and extend upvalley into the lower reaches of major tributary streams in the western portion of the field area. Thin lags of rounded fluvial cobbles are draped on discontinuous remnants of these high-level terraces as far as 10 kilometers upstream in Faith Creek. Silt-dominated deposits characterized by numerous pingos predominate in the southern part of the study area.

The products of this project are geologic-framework maps at 1:50,000 scale, one of which describes the surficial geology of the area. The map is being revised after technical review and will be released in spring of 2011. We are using the DGGS Geographic Information System (GIS) to generate these maps, and all data for the project will ultimately be stored and made available in a geographically referenced relational database. DGGS will serve these data from its website (www.dggs.alaska.gov) upon completion of the project. Past experience has shown that a thorough understanding of the geologic framework of an area acts as a catalyst for resource development, paves the way for future exploration, and fosters improved resource management and land-use planning. We anticipate a similar result for the Northeast Fairbanks geophysical tract.

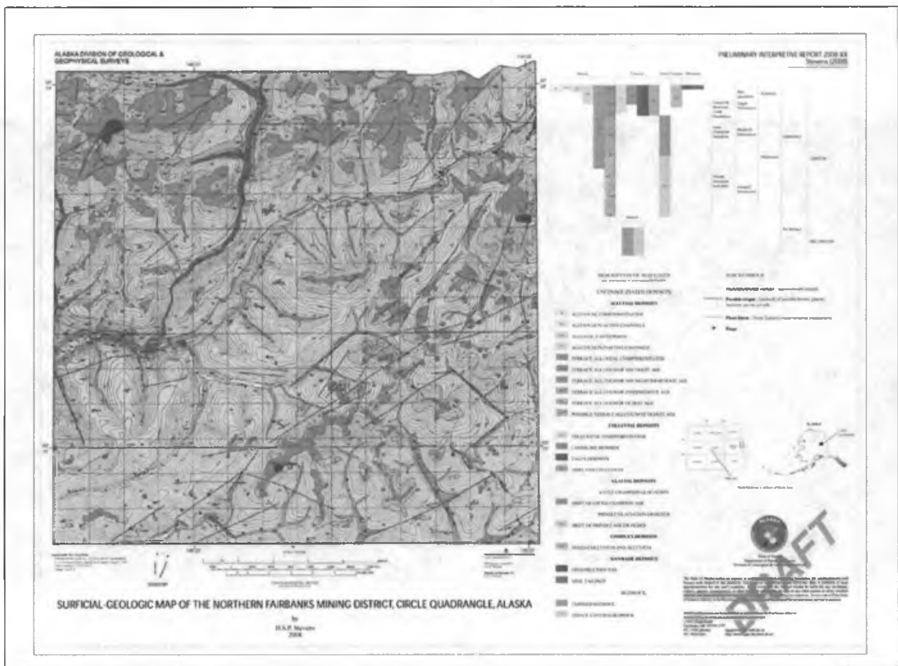

Figure 1. Draft surficial-geologic map of the northern Fairbanks mining district.

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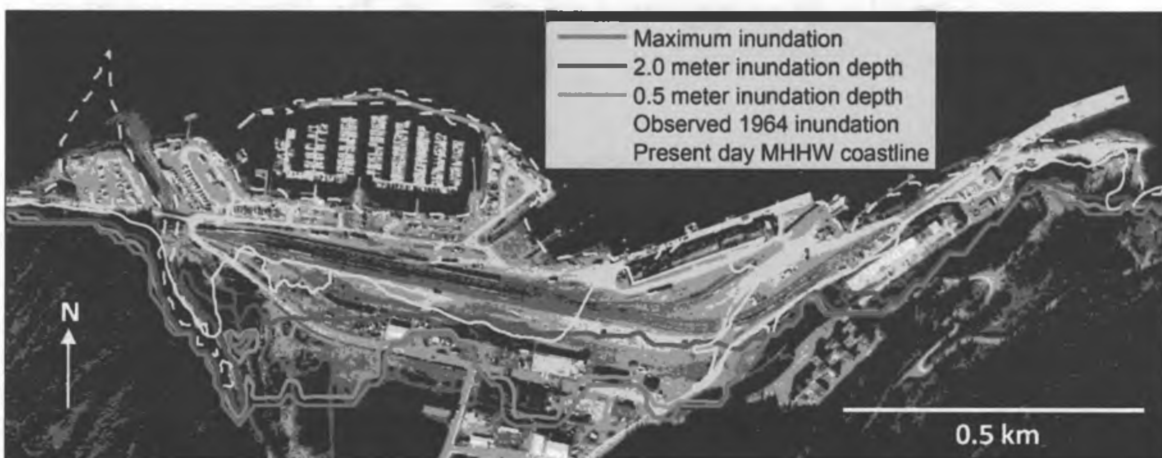
TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

With funding from Congress, the National Oceanic & Atmospheric Administration (NOAA) initiated the National Tsunami Hazard Mitigation Program in 1997 to assist Pacific states in reducing losses and casualties from tsunamis. The program included funding for five states (Alaska, Hawaii, Washington, Oregon, and California) to address four primary issues of concern: (1) quickly confirm potentially destructive tsunamis and reduce false alarms, (2) address local tsunami mitigation and the needs of coastal residents, (3) improve coordination and exchange of information to better use existing resources, and (4) sustain support at state and local level for long-term tsunami hazard mitigation. In 2005, following the catastrophic Sumatra earthquake and tsunami, the U.S. program was expanded to include Atlantic and Gulf of Mexico states and territories.

As part of this program, the Division of Geological & Geophysical surveys (DGGS) participates in a cooperative project with the Alaska Division of Homeland Security & Emergency Management (DHSEM) and the University of Alaska Geophysical Institute (UAGI) to prepare tsunami inundation maps of selected coastal communities. Communities are selected based on tsunami risk, infrastructure, availability of bathymetric and topographic data, and willingness of the community to use results for emergency preparedness. For each community, DGGS and UAGI develop multiple hypothetical tsunami scenarios that are based on the parameters of potential underwater earthquakes and landslides. We have completed and published tsunami inundation maps for the Kodiak area, Homer, Seldovia, and Seward. A draft report and maps for Whittier are currently under review for publication in early 2010 (fig. 1). Data compilation and inundation modeling for the next community, Sitka, are underway.

To develop inundation maps, we use complex numerical modeling of tsunami waves as they move across the ocean and interact with the seafloor and shoreline configuration in shallower, nearshore water. UAGI conducts the wave modeling using facilities at the Arctic Region Supercomputing Center. DGGS, UAGI, and DHSEM meet with community leaders to communicate progress and results of the project, discuss format of resulting maps, and obtain community input regarding past tsunami effects and extent. DGGS publishes the final maps along with explanatory text, which are available in both hardcopy and digital formats. DGGS also makes the GIS files of inundation limit lines available to the local communities for use in preparing their own tsunami evacuation maps.

We have presented results of this project at international tsunami symposia in Istanbul, Turkey, Seattle, Washington, and Hania, Greece; at the Tsunami Society symposium in Honolulu, Hawaii; at the International Union of Geodesy and Geophysics Symposium in Perugia, Italy; and at the American Geophysical Union annual meetings, 2003–2007. In addition, this project has been the subject of articles in *Geotimes* and *TsuInfo Alert Newsletter.*



Draft tsunami inundation map of Whittier, Alaska, showing observed 1964 inundation, maximum estimated future inundation resulting from all considered tectonic and landslide sources, and resulting water depths.

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REDOUBT VOLCANO: EDIFICE AND 2009 DOME GEOLOGIC INVESTIGATIONS

In 2008 the Alaska Volcano Observatory (AVO), led by the Division of Geological & Geophysical Surveys (DGGS), initiated efforts to produce an updated geologic map and hazard assessment of Redoubt volcano. Those efforts were interrupted by the onset of Redoubt's eruption on March 15, 2009, following 19 years of repose. Most efforts of DGGS's Volcanology Section, as well as other AVO agencies, were redirected to eruption response. The eruption waned during the late spring of 2009, and by summer 2010 work on the map and hazard assessment could resume—coupled with work on the deposits and effects of the 2009 eruption.

Activities and Results: During the 2010 field season DGGS-AVO geologists successfully completed fieldwork on Redoubt Volcano with three goals: (1) to further completion of the geologic map of Redoubt Volcano begun in 2008; (2) to sample and study the 2009 lava dome; and (3) to further describe 2009 deposits. Fieldwork to improve the geologic map entailed detailed mapping of lava flows that had been successfully dated by collaborating researchers with the U.S. Geological Survey. Early Holocene ages of flow that were thought to be older (Pleistocene) drove a reinvestigation and reinterpretation of the morphology of those flows. Dome sampling was complicated by its altitude (~8,000 feet), active fumaroles, and the potential of instability. Yet well located samples of the dome are required for investigations of the dome building process. One sampling method utilized a small dredge towed by the helicopter (fig. 1), a technique pioneered by the USGS Cascades Volcano Observatory (CVO) as a way to sample the Mt. St. Helens dome in Washington. Other samples were collected by hand during extremely brief landings. Vesicularity studies are in progress on the retrieved samples, and further chemical analyses are pending. AVO-DGGS geologists also collaborated with researchers from Cold Regions Research & Engineering Laboratories (CRREL), U.S. Army Corps of Engineers, in an attempt to acquire high-resolution ground-based LiDAR imaging of the dome surface; ultimately weather precluded data acquisition.

Products: AVO-DGGS geologists presented the ongoing research into the growth and morphology of the 2009 Redoubt Volcano lava dome at the annual American Geophysical Union conference in San Francisco in December 2010. AVO, CVO-USGS, and University of Northern Colorado colleagues are drafting a paper on dome growth and morphologic changes as part of a special issue on the 2009 eruption of Redoubt volcano to be published in the *Journal of Volcanology and Geophysical Research.* Completion of the map awaits further geochemical and age data.

Figure 1. Photograph showing helicopter (arrow) dredge-sampling the 2009 lava dome in the crater of Redoubt volcano. (Photo by Steven Anderson, University of Northern Colorado).

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REDOUBT VOLCANO: TEPHRA STUDIES

In March 2009, after nearly 19 years of quiescence, Cook Inlet's ice-covered Redoubt volcano began erupting explosively. Over the course of three weeks, at least 19 explosions sent ash into the atmosphere to heights between 5 and 19 kilometers (17,000 to 62,000 feet) above sea level (ASL), resulting in tephra fallout throughout south-central Alaska, affecting an area of ~80,000 square kilometers. Tephra is the fragmental material of varying particle size produced by volcanic explosions; it consists of pulverized rock, glass, and crystal fragments. Volcanic ash is tephra with a particle size of less than 2 mm in diameter, and is the most significant volcanic hazard to humans, machinery, and the environment owing to its wide dispersal by wind.

In spring 2009, Division of Geological & Geophysical Surveys (DGGS) geologist Janet Schaefer, along with U.S. Geological Survey (USGS) colleague Kristi Wallace, both of the Alaska Volcano Observatory, mapped, sampled, and described the 2009 Redoubt tephra deposits. Throughout the course of the year, more than 200 samples were processed in the lab. By analyzing tephra fallout patterns using NEXRAD radar data and interpreting dozens of stratigraphic sections, the geologists constructed a contour map of tephra fall density (fig. 1). A total tephra-fall volume (dense-rock equivalent) for all 19 explosions is estimated to be 22.6 million cubic meters with a single event maximum of ~6 million cubic meters. These estimates are comparable to previous historical eruptions of Redoubt volcano and are an indication of its eruptive power and continuing widespread ash impacts.

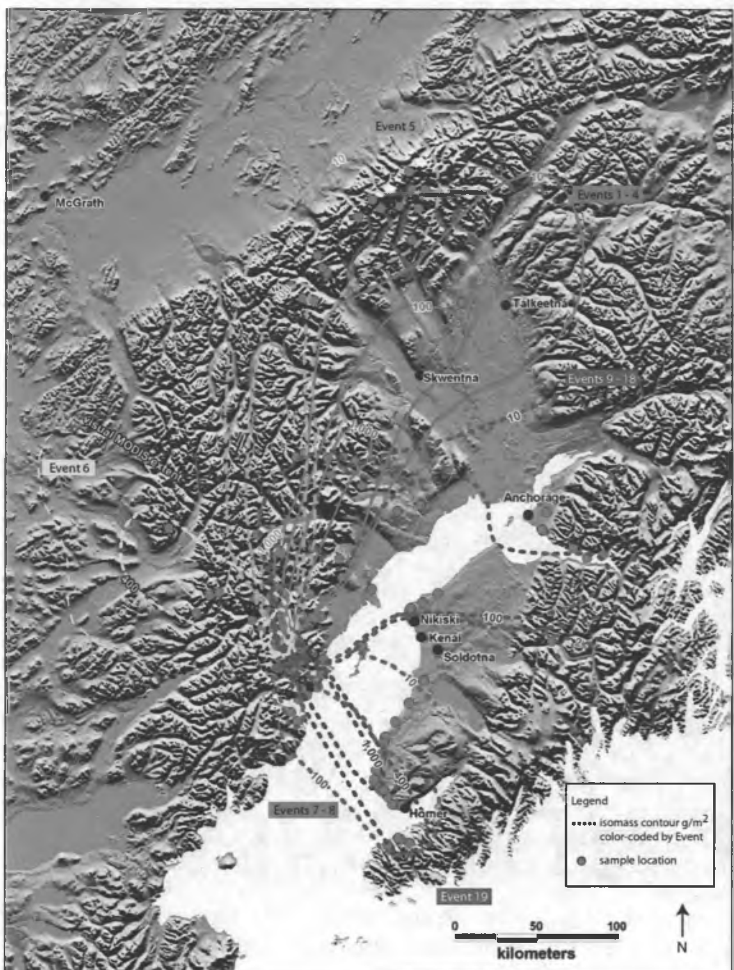

Figure 1. Map showing isomass contours of tephra-fall deposits from the 2009 eruption of Redoubt volcano. Outer contour is 10 grams per square meter, however, trace ash fall (<0.8 mm thick) extended beyond these contours, as far as Fairbanks, 550 kilometers to the north–northeast of the volcano.

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KASATOCHI VOLCANO: GEOLOGIC STUDIES AND ECOSYSTEM RESPONSE

The August 7, 2008, eruption of Kasatochi volcano, located near Adak in the Aleutian Islands, was short, powerful, and came with little warning. Over the course of about 24 hours a series of explosive eruptions produced pyroclastic flows that swept all sides of the tiny island, building new beaches some 400 meters seaward and leaving deposits more than 10 meters thick. Additionally, the explosions enlarged the 1,100-meter-diameter summit crater by more than 250 meters. Ash clouds reached the stratosphere and were carried rapidly to the east, disrupting air traffic to Alaska and along the North Pacific air route. The ash clouds ultimately circled the globe, producing vibrant sunsets in the 'Lower 48' states. The eruption was preceded by a short (36-hour), yet exceptionally intense, earthquake swarm, with more than a thousand earthquakes greater than 2 in magnitude (M), the largest of which was M 5.7. Kasatochi had not erupted for at least a century, and perhaps not during the 250 years of recorded history in Alaska.

Despite its small size—some 2.5 kilometers in diameter—Kasatochi previously supported a lush ecosystem, and that ecosystem was devastated by the eruption. Of particular concern were the auklet nesting colonies because Kasatochi was among only a dozen or so auklet nesting sites in the north Pacific, and auklets rely on existing rock crevices for nesting. Kasatochi also presented a rare opportunity to study the recovery of an island ecosystem that had been well described before the devastation. A multidisciplinary study of ecosystem recovery began in 2009, funded by the North Pacific Research Board, the USGS, and the U.S. Fish and Wildlife Service. Studies in 2009 documented that no chicks of any bird species successfully fledged, compared to ~50,000 birds that fledged in 2008; the investigations also found that, surprisingly, root mats of the pre-eruption vegetation were not all destroyed, and in some of the rare places where erosion had revealed the 2008 surface, plants now grew.

As part of the interdisciplinary project, the Division of Geological & Geophysical Surveys (DGGS) is heading efforts to produce the first geologic map of the island and to investigate the older lava and tephra units on the island. About 12 days total field time in four trips (two in 2009 and two in 2010) have resulted in identification of general stratigraphic units and a full suite of rock samples. Products of Alaska Volcano Observatory work at Kasatochi to date include numerous presentations at an American Geophysical Union special session, special editions of two major journals devoted to the eruption, and several articles in Alaska newspapers. Completion of the geologic map, anticipated in fall 2011, awaits further analytical data on sample age and composition. Support for this project (from 2010 and ongoing) is from the American Reinvestment and Recovery Act through a cooperative agreement between USGS and DGGS.

Oblique aerial photographs of Kasatochi before and after the eruption—both taken during 2008, but from different directions. Pyroclastic flows have built fans that cover previous beach bluffs and extend the shoreline up to 400 meters. In addition, the post-eruption crater is significantly larger. Both photographs are courtesy of Jerry Morris, Security Aviation

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OKMOK VOLCANO: GEOMORPHOLOGY AND HYDROGEOLOGY OF THE 2008 PHREATOMAGMATIC ERUPTION

On July 12, 2008, with less than 5 hours of precursory seismic activity, the central Aleutian volcano Okmok erupted explosively, marking the beginning of a 5-week-long eruption that dramatically changed the morphology and groundwater system in the 8-kilometer-wide caldera. The initial explosion sent an ash- and gas-rich column to 15 kilometers above sea level. Early in the eruption, heavy rain mixed with new tephra on the flanks of the volcano, generating lahars (volcanic mudflows) that traveled across the upper slopes of the volcano and down all major drainages, creating large new deltas along the shoreline. For the next 5 weeks, eruption intensity waxed and waned with explosions occurring from multiple vents on the caldera floor as rising magma interacted with shallow groundwater. One crater formed next to, and eventually captured and drained, the largest pre-existing caldera lake (total volume drained was 13.6 million cubic meters). As the eruption subsided, coalescing maar and collapse craters eventually filled with water, forming a new lake to the west of cone D (fig. 1a) and dramatically changing the morphology and volume of the old lake (fig. 1b). The longest-lived vent formed a 250–300-meter-high, ~1.5-kilometer-wide tuff cone on the western flank of pre-existing cone D. This new tuff cone, the new lakes and collapse pits, and the accumulation of many tens of meters of fine-grained tephra have significantly altered the Okmok landscape. This eruption was substantially larger than any Okmok eruption since that of 1817 (which destroyed the then-unoccupied village of Egorkovskoe on the north coast of Umnak) and far larger than the eruptions of 1945, 1958, or 1997.

Division of Geological & Geophysical Surveys (DGGS) Geologist Janet Schaefer, along with Alaska Volcano Observatory (AVO) and Northern Arizona University (NAU) scientists, visited Okmok in the summer of 2010 to investigate and document this fascinating eruption, the first phreatomagmatic event (explosive eruption caused by contact between rising magma and groundwater) to occur in the United States since the 1977 eruption of Ukinrek Maars on the Alaska Peninsula. Fieldwork focused on the stratigraphy and sedimentology of the tephra deposits from the 2008 eruption, documentation and description of vent evolution, a revision of the hazard assessment, and the creation of a post-eruptive geologic map. A summary of the stratigraphy and sedimentology of the 2008 tephra deposits was presented at the 2010 Fall meeting of the American Geophysical Union. The revised hazard map and geologic map are anticipated to be completed within 2 years.

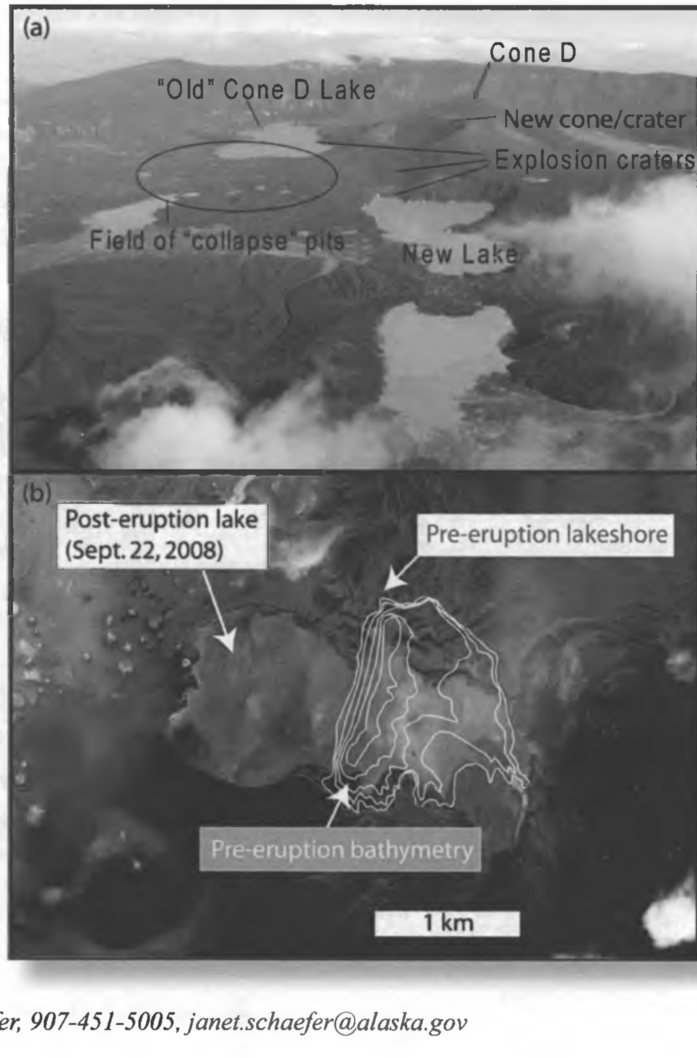

Figure 1. (a) Oblique aerial view, looking east, of Okmok caldera showing the new tuff cone, explosion craters, lakes, and a field of collapse pits adjacent to Cone D. (b) Post-eruption satellite image annotated to show the pre-eruption lakeshore (in blue) of "old" Cone D lake, the pre-eruption bathymetry (in yellow), and the expanded post-eruption lake, north of cone D. North is up.

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CHIGINAGAK VOLCANO: MONITORING ENVIRONMENTAL RECOVERY FROM THE 2005 ACID CRATER LAKE DRAINAGE

Mount Chiginagak is a hydrothermally active volcano on the Alaska Peninsula, approximately 170 kilometers (100 miles) south–southwest of King Salmon. Sometime between November 2004 and May 2005, a 400-meter-wide (~1,300-foot-wide), 100-meter-deep (~330-foot-deep) lake developed in the formerly snow- and-ice-filled crater of the volcano. In early May 2005, an estimated 3 million cubic meters (106 million cubic feet) of sulfurous, clay-rich debris and acidic water exited the crater through tunnels in the base of a glacier that breached the south crater rim. More than 27 kilometers (17 miles) downstream, the acidic waters of the flood reached approximately 1.3 meters (4 feet) above current water levels and inundated an important salmon spawning drainage, acidifying Mother Goose Lake from surface to depth (pH of 2.90 to 3.06) and preventing the annual salmon run in the King Salmon River. A release of caustic gas and acidic aerosols from the crater accompanied the mud flow and flood, causing widespread vegetation damage along the flow path. An interdisciplinary science team led by the Division of Geological & Geophysical Surveys (DGGS) has been monitoring the status of the remaining crater-lake water that continues to flow into Mother Goose Lake.

Beginning in 2009, an ice layer began to reform in the crater lake, indicating a cessation in the crater's fumarolic heat source (fig. 1). Despite the newly reformed ice layer, more than 1 million cubic meters (35 million cubic feet) of water remains in the crater and continues to supply acidic water to Mother Goose Lake and the King Salmon River.

In August and September 2010, DGGS conducted fieldwork with U.S. Fish & Wildlife Service (USFWS) fisheries biologists, sampling water and investigating the recovery of fish in the acidified system. Biologists found that a variety of salmon species had returned to Mother Goose Lake in 2010, and pH measurements confirmed that the acidity of the lake had declined (pH increase from 4.8 in 2009 to 5.4 in 2010) creating more habitable conditions for the fish. If the current trend continues, the pH of Mother Goose Lake should approach a normal range by the end of 2012.

Geologic Mapping and Volcano Hazard Assessment

The DGGS-led geologic mapping and hazard assessment fieldwork that began in 2004 was completed in 2008. Investigations have revealed a long history of hydrothermal activity, debris avalanches, and lava flows at the volcano. A geologic map and volcano hazard assessment are scheduled to be published by DGGS in 2011. This work has been supported by the USFWS.

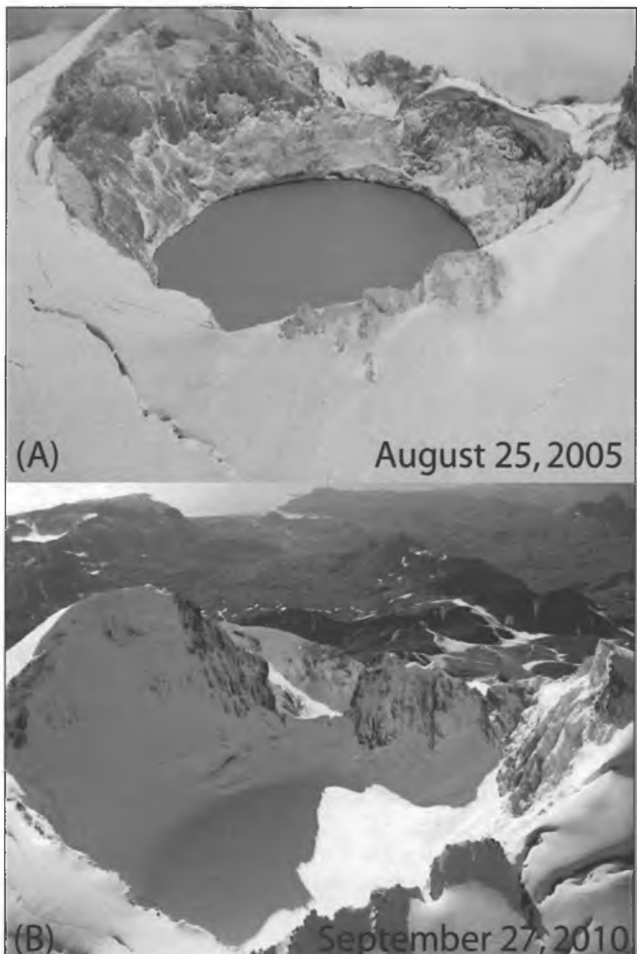

Figure 1. (A) The summit crater lake at Chiginagak volcano in August 2005, ~3-1/2 months after the crater lake partially drained, and (B) September 27, 2010. Snow and ice are once again accumulating in the crater as the glacier reforms in response to the cessation of heat flow to the summit. Photos by Janet Schaefer, DGGS.

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ALASKA VOLCANO OBSERVATORY WEBSITE AND DATABASE

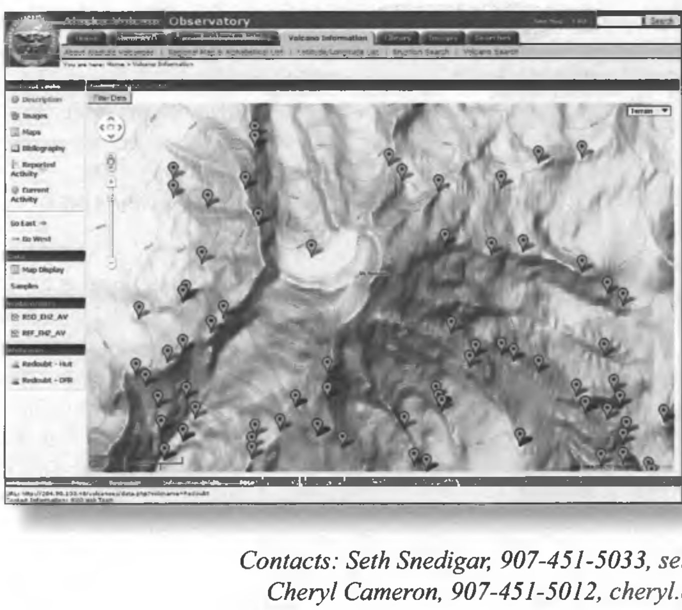
The Alaska Volcano Observatory (AVO) public website (http:www.avo.alaska.edu) serves about 2,800,000 pages and approximately 300 gigabytes of data to well over 100,000 unique visitors per month, and is among the top ten U.S. Geological Survey (USGS) and USGS-affiliated websites in the country. It continues to be the most complete single resource on Quaternary volcanism in Alaska. The Division of Geological & Geophysical Surveys (DGGS) was the original creator of the AVO website in 1994, and continues to be the site designer, builder, and manager.

During FY2010, supported by American Recovery and Reinvestment Act (ARRA) funding, three new servers were purchased and added to AVO's web-serving configuration. In the previous server configuration, one server hosted both the database and website, with a backup server doing the same. Serving both the website and database is a resource-intensive task, especially during episodes of eruptive activity. An average day's traffic generates 100,000 page views and 3,000,000 queries on the database. These numbers can expand exponentially during an eruption, made clear by how the AVO webservers were briefly unable to handle the traffic during the Redoubt unrest in January 2009. In the new configuration, the webserver and database server are separately installed on two of the new servers (in addition to the two older servers that each contain both the website and the database). The third new server will store and host GIS data about Alaska's volcanoes.

The three database servers are also configured in a multi-master replication scheme. This type of replication allows users to enter data on any database server; that data will then be available on any other server. This creates instant data redundancy; should any server fail due to load or hardware/software issues, traffic can be redirected to another server.

AVO's website content is dynamically queried from a MySQL database named GeoDIVA (Geologic Database of Information on Volcanoes in Alaska). GeoDIVA maintains complete, flexible, timely, and accurate geologic and geographic information on Pleistocene and younger Alaska volcanoes to assist scientific investigations, crisis response, and public information. GeoDIVA is currently the most comphrensive and up-to-date authoritative source for information on Alaska volcanoes. It is still under construction, in a modular format. As modules are completed, they undergo continual maintenance so that they remain timely and useful. Current modules in maintenance mode include: bibliography (4,450+ references); basic volcano information (~140 major and ~200 minor volcanic features, 52 'historically active'); eruption history (information, text, and references for more than 430 historic eruptions); images (>18,300); sample information (~7,100); hand sample storage (>15,000); and vent count (~1,200 vents). Modules in continuing development and initial data-load stages include geochemistry (~3,000 analyses, ~113,000 records); petrology (~90 1,000-point point-count analyses); GIS data, geochronology, and tephrachronology/tephra impacts. AVO now owns a dedicated server for GIS data and has licenses for geospatial software. In coming months we will work to input geospatial data and metadata into the server, and make it queryable and usable for AVO staff.

Also developed during FY2009 is the public ash-reporting database and website interface. This effort was in response to the hundreds of citizen ash reports that were phoned and emailed to AVO during the 2009 eruption of Redoubt volcano—each one requiring a staff response. The initial effort was helpful to reduce the burden of citizen ash reporting on AVO staff, but had a number of shortcomings, mostly because of the rapidity of its development. In 2010, we significantly improved and refined the database. We added a map display of samples, coded by ash present/not present and verified/not verified; created a more user-friendly interface; streamlined questions to collect the data that is most important to AVO; and incorporated suggestions from the National Weather Service and global tephra experts.



AVO is on the leading edge of web and database development for volcano observatories, and is actively sharing its expertise with other observatories in the U.S. DGGS is following new and emerging technologies that will allow further enhancement of AVO's web presence and data dissemination abilities. DGGS continually refines and enhances the applications that AVO and other observatories use on a regular basis; the focus will remain on continual incremental improvements to the site, and serving new database modules as they become available.

The Redoubt volcano data map shows locations of published samples. Each marker contains links to the sample's citation information, as well as descriptive, geochemical and petrological data if they exist.

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DIGITAL GEOLOGIC DATABASE PROJECT

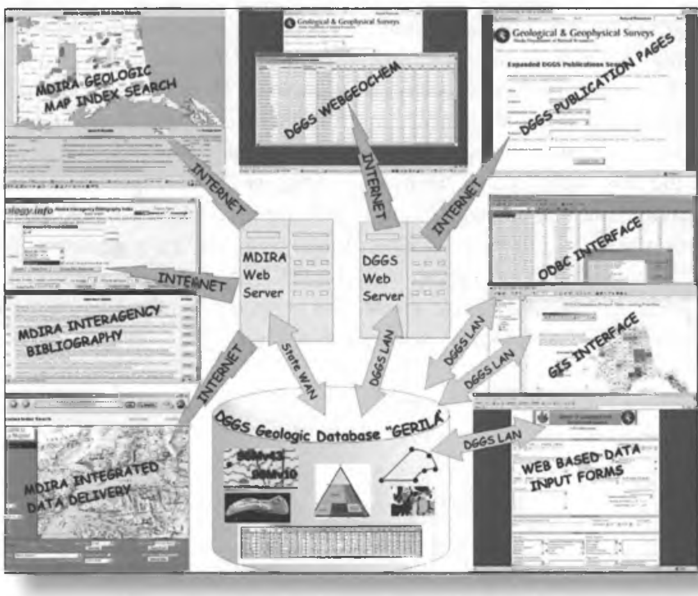
In 2000, the Alaska Division of Geological & Geophysical Surveys (DGGS) set out to develop a geologic database system to provide the architecture for consistent data input and organization. That database system now includes data identification and retrieval functions that guide and encourage users to access geologic data online at no charge. This project was initially part of the federally funded Minerals Data and Information Rescue in Alaska (MDIRA) program; ongoing data input, use, and maintenance of the database system are now part of DGGS's normal operations supported by State General Funds.

The Digital Geologic Database Project has three primary objectives. The first is to provide a spatially referenced geologic database system in a secure, centralized information architecture with networked data access for new and legacy DGGS geologic data. The second objective is to develop functional online interfaces that allow the public to find and identify geologic data available from DGGS and then view or download selected data. The third objective integrates DGGS's minerals-related data with data from other agencies through the MDIRA website akgeology.info/.

During the first 9 years, the project work group established a secure and stable enterprise database structure, started loading data into the database, and created Web-based user interfaces. As a result, the public can access Alaska-related reports and maps published by DGGS, the U.S. Geological Survey, the U.S. Bureau of Mines, and the University of Alaska Fairbanks Mineral Industry Research Laboratory. Also easily accessible are DGGS project digital GIS data through a search page on the DGGS website (www.dggs.alaska.gov/pubs), and DGGS geochemical data though a search engine (dggs.alaska.gov/webgeochem). Users can also find DGGS reports and maps, along with geology and minerals reports from other agencies, through an integrated information portal at the AKGeology.info website, akgeology.info.

During 2010, the project team continued development of various projects requiring database and application support: National Geological & Geophysical Data Preservation Program (datapreservation.usgs.gov) (p. 77), loading Alaska-related U.S. Bureau of Mines publications (p. 76), the online Guide to Geologic Hazards in Alaska (p. 54, 75), Geochronologic Database for Alaska (p. 53), Alaska Geologic Map Index (p. 52), and other ongoing maintenance of existing applications.

Additionally, DGGS secured short-term leftover funding from the MDIRA program in 2010 to ensure the maintenance of several MDIRA products on a long-term basis, both to facilitate our geologic work, and to provide public access to this geologic and mineral resource information. Two datasets compiled under MDIRA have be-come unavailable or are at risk of becoming unavailable: the Alaska Minerals Industry Data Inventory (AKMIDI) (p. 79) database and the Alaska Paleontological Database (http://alaskafossil.org/) (p.80). The databases and user interfaces for both datasets will be migrated to existing DGGS servers by the end of 2011 to ensure regular maintenance, backups, continued data expansion, and consistent public internet access.



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FIELD MAPPING TECHNOLOGY PROJECT

The Alaska Division of Geological & Geophysical Surveys (DGGS) collects, analyzes, and publishes geological and geophysical information in order to inventory and manage Alaska's natural resources and mitigate geologic-hazard risks. DGGS creates a large amount of new data each year and synthesizes the data into multiple reports and maps for publication. On average, DGGS conducts seven field projects per year, each with teams of five geologists in the field for three weeks, or 735 person-days in the field. Each geologist records detailed observations at approximately 25 locations per day in a notebook or on a paper map, which amounts to more than 18,000 multi-part parcels of data per year that must be hand recorded and then translated and parsed into digital media for analysis and eventual publication.

DGGS is committed to the timely release of data to the public and prompt fulfillment of obligations to funding sources. In 2005, DGGS began investigating the potential of digital field mapping to streamline data collection and processing. Digital mapping is defined as using a computer or personal digital assistant (PDA) to show and record information that has traditionally been recorded on paper, whether on note cards, in a notebook, or on a map. Computer technology and software are now becoming portable and powerful enough to take on some of the burden of the more mundane tasks a geologist must perform in the field, such as obtaining precise locations, plotting structural data, and color coding different physical characteristics of a rock. Additionally, computers can now perform some tasks that were formerly difficult to accomplish in the field, for example, recording text or voice digitally and annotating photographs on the spot. DGGS believes that the greatest benefit of digital mapping will be a decrease in the amount of project time necessary for data entry, thereby potentially increasing the amount and quality of information that can be recorded during a given period of time.

In 2007 and 2008, DGGS tested hand-held tablet computers and third-party field mapping software with mixed results. Ultimately, geologists decided that the mapping software setup was too different from the current work flow, and they would ideally like a customized data entry program. Also, geologists requested lighter weight, fully ruggedized, field-ready tablet computers with screens readable in bright light, the likes of which are not yet being manufactured. DGGS actively monitors technological advances in this area for likely prospects.

In order to facilitate discussion in the geologic community regarding digital field mapping technology, DGGS implemented a three-prong plan. In 2009, DGGS created a digital geologic mapping Wikipedia page (http:en.wikipedia.org/wiki/Digital_geologic_mapping). The web page was accepted into WikiProject Geology, which is an attempt to create a standardized, informative, comprehensive and easy-to-use geology resource. In 2010, DGGS created a mailing list (http://list.state.ak.us/soalists/geomapping_technology/jl.htm) that currently has 59 members in the U.S. and abroad. DGGS also surveyed the geologic community regarding their interest in digital geologic mapping and the current technology being used. With the help of the American Geological Institute, the e-mail survey went out to over 1,250 organizations (university geology departments, state and national geological surveys, and the private sector) with a ~13% response rate. Preliminary results of the survey are posted at (http://ngmdb.usgs.gov/Info/dmt/docs/DMT10_Athey.pdf). DGGS is currently compiling the final survey results for release in a U.S. Geological Survey publication.

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WEBSITE DEVELOPMENT/ONLINE DIGITAL DATA DISTRIBUTION

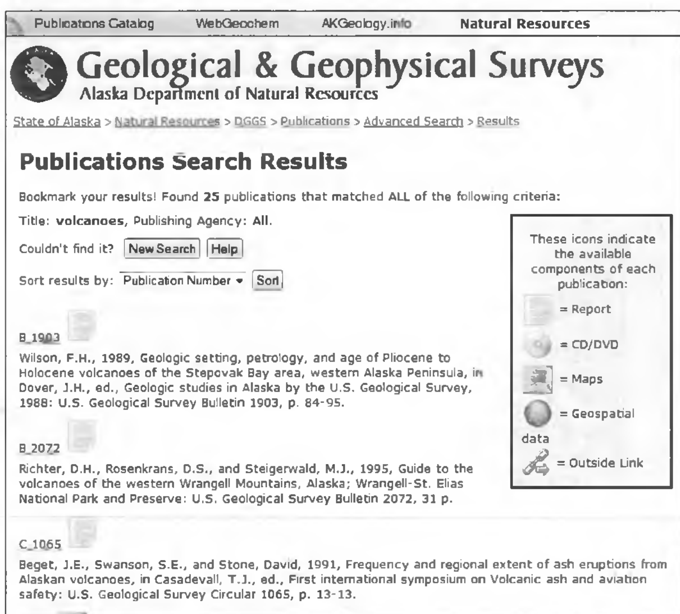
Since its creation in the late 1990s the DGGS website (www.dggs.alaska.gov) has grown from a few static HTML pages to the division's primary mechanism for distribution of geologic publications and information. As the cumulative result of a series of multi-year projects, our current website allows our online customers to search our publications catalog, download DGGS and USGS publications, view and download DGGS geochemical data, and find current information about various geologic projects and topics of interest. Users can currently select and download (at no charge) more than 7,000 text reports, 9,000 oversize sheets and more than 100 digital geospatial datasets.

The DGGS digital geospatial datasets are among the most popular items on the DGGS website. These datasets provide internal and external users with geospatial data that are organized and distributed in formats that can be readily utilized in spreadsheet programs as well as GIS and database applications. Currently, nearly all of our map and analytical publication releases are accompanied by a downloadable digital data package. Each data distribution package includes geospatial data in either CSV (comma-separated values) or ESRI shapefile format as well as an accompanying FGDC metadata file.

Developing an expedient process for generating organized and accurate metadata for digital data has required dedicated effort. One of the most significant challenges to geospatial data distribution is providing users with consistent and meaningful documentation of each dataset's entity-attribute values and relevant data-quality information. DGGS provides this documentation in the form of FGDC (Federal Geographic Data Committee) compliant metadata files. While providing FGDC metadata is an essential step in making our digital data meaningful and available to the public, DGGS scientists and publications staff have found that efficient implementation requires ongoing investment into developing GUI based data entry tools, internal standards for digital data organization, and specific staff training in how to apply the FGDC metadata standard to geologic data.

In previous years DGGS Geologic Communications staff provided authors with customized metadata editing software to facilitate data entry. During FY09 and FY10, we have continued work to facilitate data documentation by developing an in-house training program for publication authors. The training module teaches DGGS authors how to: navigate existing metadata files to find pertinent information, populate metadata fields, and use in-house tools and standards. It expedites the DGGS publication process and provides a higher quality digital data distribution product by helping authors indentify and utilize relevant preexisting data, reducing metadata compilation and editing time, and providing subsequent users with high quality data documentation.

In addition to ongoing work in expanding our selection of digital data files, DGGS has also completed an update of our online *Guide to Geologic Hazards in Alaska*. This guide provides general information about geologic hazards in Alaska, links to timely geohazard advisory information, links to pertinent DGGS and USGS publications, and geohazard publication listings grouped by Alaska Coastal Management Program (ACMP) coastal district. Work for this project is funded by the ACMP Enhancement Grants Program. Project objectives were to (1) update the information included in the online Guide to Geologic Hazards in Alaska (maps, reports, and website resources), (2) improve hazards map search capabilities by incorporating a map-based interface to allow users to graphically select specific geographic areas about which they need geologic-hazards information, and (3) maintain the currency of the delivered data.



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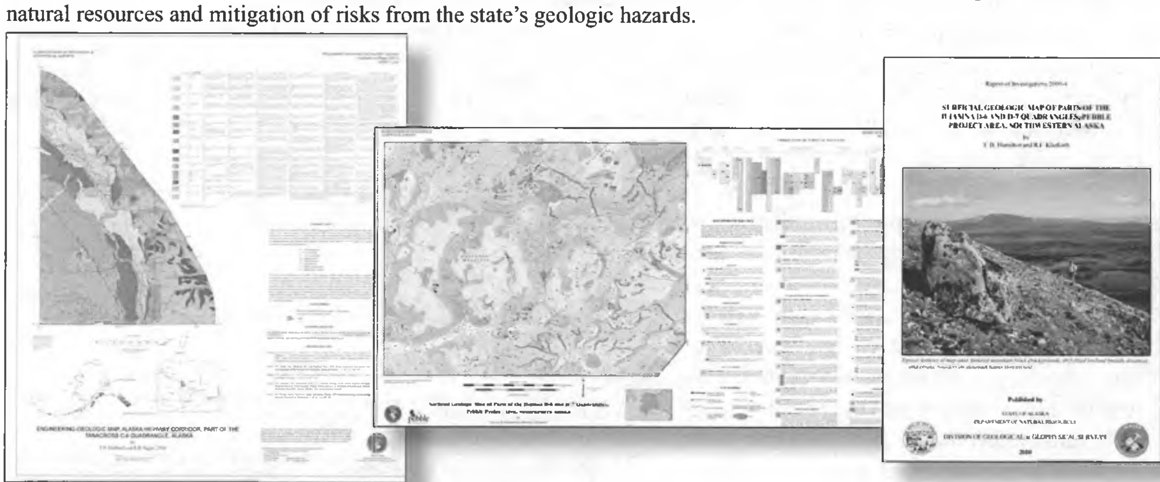
PUBLICATIONS AND OUTREACH PROJECT

The Publications and Outreach Project publishes and distributes geologic data that has been collected, analyzed, and assembled by geologists in the Minerals, Energy, Engineering Geology, and Volcanology sections of DGGS. Some of the functions carried out under this project are:

- Design, digitally assemble, edit, and oversee final production of technical and educational geologic maps, reports, and informational publications in printed and digital formats.
- Prepare an annual report, written by division staff and required by statute, recounting DGGS activities, announcing products, and describing plans for future projects.
- Publish newsletters that summarize DGGS's progress and report new publications.
- Prepare displays and represent the division at geologic conferences and meetings by providing staff and assembling and transporting the display booth (seen at right).
- Staff geologic information center in Fairbanks, providing information about Alaska's geologic resources and hazards through DGGS's publications and other resources. Sell and distribute printed and online geologic reports, maps, and digital data.
- Review and complete metadata for each digital project and file it in its appropriate online repository. Assist DGGS staff as they prepare metadata for digital spatial data.
- Manage DGGS's reference library so that reports, maps, and other data are available and publications are on hand that geologists need to prepare geologic products.
- Maintain as complete a collection as possible of Alaska-related publications produced by the U.S. Geological Survey, the former U.S. Bureau of Mines, and the U.S. Bureau of Land Management; collect and maintain other Alaska-related publications as needed.

Publications produced and distributed by this group record and preserve geologic data such as definitive statistics for Alaska's mineral industry; detailed (1:63,360-scale) bedrock, surficial, and engineering geologic maps for specific areas in the state; sources of Alaska's geologic information; annual information about DGGS's programs and accomplishments; airborne geophysical data for areas with promising mineralization; and educational brochures and pamphlets explaining Alaska's geology or natural-science features. Some of the most recent DGGS publications include: Historically Active Volcanoes of Alaska playing cards; Tsunami-inundation Maps for Seward and northern Resurrection Bay; a Surficial Geologic map of the Pebble project area in southwestern Alaska; four technical reports on faults, floods, permafrost, and engineering-geologic information on the Alaska Highway Corridor; two geochemical reports; and 14 reports describing analyses of materials housed at the Geologic Materials Center.

Publications are available in paper format (plotted as needed and sold for the cost of printing) and as digital PDF documents and scanned, compressed maps on the DGGS web page (available for download at no charge). An increasing number of digital datasets are available on the publications pages as additional products are completed. Work continues in FY2011 to increase the availability of digital datasets from which GIS maps are produced, so that customers can manipulate data as they choose; and publishing documents in digital format first, then using the digital publication to produce a paper copy when necessary. The geological and geophysical data and reports published by DGGS encourage wise management and exploration of Alaska's natural resources and mitigation of risks from the state's geologic hazards.



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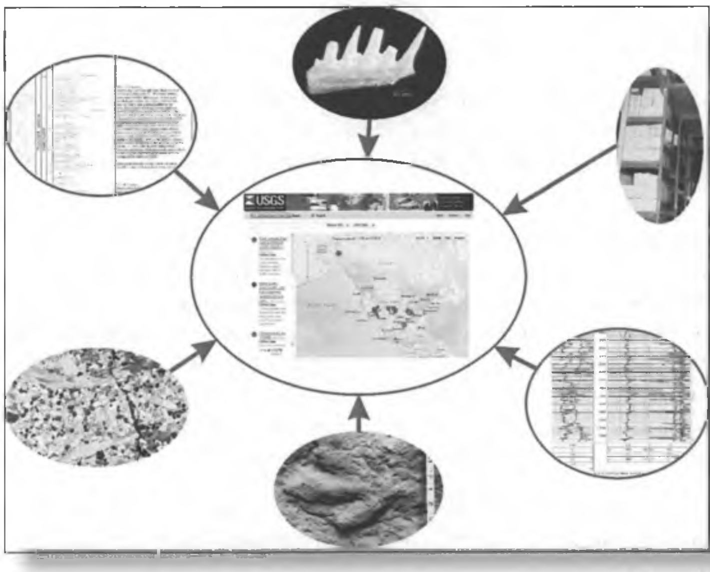
NATIONAL GEOLOGICAL & GEOPHYSICAL DATA PRESERVATION PROGRAM

The Alaska Division of Geological & Geophysical Surveys (DGGS) is statutorily charged with the responsibility for collecting, archiving, managing, and disseminating geological and geophysical data describing and inventorying the subsurface energy resources, mineral resources, and geologic hazards of the state. During the past 10 years, through the federally funded former Minerals Data and Information Rescue in Alaska (MDIRA) program, DGGS cataloged and greatly improved the condition of its geological and geophysical data archive, upgraded its data management system, and began disseminating this data through the internet.

DGGS is advancing its data preservation goals by participating in the federally funded National Geological & Geophysical Data Preservation Program (NGGDPP). This program is committed to assisting state geological surveys with four data preservation priorities: (1) inventory geological and geophysical data collections to assess their data preservation needs, (2) create site-specific metadata for individual items in those data collections, (3) create new digital infrastructure or improve the state's existing digital infrastructure for archiving and preserving these data, and (4) rescue geologic data at risk of loss through "special needs" awards. DGGS received funding for the FY2010 phase of NGGDPP to directly address the site-specific metadata priority and the "special needs" data preservation priority.



First, site-specific catalog metadata will be prepared and submitted for published data from the inventoried energy-related collection of organic geochemistry analyses of samples collected during projects involving DGGS geologists. Project team members are currently completing a collection inventory on this dataset, extracting the proper metadata profile elements and analysis data values to be loaded into DGGS's central database. The division has 30–40 publications to review as sources of published energy-related data, and approximately 20 of the publications contain organic geochemistry data.

Second, DGGS is rescuing the valuable Amchitka hard-rock mineral core and coalbed methane core samples stored in deteriorating boxes in unheated Connex containers at the Alaska Geologic Material Center (GMC) in Eagle River. NGGDPP support will prevent the loss of up to 1,600 boxes of rock material, representing approximately 10,300 feet of core. The samples are in jeopardy, as sample information recorded on severely damaged boxes is deteriorating, and samples are being further damaged from multiple freeze–thaw cycles and moisture. Project team members are currently inventorying and re-boxing these valuable samples. The updated inventory will subsequently be loaded into the DGGS central database.

The metadata records of these collections will be served out to the National Digital Catalog through DGGS's Web Feature Service (WFS) interface. The DGGS WFS is currently a beta version for internal staff to import data into Geographic Information Systems (GIS) software. However, the WFS allows the site-specific metadata records to be harvested and synchronized automatically by the National Catalog system, thus freeing DGGS staff members of the manual task of uploading data to an additional database on a regular basis. These relevant energy-related datasets will be available for harvest by National Digital Catalog by the end of FY2011. Access to these collections through the National Digital Catalog will improve their accessibility to both in-state and national users.

This project is funded by the U.S. Geological Survey as part of the National Geological & Geophysical Data Preservation Program, authorized by the National Energy Policy Act of 2005. For more information on this program, please refer to the web page: http://datapreservation.usgs.gov/.

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INFORMATION TECHNOLOGY (IT) INFRASTRUCTURE PROJECT

The major accomplishment of the Division of Geological & Geophysical Surveys' (DGGS) Information Technology group during the last year was virtually to eliminate the incidence of server downtime. Our disk-based backup sys-tem for both desktop machines and servers has performed flawlessly. While this year did not see many large up-grades to server architecture, the IT staff has still been busy. We have integrated our remote access and inventory software, LANDesk, to act as the primary tool to track DGGS's current hardware and software inventory, not only for the backup server and the Microsoft Update procedure, but also for the anti-virus server. This change ensures that no computer hardware in the division is overlooked for backups or updates. It also allows for more accurate inventory control and tracking, as well as development of life-cycle-based plans for hardware upgrades and replacements.

With the help of its IT staff, the division acquired and configured the domain name dggs.alaska.gov. We experienced a seamless transition to the new domain name, while concurrently keeping the older www.dggs.state.ak.us name active for all existing links. This will eliminate "web rot," a situation when a bookmarked link becomes non-functional and the server responds with "file not found" messages.

The IT group also set up a separate domain name and website for the Alaska Seismic Hazards Safety Commission (http://seismic.alaska.gov/). The commission now has their own web presence separate from DNR and DGGS, which will provide simpler website access, and allow them to continue their mission to reduce the state's vulnerability to earthquakes.

The Information Technology group marched ahead in efforts to find innovative ways to distribute geologic information online to the public. In addition to its website presence (with 111,765,249 views on the main DGGS and Alaska Volcano Observatory [AVO] websites in FY 2010), DGGS now hosts a Facebook "fan" page (www.facebook.com/akdggs) where users can read notifications of the most recent publications or just a random interesting geologic fact. DGGS has also added a Twitter page (www.twitter.com/akdggs). Twitter is a social networking and microblogging service that enables its users to send and read user messages. At last count, more than 300 people had signed up to read our Twitter postings. By choosing to use Facebook and Twitter as communication tools, we have another information distribution channel to interested members of the public.

This year, DGGS established a cooperative agreement with the University of Alaska Fairbanks (UAF) wherein we physically host an AVO webserver in our server room, but its Internet connectivity remains through UAF. This allows us to have 24-7 physical contact with the AVO webserver, in the unlikely event that the server needs hands-on attention. Three new AVO servers were added to the State of Alaska network in April to facilitate bandwidth conservation, GIS mapping tools, and database synchronization. As AVO is a high-traffic site that responds to hundreds of millions of data requests per year, multiple levels of built-in redundancy are required to eliminate the chance that the website will not answer.

The Geologic Materials Center (GMC) in Eagle River was finally able to join the State of Alaska network this year. This change allows staff at the GMC to not only access the main fileserver in Fairbanks, but they can now drag and drop files to the server just as if they were in the Fairbanks office, eliminating the tedious process of transferring files via e-mail or an FTP site. Also through this connection, GMC staff has access to the ArcGIS licenses in Fairbanks. In adding the GMC to the state network, we were also able to bring a strong motion instrument online for the Alaska Earthquake Information Center (AEIC), passing live earthquake data as needed back to the AEIC.

Plans in the immediate future include relocating a backup server to another DNR facility in Fairbanks, upgrading our Oracle database to the most current release, and surplusing our last Sun-based server.

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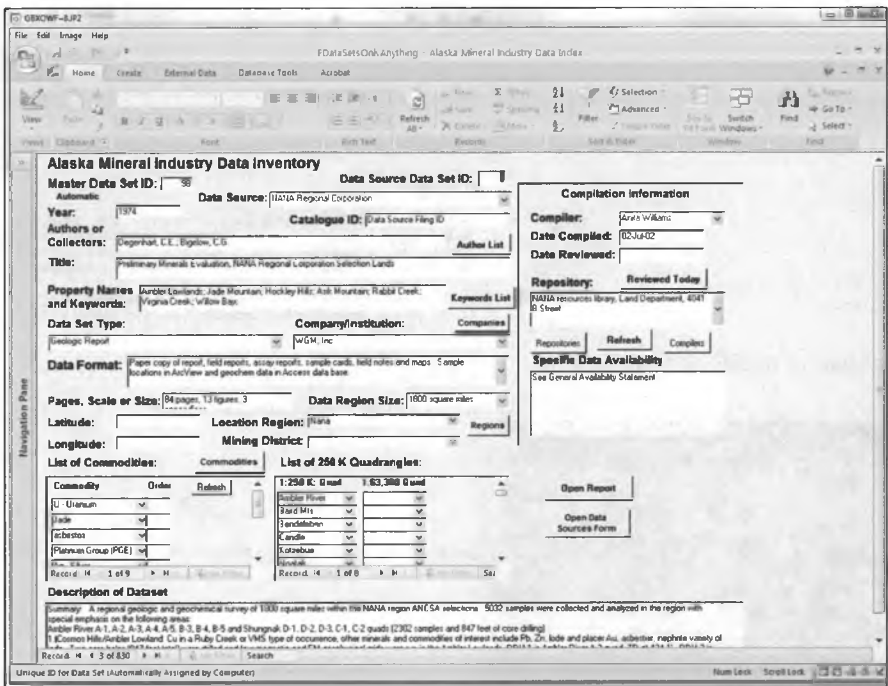
ALASKA MINERAL INDUSTRY DATA INDEX (AKMIDI)

The Alaska Mineral Industry Data Index (AKMIDI) is a database of nearly 16,000 records of mineral information owned by 18 different groups around the state, including Native corporations, private companies, state libraries, and land managers. This index includes industry reports and maps, field notes, drill logs, and other archived data from the private sector. Much of the actual data may still be held and controlled by the private entities. Approximately 1,800 files and 4,300 maps from the Anaconda Collection of minerals exploration data are available through Alaska Resources Library and Information System (ARLIS). The AKMIDI web search engine was de-supported in 2009 and is currently off-line. In the interim, the original Microsoft Access database is available for download at (http:www.dggs.alaska.gov/pubs/akmidi.jsp).

This project will integrate the existing AKMIDI database into DGGS's enterprise Oracle database and convert the search- and data-management tools into Java server pages (JSP). DGGS will create an organized index of its archived project file materials, allowing for web-based public queries of the data, as well as routine, secure data maintenance. The search pages will be enhanced with a map-based search tool, and digital images, including those of the Anaconda Collection maps, will be made available for viewing online. The index will be available on DGGS's website and through a link on the website (http:akgeology.info/).

DGGS will also create a data-entry interface so the AKMIDI database holdings can be expanded in the future. As in the past, new data will be added to the database through a process of sorting, bar coding, and indexing. Digital images of maps, reports, and other data will be collected and linked to or stored in the relational database so that the public can obtain some insight about the content of a potentially useful map, figure, or photograph without having to retrieve the physical materials from the archive.

This project is funded through the federal Minerals Data and Information Rescue in Alaska (MDIRA) program. The primary objective of the MDIRA program is to ensure that all available Alaska minerals data are securely archived in perpetuity and in a format readily accessible by all potential users. Information on mineral resources is important for management policy decisions in both the public and private sectors. Increased use of high-quality data should lead to better economic, legislative, and environmental decisions.



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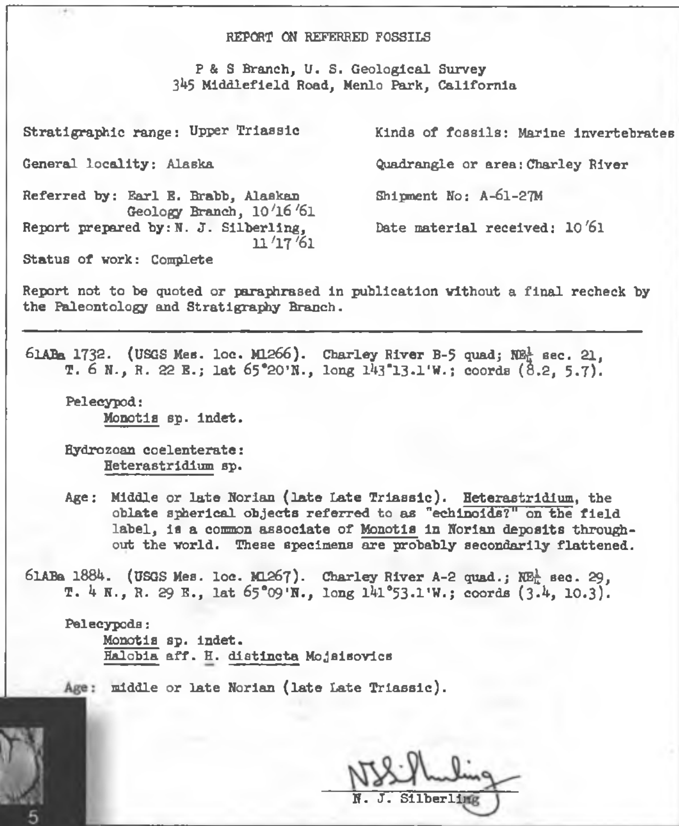
ALASKA PALEONTOLOGICAL DATABASE MIGRATION

The Alaska Paleontological Database contains detailed information on fossils and fossil localities in Alaska. The database was created by Alaska paleontologist Robert Blodgett and computer paleontologist/programmer Ning Zhang with funding from the federal Minerals Data and Information Rescue in Alaska (MDIRA) program. The primary objective of the MDIRA program is to ensure that all available Alaska minerals data are securely archived in perpetuity and in a format readily accessible by all potential users. Information on mineral resources is important for management policy decisions in both the public and private sectors. Increased use of high-quality data should lead to better economic, legislative, and environmental decisions.

Information contained in the fossil database is sourced from informal, unpublished USGS "Examine and Report" (E&R) fossil reports (fig. 1) and published literature (fig. 2), as well as released industry data. Data entry for this project is about 60 percent complete. The database's website (http://alaskafossil.org/) receives daily traffic, primarily from Alaskans, including those from bush communities, and from worldwide locations. The database most -specifically benefits the minerals community in areas with sedimentary -rock-hosted stratiform or stratabound mineral occurrences. Currently the database is hosted on a privately owned server, which is occasionally (and currently) off line.

The purpose of this MDIRA-funded project is to migrate the fossil database to DGGS's Digital Geologic Database so the database is assured ofensured regular maintenance, back-up, continued data expansion, and consistent public internet access. The existing database system and user interface are incompatible with DGGS's database and web environment. The current SQL database will be transferred to DGGS's existing enterprise Oracle database. Current ASP-based user interfaces (a data-entry form and a public-access, text-based search application) will be rebuilt into JSP-based web pages. The paleontological database will be available on DGGS's website and through a link on the MDIRA website (http:akgeology.info/).



REPORT ON REFERRED FOSSILS

P & S Branch, U. S. Geological Survey
345 Middlefield Road, Menlo Park, California

Stratigraphic range: Upper Triassic
Kinds of fossils: Marine invertebrates
General locality: Alaska
Quadrangle or area: Charley River
Referred by: Earl E. Brabb, Alaskan Geology Branch, 10/16/61
Shipment No: A-61-27M
Report prepared by: N. J. Silberling, 11/17/61
Date material received: 10/61
Status of work: Complete

Report not to be quoted or paraphrased in publication without a final recheck by the Paleontology and Stratigraphy Branch.

61ABa 1732. (USGS Mes. loc. M1266). Charley River B-5 quad; NE¼ sec. 21, T. 6 N., R. 22 E.; lat 65°20'N., long 143°13.1'W.; coords (8.2, 5.7).

Pelecypod:
Monotis sp. indet.

Hydrozoan coelenterate:
Heterastridium sp.

Age: Middle or late Norian (late Late Triassic). Heterastridium, the oblate spherical objects referred to as "echinoids?" on the field label, is a common associate of Monotis in Norian deposits throughout the world. These specimens are probably secondarily flattened.

61ABa 1884. (USGS Mes. loc. M1267). Charley River A-2 quad.; NE¼ sec. 29, T. 4 N., R. 29 E., lat 65°09'N., long 141°53.1'W.; coords (3.4, 10.3).

Pelecypods:
Monotis sp. indet.
Halobia aff. H. distincta Mojsisovics

Age: middle or late Norian (late Late Triassic).

N. J. Silberling

Figure 1. Example E&R report.

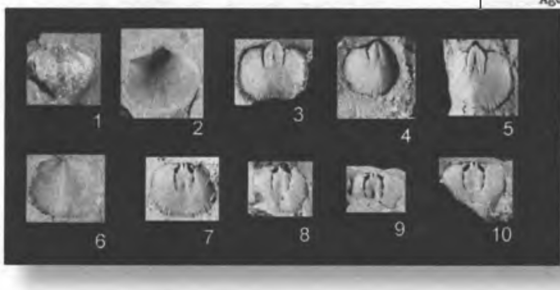


Figure 2. Photographs of fossils described in the database.

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THE ALASKA GEOLOGIC MATERIALS CENTER

The Alaska Geologic Materials Center (GMC) in Eagle River holds nonproprietary rock core and cuttings that represent nearly 13 million feet of exploration and production drilling on Federal, State, and private lands in Alaska, including the Alaska outer continental shelf. Additionally, the collection holds more than 450,000 feet of diamond-drilled hard-rock mineral core, representing nearly 1,100 exploratory boreholes; rock materials from more than 1,600 oil and gas exploratory or production wells; samples for geotechnical test wells; and numerous surface rock samples. The collection also includes extensive geochemical data, petrographic thin sections, and paleontological glass slides derived from this rock.

The GMC is operated by the Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys, with support from cooperating government agencies that include the U.S. Bureau of Land Management (BLM), U.S. Geological Survey (USGS), U.S. Bureau of Ocean Energy Management, Regulation, and Enforcement (BOEMRE), and Alaska Oil and Gas Conservation Commission (AOGCC). The mission of the GMC is to permanently archive, index, and protect Alaska's geologic material and subsequent analytical data to advance our knowledge of natural resources. Chief users of the GMC are the oil and gas industry, although use by the minerals industry, government, engineering firms, and academic institutions is increasing.

The current staff, consisting of a Curator, two full-time staff members, a contract curator, two volunteers, and three student interns, is highly motivated and hopes to breathe new life into the aging facility. The current Curator's focus is to preserve and ensure the safety of the material stored at the facility and make the material and its derived data more accessible to the public. Despite the ongoing struggle to maintain the 26-year-old collection in a much older and deteriorating facility, many improvements have occurred at the GMC during 2009 to present.

Since arriving in May 2009, GMC staff member Kurt Johnson has led the charge to organize, document, and detail approximately 90 percent of the hard-rock material stored in more than 20 metal shipping containers as part of the GMC Database Inventory Integration project, federally funded by the former Minerals Data and Information Rescue in Alaska (MDIRA) program. Kurt and four interns, Joseph Skutca, Herbert Mansavage, Josh Stucky, and, recently, Kjol Johnson, moved, detailed, and indexed an impressive 1.5 million pounds (680 metric tons) of rock since the project began. Their efforts have vastly improved the quality and usefulness of the mineral-core inventory and resulting data, allowing staff to help users of the facility find information more quickly, whether onsite or online. The entire GMC staff was nominated for the Governor's Peak Performance Denali Award as a result of these amazing efforts.

During FY 2010, the GMC had 424 visitors; acquired 4,010 processed slides, oil and gas material representing 78,496 feet or 37 wells, 15,180 feet of hard-rock mineral core, 2,500 pounds of surface samples; and released 13 new data reports. Improving and performing quality control on the GMC's inventory requires a large amount of research, patience, and an eye for detail. Geologist Jean Riordan has been "keeping the train on track" in this respect for the past five years and is responsible for the improved quality and accuracy of the ever-growing inventory. Contract curator and former Alaska State Geologist Don Hartman has also been working hard to improve the caliber of the inventory. Don has been specifically detailing and confirming the material, box by box, for the State, USGS (Henry Bender), NPR-A, Oxy, and Shell collections.

Figure 1: Several rows of temporary tables barely hold the 30- to 40-pound boxes of 5-inch core.

The GMC is constantly acquiring additional inventory details and performing quality control on the information for hundreds of thousands of samples—a process that will take many years to complete. As a result, the GMC

Contact: Kenneth Papp, 907-696-0079, kenneth.papp@alaska.gov strives to find a balance between the public release of samples with more accurate data versus suppressing sample information with partial and/or inaccurate data. The GMC is biased towards greater public access to our store of geologic wealth.

In this spirit, an online version of the Alaska GMC inventory was released to the public in April 2010 and is available on the GMC Inventory web page. This dataset, created by GMC staff members Kurt Johnson and Jean Riordan and available in the popular and easy-to-use Google Earth format, includes oil and gas well locations, mineral prospect locations, sample types, and box-level details for more than 80 percent of the materials inventory available at the GMC. The online inventory allows users to quickly and easily view details of the materials repository before visiting the facility—the number one request from GMC users.

The current facility lacks sufficient space and equipment for proper sample storage, processing, layout, and viewing. Demands for heated warehouse space have long exceeded available space, and approximately 70% of the GMC inventory is stored in unheated, unlighted portable shipping containers, endangering the samples by exposing them to drastic changes in temperature and humidity. We estimate that within 3 years, potential new donated material will have to be turned away due to a lack of proper storage space.

Despite these setbacks, the GMC is making better use of existing space. The rear garage/lab area of the main warehouse was created in part by in-kind donations from the U.S. Minerals Management Service (now the Bureau of Ocean Energy Management, Regulation, and Enforcement). Sadly, much of the equipment is outdated, in poor working order, or is potentially dangerous to use. Moreover, a greater number of users have been requesting to view material for an entire well or borehole. In October 2010 GMC staff cleaned out old and unused equipment from this area and set up a dozen heavy-duty temporary tables. As a result, the facility now has the capability to lay out and display boxes of core for an entire well or borehole (fig. 1). During the week of October 4, for example, GMC staff was able to display 218 boxes of 5-inch core, top to total depth, totaling 654 feet of the well. The Curator is currently researching ways to improve the lighting conditions in this space.

More recently, the GMC incorporated geologic formation-top picks into its online inventory—another common request from frequent users. In-kind data contributions by the AOGCC (Steve Davies, pers. commun.) and USGS (David Houseknecht, pers. commun.) were compiled by GMC staff and entered into the database. Users can now view all of the oil and gas well material that is associated with a particular geologic formation and therefore more easily identify the available materials that contain potential oil- and gas-bearing rock layers.

Despite recent major improvements in organizing and providing its inventory data to the public, continuing to simply maintain the current GMC facility would likely physically jeopardize the material the State has worked so diligently to acquire and preserve. The cores and samples stored at the GMC are extremely important, as the information they provide may potentially help discover new or additional oil and gas reserves, regions of viable geothermal energy, or new mineral prospects. Although many other tools are available for natural resource exploration, the examination of rock samples and cores is the greatest single source of information, and despite the constant evolution of geological, geophysical, and engineering concepts and analytical techniques, there is a constant need to revisit and re-examine rock samples over time.

DGGS managers, working with the Alaska Department of Transportation and Public Facilities (DOTPF) and GMC staff, are developing plans for a new facility to help safeguard the future accessibility and security of the material currently stored at the GMC. Site selection and design work are currently underway for the new facility. These plans are described in a concept study report and a brochure entitled "A Vision for Responsible Stewardship," both downloadable from the GMC website.

Despite major improvements in public access to its inventory, the GMC is still in desperate need of a new repository to ensure the future safety of its physical archive of geologic materials. Although the future facility will transform the current GMC into a world-class repository, simply waiting idle in hopes of it becoming a reality is not in the best interest of the GMC's users. In the interim, the GMC is determined to use the facilities it has to provide more useful geologic information to its users and accommodate their current needs. Finally, users who haven't visited the GMC in the last several years are strongly encouraged to do so. As always, we weclome user feedback.

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PUBLICATIONS RELEASED IN 2010

ANNUAL REPORTS

AR 2009. Alaska Division of Geological & Geophysical Surveys Annual Report, by DGGS Staff, 2010, 77 p. Free

GEOLOGIC MATERIALS CENTER REPORTS

GMC 370. Analyses of rare earth element and uranium mineralization in Bokan Mountain archive sample splits: Reevaluation of older data (1984-1987) with newer analytical techniques, by ActLabs, Ltd., 2010, 1 p. Analyses were completed in 2008. $2

GMC 371. The history of the Orange Hill Alaska Copper-Molybdenum Property under Northwest Explorations joint venture ownership - (1970 to 2005) and plan of operation (2006), by Northwest Explorations, 2010, 44 p. $5

GMC 372. 1928 Alaska Nebesna Corporation drill logs and assay records for the Orange Hill Property, Nabesna Quadrangle, Alaska: Drill holes No. 1 through No. 10, by Alaska Nebesna Corporation, 2010, 28 p. $3

GMC 373. 1964 Bear Creek Mining Company drill logs and assay records for the Orange Hill Property, Nabesna Quadrangle, Alaska: Drill holes OH #1 and OH #2, by Bear Creek Mining Company, 2010, 13 p. $2

GMC 374. 1968 Duval Corporation drill logs for the Orange Hill Property, Nabesna Quadrangle, Alaska: Drill holes Duval #1 and Duval #3, by Duval Corporation, 2010, 27 p. $3

GMC 375. 1970 AMEX drill logs and assays for the Orange Hill Property, Nabesna Quadrangle, Alaska: Drill holes No. 3, 6, 8, 9, 10, 11, 11A, 13, 14, 15, 16, 17, 18, 19, 20, 26, 27, 28, 29, 30A, 31, by AMEX Exploration, Inc., 2010, 38 p. $4

GMC 376. 1973 and 1974 NWE drill logs for the Orange Hill Property, Nabesna Quadrangle, Alaska: Drill holes No. 112 through No. 123, by Northwest Explorations, 2010, 97 p. $10

GMC 377. 1980 U.S. Borax assay report for the Orange Hill Property, Nabesna Quadrangle, Alaska: Technical Service Report No. TS 8009-14, by U.S. Borax, 2010, 20 p. $2

GMC 378. 1967 report on the induced polarization and resistivity survey in the Orange Hill area, Alaska for Duval Corporation, by McPhar Geophysics Limited, 2010, 17 p. $2

GMC 379. 1973 Orange Hill, Alaska project report, by McGregor, Wallace, 2010, 40 p. $4

GMC 380. 1974 control survey report for Orange Hill, Alaska, by Smith, W.H., 2010, 19 p. $2

GMC 381. 1974 summary report of exploration activities, Orange Hill, Alaska, by Trautwein, C.M., 2010, 73 p. $7

GMC 382. 1974 NWE Orange Hill, Alaska specimen index: Cross reference of specimens from skeletonized drill cores and other samples, by Northwest Explorations, 2010, 37 p. $4

GMC 383. Makushin Geothermal Project ST-1, A-1, D-2 Core 2009 re-sampling and analysis: Analytical results for anomalous precious and base metals associated with geothermal systems, by Alaska Earth Sciences, 2010, 1 p. $2

GEOPHYSICAL MAPS & REPORTS

GPR 2010-1. Line, grid, and vector data, and maps for the airborne geophysical survey of the Moran Survey Area, Melozitna and Tanana quadrangles, central Alaska, by Burns, L.E., Fugro Airborne Surveys Corp., and Stevens Exploration Management Corp., 2010, 56 sheets, scale 1:63,360, 1 disk. 2 linedata files, 19 grids, 20 GeoTIFFs and Google Earth KMZ files, 15 vector files, and 28 maps (56 sheets total) $10

INFORMATION CIRCULARS

IC 60. Alaska's mineral industry 2009: A summary, by Hughes, R.A., Szumigala, D.J., and Harbo, L.A., 2010, 15 p. Free

MISCELLANEOUS PUBLICATIONS

MP 137. Active volcanoes of Kamchatka and northern Kurile Islands, by Robbins, S.D., 2010, 3 sheets, scale 1:3,500,000. $39

MP 138. Generalized geologic map of Alaska, by Werdon, M.B., Szumigala, D.J., and Davidson, G., 2010, 2 p. Free

MP 139. Technical review of a trench across a potential fault scarp feature east of Lower Talarik Creek, Lake Iliamna area, southwestern Alaska, by Koehler, R.D., 2010, 10 p. $2

NEWSLETTER (ALASKA GEOSURVEY NEWS)

NL 2010-1. Evidence for late Wisconsinan outburst floods in the Tok-Tanacross basin, upper Tanana River valley, east-central Alaska, by Hubbard, T.D., and Reger, R.D., 2010, 9 p. Free

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PIR 2009-6B. Engineering-geologic map of the Alaska Highway Corridor, Robertson River to Tetlin Junction, Alaska, by Hubbard, T.D., and Reger, R.D., 2010, 4 sheets, scale 1:63,360. $52

PIR 2009-6C. Reconnaissance interpretation of 1978-1983 permafrost, Alaska Highway Corridor, Robertson River to Tetlin Junction, Alaska, by Reger, R.D., and Hubbard, T.D., 2010, 13 p., 4 sheets, scale 1:63,360. $54

PIR 2010-1. Active and potentially active faults in or near the Alaska Highway corridor, Dot Lake to Tetlin Junction, Alaska, by Carver, G.A., Bemis, S.P., Solie, D.N., Castonguay, S.R., and Obermiller, K.E., 2010, 42 p. $4

RAW-DATA FILES

RDF 2010-1. Results of mercury-injection capillary pressure tests on outrcrop samples in the Tyonek area of Cook Inlet, by Loveland, A.M., 2010, 102 p. $10

RDF 2010-2. Major-oxide, minor-oxide, and trace-element geochemical data from rocks collected in the Chistochina mining district, Mount Hayes Quadrangle, Alaska, in 2005-2009, by Athey, J.E., Freeman, L.K., Hults, C.P., Szumigala, D.J., Werdon, M.B., Denny, C.L., and International Tower Hill Mines Ltd., 2010, 130 p. $13

RDF 2010-3. Major-oxide, minor-oxide, trace-element, and geochemical data from rocks collected in 2010 in the Tolovana mining district, Livengood B-3 and B-4 quadrangles, Alaska, by Griesel, G.A., Szumigala, D.J., Freeman, L.K., Newberry, R.J., Elliott, B.A., and Werdon, M.B., 2010, 31 p. $3

REPORTS OF INVESTIGATIONS

RI 2009-4. Surficial geologic map of parts of the Iliamna D-6 and D-7 quadrangles, Pebble project area, southwestern Alaska, by Hamilton, T.D., and Klieforth, R.F., 2010, 19 p., 1 sheet, scale 1:50,000. *This geologic investigation was commissioned and funded by the Pebble Limited Partnership; the digital GIS data belong solely to Pebble LP and have not been made available to our office. This map sheet is a graphics file that has been reformatted to conform to the editorial standards of the Division of Geological & Geophysical Surveys.* $15

RI 2010-1. Tsunami inundation maps of Seward and northern Resurrection Bay, Alaska, by Suleimani, E.N., Nicolsky, D.J., West, D.A., Combellick, R.A., and Hansen, R.A., 2010, 47 p., 3 sheets, scale 1:12,500. $44

RI 2010-2. Top Mesozoic unconformity depth map of the Cook Inlet Basin, Alaska, by Shellenbaum, D.P., Gregersen, L.S., and Delaney, P.R., 2010, 1 sheet, scale 1:500,000. $13

SPECIAL REPORTS

SR 63. Alaska's mineral industry 2008, by Szumigala, D.J., Hughes, R.A., and Harbo, L.A., 2009, 89 p.

SR 64. Alaska's mineral industry 2009, by Szumigala, D.J., Harbo, L.A., and Hughes, R.A., 2010, 81 p. Free