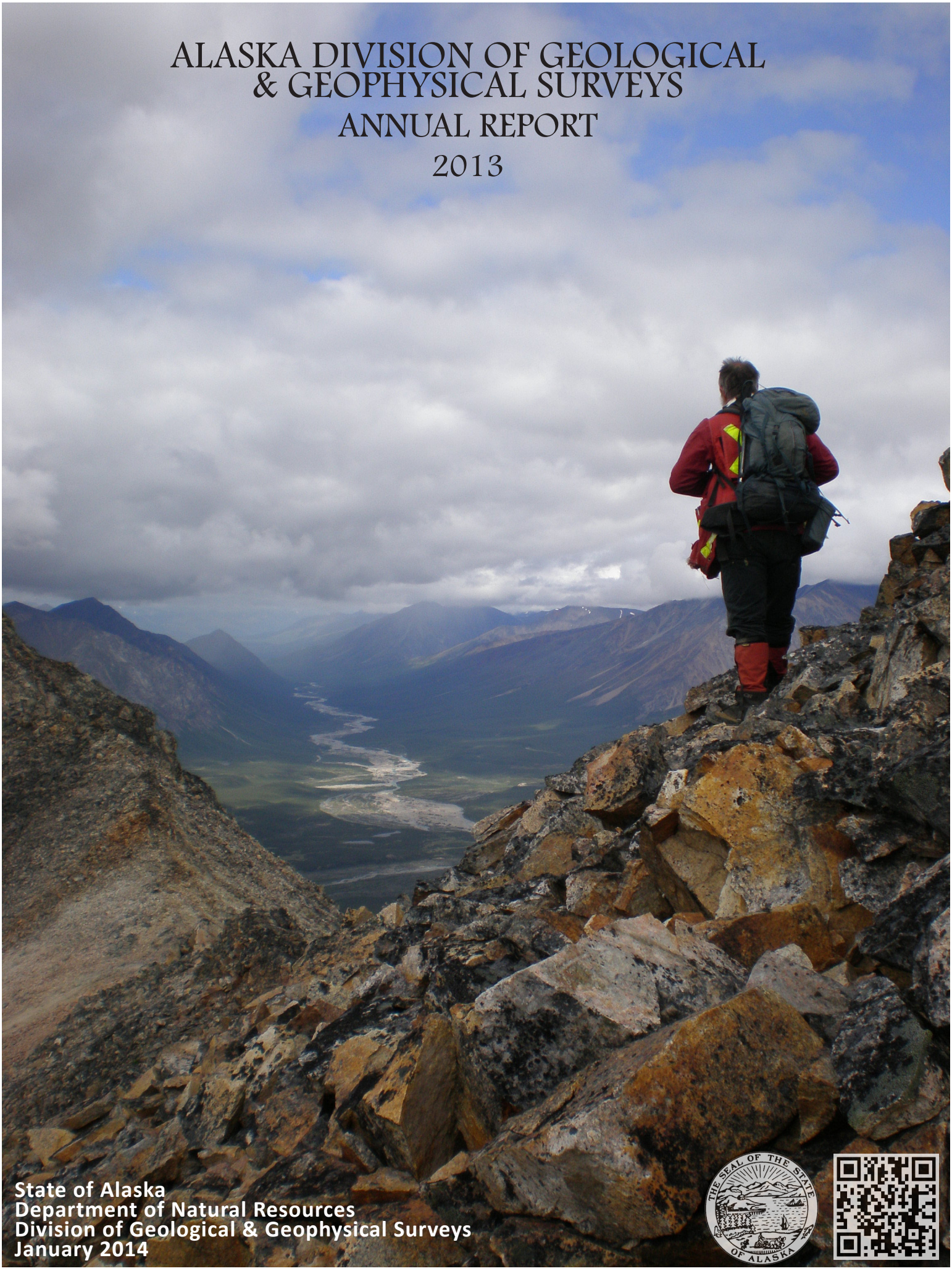
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

ANNUAL REPORT

2013



State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys
January 2014

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
ANNUAL REPORT
2013

Front cover: *Geologist Larry Freeman (Alaska Division of Geological & Geophysical Surveys) traversing a granite ridge of the Eocene Merrill Pass pluton above the Styx River in the Lime Hills C-1 Quadrangle. The Merrill Pass pluton is one of multiple suites of igneous rocks in the Styx River map area that are being investigated to determine the igneous history and relation to ore deposit formation in a very metal-rich part of the Western Alaska Range. The Styx River mapping project is a component of the Airborne Geophysical & Geological Mineral Inventory (AGGMI) Program which provides basic geological, geochemical, and geophysical data and interpretations to help guide and encourage mineral investment in the State's mineral endowment. For more information on the Styx River project see page 45. Photo by David Reioux, DGGS.*

State of Alaska
Department of Natural Resources
Division of Geological & Geophysical Surveys
January 2014

STATE OF ALASKA
Sean Parnell, *Governor*

DEPARTMENT OF NATURAL RESOURCES
Joe Balash, *Commissioner*

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
Steve Masterman, *Acting State Geologist and Director*

Publications produced by the Division of Geological & Geophysical Surveys (DGGS) are available for free download from the DGGS website (http://www.dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys
3354 College Rd., Fairbanks, Alaska 99709-3707
Phone: (907) 451-5020 Fax (907) 451-5050
dggspubs@alaska.gov
http://www.dggs.alaska.gov

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

Alaska Resource Library & Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503-3982

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

University of Alaska Anchorage Library
3211 Providence Drive
Anchorage, Alaska 99508-4614

Publication of this report is required by Alaska Statute 41.08.

CONTENTS

DIRECTOR'S FOREWORD

2013 has been a year of transition for DGGS. During the year several long-term staff members retired or moved on to new opportunities. Vickie Butherus, Rod Combellick, Dr. Chris Nye, and Bob Swenson are among those who will be greatly missed. These four amassed a collective 88 years of service with the Division and take with them a wealth of technical and institutional knowledge. Vickie retired as the division's Administration Officer in May after 21 years with DNR. In June, Rod retired as Division Operations Manager after 32 years at DGGS. Chris retired in October after 27 years with the Division and the Alaska Volcano Observatory, but is continuing his work with the Division as a volunteer. In November, after 8 years as Director and State Geologist Bob left DGGS to take his current position as Deputy Commissioner of the Department of Natural Resources. I am privileged to serve as Acting Director during the search for a new State Geologist and Director.

Alaska's potential for unconventional energy resources has recently become a focus for industry and for the many communities struggling with high energy prices. DGGS is leading or involved in multiple projects to provide baseline information on conventional and unconventional energy resource potential. Transitioning to new forms of energy will bring new challenges and opportunities to all Alaskans, and also to DGGS as we meet the changing needs for energy-related information.

2013 was also a transitional year for the minerals industry. Record commodity prices had led to a boom in exploration activity in recent years, but a downturn in metals prices this year affected the availability of funding and slowed exploration activity. Metal price fluctuations are a normal part of the economic cycle and when commodity prices improve, industrial activity will increase. Despite the current downturn in industrial activity, we continue our leadership role expanding the amount of publicly available minerals resource data in areas of high mineral potential. Now is an ideal time to provide new geology and mineral resource data to stimulate exploration activity, and be available for industry when metal prices recover.

Our changing Arctic climate presents special challenges for building and maintaining communities. Many parts of the state are experiencing increased erosion, storm surges, and thawing permafrost in response climate change. DGGS is working to provide the necessary data to allow science-based decision making by community planners and engineers as they work to accommodate a changing climate.

Increasing demand for digitally available data and less reliance on paper maps is challenging DGGS to make data readily and rapidly available in new and evolving formats. DGGS must move with the speed of business as we transition to digital presentation of data via geographic information systems, web-based applications, and data access portals. It will be challenging to meet this demand while maintaining the superior product quality and unbiased scientific analyses for which we are known. I encourage you to visit our website, where you can see the new products we are developing, and suggest how we can improve.

Throughout all these changes, the staff at DGGS have continued their dedicated service and commitment to provide unbiased geologic information, allowing you to make sound, science-based policy and development decisions. I encourage you to read this annual report to learn more about our people and our programs, and also to visit our website (www.dggs.alaska.gov), where you can review our projects and find a wealth of information about Alaska's geology and resources.

Steve Masterman, Acting State Geologist and Director
Division of Geological & Geophysical Survey

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

ANNUAL REPORT 2013

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, prior to 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

Eleven 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 (Acting), 2003–January 2005
- Mark D. Myers, February–October 2005
- Robert F. Swenson, November 2005–November 2013
- Steven S. Masterman (Acting), November 2013–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.

Division of Geological & Geophysical Surveys offices Fairbanks

Geologic Materials Center Eagle River

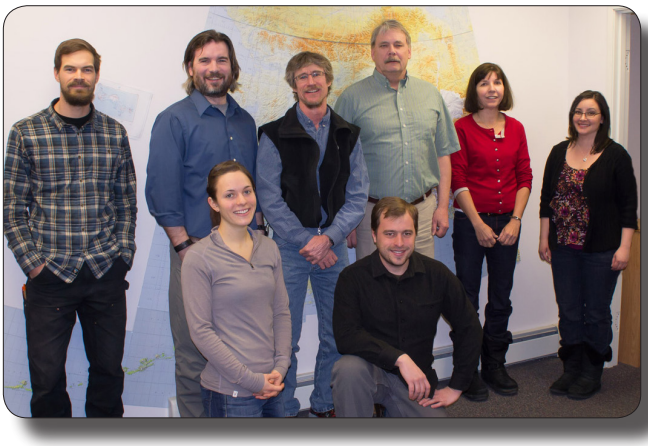
ORGANIZATION

DGGS is one of seven divisions and seven 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 (see organizational chart). The Division also administers the 11-member Alaska Seismic Hazards Safety Commission.

Current DGGS staff totals 40 permanent full-time professional and support positions, a Director, a Division Operations Manager, 11 nonpermanent staff, and 11 student interns.

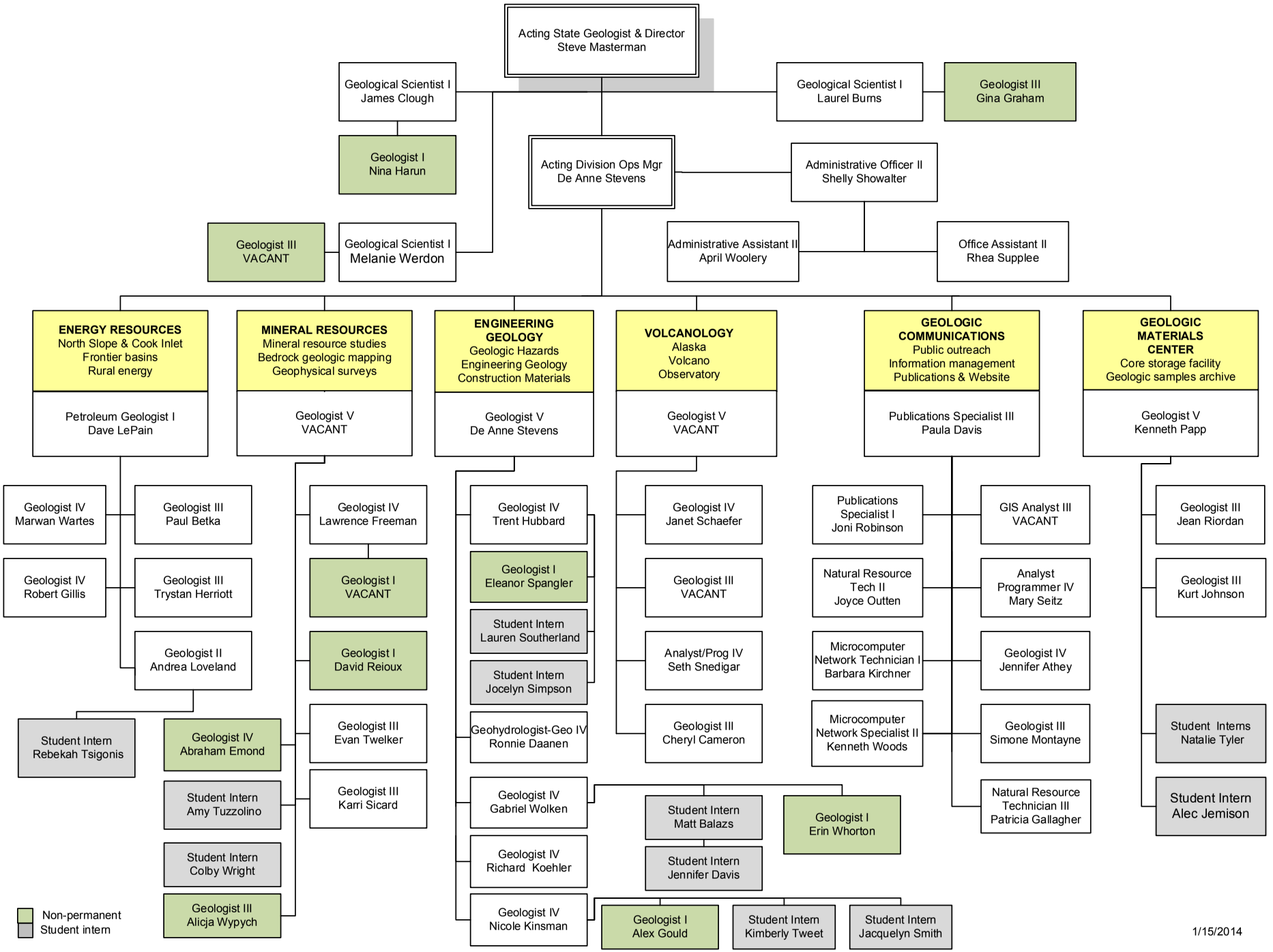
The **Director's Office** provides strategic planning for the Division's programs to ensure that DGGS is meeting the needs of the public under the guidelines of AS 41.08.020, manages the Division's fiscal affairs, and provides personnel and clerical services. The Director acts as a liaison between the 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.

L TO R: *Rhea Supplee, April Woolery, Steve Masterman, Shelly Showalter*



L TO R: *Trystan Herriott , Marwan Wartes, Bob Gillis, Jim Clough, Nina Harun, Andrea Loveland*
KNEELING: *Rebekah Tsigonis, Paul Betka*

The **Energy Resources Section** generates new information about the geologic framework of existing and 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 potential local sources of energy for rural Alaska villages and enterprises.


Acting State Geologist & Director
Steve Masterman
Geological Scientist I
James Clough
Geologist I
Nina Harun
Geological Scientist I
Laurel Burns
Geologist III
Gina Graham
Acting Division Ops Mgr
De Anne Stevens
Administrative Officer II
Shelly Showalter
Geologist III
VACANT
Geological Scientist I
Melanie Werdon
Administrative Assistant II
April Woolery
Office Assistant II
Rhea Supplee
ENERGY RESOURCES
North Slope & Cook Inlet
Frontier basins
Rural energy
Petroleum Geologist I
Dave LePain
MINERAL RESOURCES
Mineral resource studies
Bedrock geologic mapping
Geophysical surveys
Geologist V
VACANT
ENGINEERING GEOLOGY
Geologic Hazards
Engineering Geology
Construction Materials
Geologist V
De Anne Stevens
VOLCANOLOGY
Alaska
Volcano
Observatory
Geologist V
VACANT
GEOLOGIC COMMUNICATIONS
Public outreach
Information management
Publications & Website
Publications Specialist III
Paula Davis
GEOLOGIC MATERIALS CENTER
Core storage facility
Geologic samples archive
Geologist V
Kenneth Papp
Geologist IV
Marwan Wartes
Geologist IV
Robert Gillis
Geologist III
Paul Betka
Geologist III
Trystan Herriott
Geologist II
Andrea Loveland
Student Intern
Rebekah Tsigonis
Geologist IV
Abraham Emond
Student Intern
Amy Tuzzolino
Student Intern
Colby Wright
Geologist III
Alicja Wypych
Geologist IV
Lawrence Freeman
Geologist I
VACANT
Geologist I
David Reioux
Geologist III
Evan Twelker
Geologist III
Karri Sicard
Geologist IV
Trent Hubbard
Geologist I
Eleanor Spangler
Student Intern
Lauren Southerland
Student Intern
Jocelyn Simpson
Geohydrologist-Geo IV
Ronnie Daanen
Geologist IV
Gabriel Wolken
Geologist IV
Richard Koehler
Geologist IV
Nicole Kinsman
Student Intern
Matt Balazs
Student Intern
Jennifer Davis
Geologist I
Erin Whorton
Geologist I
Alex Gould
Student Intern
Kimberly Tweet
Student Intern
Jacquelyn Smith
Geologist IV
Janet Schaefer
Geologist III
VACANT
Analyst/Prog IV
Seth Snedigar
Geologist III
Cheryl Cameron
Publications Specialist I
Joni Robinson
Natural Resource Tech II
Joyce Outten
Microcomputer Network Technician I
Barbara Kirchner
Microcomputer Network Specialist II
Kenneth Woods
GIS Analyst III
VACANT
Analyst Programmer IV
Mary Seitz
Geologist IV
Jennifer Athey
Geologist III
Simone Montayne
Natural Resource Technician III
Patricia Gallagher
Geologist III
Jean Riordan
Geologist III
Kurt Johnson
Student Interns
Natalie Tyler
Student Intern
Alec Jemison
Non-permanent
Student intern
1/15/2014

L TO R: *Alicja Wypych, Evan Twelker, Laurel Burns, Karri Sicard, Melanie Werdon, Larry Freeman, David Reioux, Gina Graham*

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.

The **Engineering Geology Section** collects, analyzes, and compiles geologic data useful for engineering and hazard risk-mitigation purposes, and hydrologic data needed for managing Alaska's water resources. Studies of major geologic hazards such as earthquakes, active faults, coastal flooding and erosion, and tsunamis result in reports outlining potential hazards in susceptible areas. 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. In 2013 DGGS added a hydrogeologist to this section to develop groundwater models for resource development and urban areas. The section advises other DNR divisions and State agencies regarding water resources and potential hazard risks to proposed developments and land disposals.

L TO R: *Jennifer Davis,Trent Hubbard, Alexander Gould, Gabriel Wolken, Richard Koehler, Erin Whorton, Nicole Kinsman, Ronald Daanan, Eleanor Spangler, Matthew Balazs, De Anne Stevens*

MISSING: *Lauren Southerland, Jacquelyn Smith, Jocelyn Simpson, Kimberly Tweet*

L TO R: *Chris Nye, Cheryl Cameron, Janet Schaefer, Seth Snedigar*

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 (http://www.avo.alaska.edu), as well as an internal website providing communication, record keeping, and data sharing within AVO. During volcanic eruptions (three in 2013) Volcanology Section staff spend a significant amount of time responding to the eruption. Responsibilities include: Responding to e-mails from the public; ensuring the public website contains the most up-to-date volcanic information releases and photographs; keeping the internal data flow manageable through the internal website and communications log; participating in daily seismic and remote sensing data monitoring checks; contributing to eruption scenario forecasts; and keeping a detailed record of ash fall, eruption chronology, and the eruption's impact on air traffic and infrastructure.

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; websites for the Division (http://www.dggs.alaska.gov), the Alaska Seismic Hazards Safety Commission (http://www.seismic.alaska.gov), and the Association of American State Geologists (http://www.stategeologists.org); and ensures an efficient and appropriately sized network with virtually no downtime and individual computer resources that are optimized for the work each staff member is assigned.

L TO R: *Paula Davis, Joyce Outten, Jen Athey, Susan Seitz, Simone Montayne, Joni Robinson, Bobby Kirchner, Ken Woods, Trish Gallagher*

L TO R: *Natalie Tyler, Contract Curator Don Hartman, Kurt Johnson, Alec Jemison, Jean Riordan, Ken Papp*

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 analyses of the geologic materials stored there must be returned to the GMC database in the form of data reports.

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, sales, selections, or relinquishments; mineral potential; and construction materials availability. The DGGS Energy Resources Section works closely with geologic personnel in the Division of Oil & 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 works with the Division of Economic Development in the Department of Commerce, Community, and Economic Development (DCCED), to report on the status of Alaska's mineral industry. 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 update the State Hazard Mitigation Plan. Engineering Geology staff also work closely with DCCED, the Department of Transportation & Public Facilities, University of Alaska Fairbanks, and other agencies to assess the impacts of flooding, erosion, and other processes potentially accelerated by climate change; with the Alaska Energy Authority to evaluate hazards to proposed hydroelectric, geothermal, and other energy projects; and with the Division of Mining, Land and Water (DMLW) to evaluate groundwater and address issues affecting Alaska's water resources. The Volcanology Section works with DHSEM and the Department of Environmental Conservation to mitigate risks from eruptions, and with the Alaska Energy Authority to provide technical expertise concerning geothermal resource potential. DGGS also evaluates resource potential around the state that may provide viable alternatives for energy development in rural Alaska. In recent years DGGS has developed close working relationships with the Alaska Gas Pipeline Project Office, Alaska Gasline Development Corporation, and the State Pipeline Coordinator's Office to assist in geologic data collection and hazards risk assessment for proposed natural gas pipelines.

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, Seward, Whittier, Valdez, and Sitka, 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 Chenega Bay, Tatitlik, and Cordova for the next tsunami-inundation maps to be generated by this program. The Engineering Geology Section works closely with local communities to help assess hazards and alternatives for mitigating the effects of erosion, flooding, and other surface processes 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. During unrest and eruption, the Alaska Volcano Observatory communicates with local village councils and schools to share information and observations of volcanic unrest in their region.

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 Fairbanks. UAF 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 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 through research intern programs established recently through Memoranda of Agreement with the UAF Department of Geology & Geophysics and Department of Mining & Geological Engineering. DGGS and the University make frequent use of each other's libraries and equipment. University

faculty and students occasionally visit the Geologic Materials Center in Eagle River to study the geology represented in cores and surface samples from around the state. DGGS's Volcanology Section has a long-term cooperative relationship with the UAF Geophysical Institute resulting from partnership in the Alaska Volcano Observatory.

RELATIONSHIPS WITH FEDERAL AGENCIES

DGGS has cooperative programs with the U.S. Geological Survey (USGS), and periodically with the U.S. Bureau of Land Management (BLM) and the U.S. Department of Energy. 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 [BOEM]), 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 federal funds to support mineral inventory mapping, surficial and earthquake hazards-related mapping, volcanic-hazards evaluations, and studies related to oil and gas and geothermal potential. Although DGGS has historically been very successful in receiving federal grants and appropriations, the process is competitive and these funds are therefore project-specific or complementary to State-funded programs and do not replace State general fund support. Federal funding is pursued only for projects that are needed to advance the Division's statutory mission.

Two ongoing cooperative programs with federal agencies have provided support for key elements of the DGGS mission for many 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, 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 the USGS. STATEMAP provides matching funds for geologic-mapping projects according to priorities set by the Alaska Geologic Mapping Advisory Board (see below).

DGGS has been successful in receiving cooperative agreements for two key federal programs, the National Geological & Geophysical Data Preservation Program (NGGDPP) and the Coastal Impact Assistance Program (CIAP). The NGGDPP, established by the National Energy Policy Act of 2005 and funded by the USGS, has supported several DGGS projects to archive, catalog, and make publicly available inventories of geologic samples and data through a National Digital Catalog hosted by the USGS. DGGS received major, multi-year CIAP support through a highly competitive proposal process administered originally by MMS, then BOEM, and currently by the U.S. Fish & Wildlife Service. CIAP funding supports DGGS geologic mapping and hazards evaluations of coastal communities in Alaska that are potentially impacted by Outer Continental Shelf petroleum development and face current risks from coastal erosion and storm-wave flooding.

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 review and advise on priorities for geologic mapping recommended by the State Geologist and provide letters of support to accompany DGGS's annual STATEMAP proposals to the U.S. Geological Survey.
- 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. Board members nominate candidates to fill vacancies and the State Geologist makes the appointments with approval of the Commissioner of DNR.

Current members of the board are:

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

James Jones
U.S. Geological Survey, representing the federal government, earthquake hazards, and mapping interests
Dr. James Jones is a geologist in the Anchorage office of the USGS Geologic Division, specializing in geology, tectonic evolution, and mineral resources.

Tom Homza
Shell Exploration and Production, Alaska, representing petroleum industry interests with emphasis on the North Slope
Tom Homza is a Principal Regional Geologist for Alaska at Shell with 17 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 College of Natural Science and Mathematics, representing the academic community
Dr. Paul Layer is Dean of the College, a Professor of Geophysics, and former Chair of the Department of Geology & Geophysics.

Steve Adamczak
Shannon and Wilson Inc., representing the engineering geology and geotechnical community
Steve Adamczak is Vice President, with more than 30 years of geotechnical engineering experience in Alaska.

Lance Miller
Nana Regional Corporation, representing Alaska Native corporation interests
Lance Miller is Vice President for Resources and a geologist with mineral exploration background.

2013 ACCOMPLISHMENTS

ENERGY RESOURCES

- Conducted 250 square miles of 1:63,360-scale geologic mapping of the Iniskin Peninsula on the west side of lower Cook Inlet to better understand stratigraphic and structural characteristics of the Cook Inlet Mesozoic basin margin and potential implications for its Mesozoic petroleum system.
- Discovered two previously undocumented occurrences of oil-stained rock on the Iniskin Peninsula.
- Completed collection of new and legacy geothermal data as part of the U.S. Department of Energy-funded National Geothermal Data System (NGDS) program. These new data are accessible online to industry and the public and will enable research and development of geothermal sites in Alaska.
- Published a new tectonic model for the development of the gas-prone Brooks Range foothills in the peer-reviewed journal *Terra Nova*.
- Published a seven-chapter compilation report detailing initial progress and findings of its 2012 field studies of upper Alaska Peninsula and lower Cook Inlet Mesozoic strata. Individual reports discuss ongoing work understanding petroleum source rocks to the Cook Inlet petroleum system, reservoir potential of selected stratigraphic intervals, hydrocarbon-bearing rocks on the upper Alaska Peninsula (including a newly-discovered occurrence), and ongoing investigations of the Bruin Bay fault.
- Published four separate raw data files pertaining to the petroleum seal capacity of Jurassic, Cretaceous, and Cenozoic strata of the upper and lower Cook Inlet region.

- Published a progress report for 2012 field studies in the Susitna basin aimed at better understanding its hydrocarbon potential.
- Published a progress report for 2012 field studies surrounding the Nenana and Tanana basins to gather baseline geologic information about its potential role as a source for rural energy in interior Alaska.
- Presented new data relevant to oil and gas exploration in Cook Inlet at the Pacific Section of the AAPG held in Monterey, CA.
- Presented preliminary results from recent studies on the geologic evolution of the Susitna Basin at the national meeting of the Geological Society of America in Denver, CO.
- Presented new interpretations of potential Brookian reservoirs on the North Slope at an international Arctic oil and gas conference in Stavanger, Norway.
- Presented the new pending *Geothermal Sites of Alaska Map* and Alaska's new geothermal data set at the American Geophysical Union's Annual Meeting in San Francisco, CA.
- Hosted an information booth at the Annual Meeting of American Association of Petroleum Geologists (AAPG) in Pittsburg, PA, and discussed oil and gas opportunities in Alaska with meeting attendees.

MINERAL RESOURCES

- Initiated a multi-year Strategic and Critical Mineral Copper–Nickel–Cobalt Platinum-Group-Element assessment of 2,600 square miles by targeted stream-sediment sampling, rock sampling, and geology.
- Continued the Strategic and Critical Minerals Assessment project to assess Alaska's potential for strategic and critical minerals (SCMs). Digitally compiling historical and obtaining new statewide SCM data.
- Completed the airborne geophysical survey and acquired data for 854 square miles in the Farewell area, south-central Alaska.
- Conducted a 210-square-mile geologic mapping program in the Lime Hills C-1 Quadrangle, western Alaska Range, covering part of the 2008 Styx River geophysical survey area, a region with potential for igneous-related gold and porphyry copper deposits.
- Conducted follow-up rock geochemical sampling and continued geologic research and strategic and critical mineral-resource assessment of 3,500 square miles in the Ray Mountains-Dalton Highway area, Interior Alaska.
- Contracted for a 1,400-square-mile Strategic and Critical Minerals-related airborne geophysical survey covering part of the Wrangellia terrane and adjacent to previous Iron Creek, Valdez Creek, and Southern Delta River airborne geophysical surveys in south-central Alaska.
- Contracted for a 1,057-square-mile mineral inventory airborne geophysical survey in the East Styx area, extending the earlier East Styx survey in south-central Alaska.
- Published *Alaska's Mineral Industry 2012* (Special Report 68), an authoritative annual report of the statewide mineral industry, including exploration, development, and production activities.
- Published an updated statewide map of Alaska's mineral resources (Miscellaneous Publication 149).
- Published geophysical maps and data for 238 square miles in two areas (Middle Styx and Dalzell) of the Farewell survey area, adjacent to the previously flown Styx River survey.
- Published geophysical maps and data for 1,029 square miles in three areas (Southern Dishna River, Fox Hills, and Beaver Creek) adjacent to the previously flown Aniak and Iditarod surveys, western Alaska.
- Published a geochronology report for the Alaska Highway corridor.
- Published an apatite fission track report for the Alaska Highway corridor.
- Published a geochemical report from archived U.S. Bureau of Mines samples for the Ray Mountains, Dalton Highway area, Interior Alaska.
- Published geochemical data for rock samples from Annette Island, Southeast Alaska.
- Supported the Division of Mining, Land & Water and the U.S. Bureau of Land Management by providing extensive mineral-resource reviews for area plans and State land sales.
- Provided mineral-resource-potential evaluations of State land throughout Alaska, to identify and prioritize appropriate land to relinquish from the State of Alaska's overselected land entitlement.
- Presented a poster on the Ray Mountains Strategic and Critical Minerals project.
- Presented four talks on the DGGS Styx River and Wrangellia Strategic and Critical Minerals and Geophysics projects.
- Presented two talks on an annual review of the Alaska Mineral Industry.
- Responded to more than 850 public, industry, and agency requests for mineral resources information.

ENGINEERING GEOLOGY

- Initiated a new hydrogeology program to rigorously assess Alaska's water resources and lead research efforts that focus on groundwater issues related to development of resources and urban areas.
- Launched a widely used (20–30 visits/month and growing) online calculator for tidal datum conversions in Alaska.
- Completed the first year of a multi-year glacier change and hydrology study of the upper Susitna drainage basin as part of pre-licensing studies for the Susitna–Watana Hydroelectric Project.
- Installed three high-elevation automated weather stations in central and south-central Alaska for use in climate and cryosphere studies.
- Collected new radar-derived winter snow accumulation data on Alaska south-central and maritime glaciers, and in tundra, shrub tundra, and boreal forest biomes.
- Conducted geologic fieldwork along the Alaska and Parks highways in support of proposed export and in-state natural gas pipeline projects.
- Conducted geologic fieldwork in and near Savoonga, Gambell, Port Heiden, Golovin, Hooper Bay, Valdez, Whittier, Yakutat (Hubbard Glacier), and Cordova in support of community-based hazards evaluation projects.
- In collaboration with Geothermal Resources Group, Zonge Inc., and Nevada Bureau of Mines and Geology, conducted geologic mapping of alteration zones and fault structures related to the Akutan Geothermal Project and evaluation of lateral spread features, including assessment of permeability and temperature.
- Participated in collaborative research with the U.S. Geological Survey on Umnak Island, Alaska, to examine the timing of past great earthquakes and tsunamis along the Aleutian subduction zone in order to assess the recurrence of these earthquakes and segmentation patterns along the Aleutian trench.
- Completed and published the results of a short-fuse field project for the Alaska Department of Transportation and Public Facilities (DOT&PF) to provide baseline geotechnical and geomorphic observations on a landslide that occurred adjacent to the Yukon River bridge along the Dalton Highway.
- Completed agency reviews regarding potential geologic hazards and engineering-geologic considerations for multiple DNR land disposals; area plans; resource development and subdivision projects; Environmental Impact Statements and Resource Management Plans for the U.S. Bureau of Land Management (BLM); statewide and community hazard mitigation plans for the Alaska Department of Military & Veterans Affairs (DMVA); study plans for the Alaska Energy Authority; and a reconnaissance road access study by DOT&PF.
- Published an engineering-geologic map with accompanying GIS data in support of geologic and hazards studies along the Alaska Highway between Tetlin Junction and the Canada border.
- Published a paleoseismic–neotectonic report documenting observations related to potential active faulting along the Alaska Highway corridor between Delta Junction and the Canada border.
- Published tsunami-inundation maps and reports for the communities of Sitka and Valdez as part of an ongoing collaboration with the University of Alaska Fairbanks.
- Published a report on coastal vulnerability for an island near Shishmaref that is being considered as a potential community relocation site.
- Published a legacy geologic map with accompanying GIS data in support of geologic studies in the Livengood mining district.
- Published digital GIS data for Quaternary faults and folds in Alaska.
- Published six papers in outside professional journals and government reports.
- Provided administrative and scientific support for the Alaska Seismic Hazards Safety Commission. The Commission produces a separate annual report.
- Worked with a consortium of USGS, DGGS, ASHSC, DHS&EM, UAF, and NOAA representatives to refine and update the publication, *Are You Prepared for the Next Big Earthquake in Alaska?:* http://www.aeic.alaska.edu/html_docs/pdf_files/eqprepare.pdf
- Supported the Alaska Energy Authority by reviewing alternative energy project proposals for potential geologic hazards that should be addressed in project implementation.
- Presented talks and posters at numerous state, national, and international venues, to inform the geologic community and government representatives about DGGS Engineering Geology geologic studies, with the primary goals of disseminating geologic information and encouraging informed planning and development in Alaska.

VOLCANOLOGY

- Provided helicopter procurement and fuel logistics support for all AVO field projects, including geophysical-monitoring-station maintenance, geologic field investigations, and eruption response.
- Processed more than 80 tephra samples from both terrestrial sources and lake core sediments in support of Chiginagak volcano and Alaska Peninsula ash fall hazard analysis.
- Compiled a GIS database of Chiginagak volcano geologic information, including $^{40}Ar/^{39}Ar$ age dates, water chemistry data, geologic units, radiocarbon dates, and ice cover.
- Participated in a multi-agency team studying the recent eruptive history of Makushin volcano. DGGS took the lead role in further developing a tephra fall hazard analysis of the Dutch Harbor/Unalaska region. In addition to the tephra work DGGS compiled a GIS database of Makushin volcano geologic information including station and sample information, radiocarbon dates, and thickness data of major explosive events.
- Compiled a GIS database of Okmok volcano imagery, topographic data, geologic samples, and geomorphic changes resulting from the 2008 eruption.
- Published the final year's water geochemistry data from the Chiginagak volcano acid-flood project. This completes the 8-year environmental monitoring of acid water input to Mother Goose Lake (DGGS RI 2011-6 v. 2).
- DGGS played a significant role in the response to the eruptions of both Pavlof and Veniaminof volcanoes. Pavlof volcano began erupting on May 13 and Veniaminof on June 8, 2013.
- In response to requests from members of the public and emergency management officials, DGGS created a formal AVO **Facebook** page in June 2013. All AVO volcanic activity notifications, including both daily and weekly summaries, are automatically posted to the new **Facebook** page as well as to the main AVO public website. DGGS/AVO staff monitor the page to post photos and informal communications, as well as to receive photos and volcano-related information from the public. http://www.facebook.com/alaska.avo
- Successfully implemented the *"Is Ash Falling?"* database and ash fall reporting module in cooperation with USGS colleagues. https://www.avo.alaska.edu/ashfall/ashreport.php
- Continued to build and improve the geochemical database of volcanic rocks of Alaska. The database now includes 6,159 analyses.
- Quaternary vents of Alaska database now includes 1,134 vents, a geographic and volcano-based hierarchy, vent types, locations, age descriptions, and references, and has undergone review by many volcanologists who work in Alaska.
- DGGS staff answered over 300 emails from the public through our AVO website email interface.
- Completed a multi-year slide scanning project by digitizing the last 500 legacy slides held by AVO. These slides were taken by AVO geologists before digital cameras were the norm.
- As the administrator of the AVO website, DGGS staff continued to improve functionality by developing the internal site for mobile users; creating a new version of the image database (currently contains 21,332 images and metadata); installing software to better track file downloads; adding distance and bearing to nearby towns on the volcano information pages; and making several other programming improvements that result in AVO's website being the model for other volcano observatory websites worldwide.
- Significant updates to GeoDIVA (Geologic Database of Information on Volcanoes of Alaska) include expansion of the on-line reference library (currently contains 4,800 references) and additions to the eruption histories of Cleveland, Veniaminof, and Pavlof volcanoes, incorporating a timeline of events and impacts of the 2013 eruptions at these volcanoes.

GEOLOGIC COMMUNICATIONS

- The Division published 52 new geologic maps and reports (total 1,268 pages and 16 sheets).
- Distributed 1,103 hard-copy publications; 1,597 digital data sets (downloaded free from the DGGS website, http://dggs.alaska.gov); responded personally to hundreds of significant geologic information requests (most from the online "Ask a Geologist" feature); and recorded nearly 6.1 million web page views, a 35 percent increase from FY12. The highest-demand new product was high-resolution LiDAR data collected to provide background topographic information for proposed Alaska infrastructure corridors (640 downloads and eight requests for the entire LiDAR database).
- Distributed 1,597 geospatial digital datasets (downloaded free from the DGGS website, http://dggs.alaska.gov). While the number of downloads has decreased 43 percent from FY12, we have released our most popular datasets (LiDAR and Quaternary Faults and Fold Database) as interactive web maps and web-mapping services (WMS), thus decreasing the number of users that need to download dataset shapefiles.

- Entered the realm of social networks. We ended FY13 with 1,186 followers on **Twitter**, 386 e-mail subscribers to our **RSS feed,** 27 **RSS reader** subscribers, and 22 followers on **LinkedIn**. Our **Facebook** page has been visited by 39,960 people since January 1.
- Introduced a new publication series, Digital Data Series (DDS), to provide the public with real-time interaction with the Division's geologic data and facilitate the release of geologic databases, web map interfaces, and other regularly updated compilations of digital geologic information. Developed an IT platform and template for the web-mapping applications, including implementing ArcGIS Server, and created a splash page (http://maps.dggs.alaska.gov/) to provide the public easy access to the web-mapping applications. To date, three web-mapping applications have been published:
- AGDI, the *Alaska Geologic Data Index* (formerly known as Alaska Minerals Industry Data Inventory [AKMIDI] database), an actively growing online index of more than 16,000 unpublished data sets from sites throughout Alaska. AGDI includes information about and locations of industry reports and maps, field notes, drill logs, and other unpublished geology-related data.
- *Quaternary Faults and Folds*, displaying locations and activity of known, relatively recently active structures in Alaska.
- *LiDAR Datasets of Alaska*, a viewer for Alaska's public-domain LiDAR datasets. Datasets that support the applications have also been made available as 21 live data feeds for the public to access using their own GIS software.
- Published a compilation of Alaska Quaternary fault and fold data, including launch of an interactive online map (described above). This geospatial dataset contains information on faults and associated folds believed to be sources of M6 or greater earthquakes during the Quaternary period (the past 1.6 million years). This presents a single source of paleoseismic data compiled from hundreds of journal articles, maps, theses, and other documents, and will be used in probabilistic seismic analyses for Alaska.
- Currently running 26 Web Mapping Services (WMS) on ArcGIS for Server. Of those, six are Web Feature Services (WFS) and four are Web Mapping Tiling Services (WMTS). The following publications use these services to provide interactive web maps:
    - DDS 1—Alaska Geologic Data Index (AGDI)
      http://www.dggs.alaska.gov/pubs/id/24504
    - DDS 3—Quaternary Faults and Folds (QFF)
      http://www.dggs.alaska.gov/pubs/id/24956
    - DDS 4—LiDAR Datasets of Alaska
      http://www.dggs.alaska.gov/pubs/id/25239
    - SR 37—Map of Alaska's coal resources
      http://www.dggs.alaska.gov/pubs/id/2636
    - MP 8—Geothermal resources of Alaska
      http://www.dggs.alaska.gov/pubs/id/671
    - MP 141—Quaternary faults and folds in Alaska: A digital database
      http://www.dggs.alaska.gov/pubs/id/23944
    - MP 150—Digitized faults of the Neotectonic map of Alaska (Plafker and others, 1994)
      http://www.dggs.alaska.gov/pubs/id/24791
    - MP 133—Historically active volcanoes of Alaska
      http://www.dggs.alaska.gov/pubs/id/20181
      IC 38—Volcanoes of Alaska
      http://www.dggs.alaska.gov/pubs/id/7043
    - SR 66—Fossil fuel and geothermal energy sources for local use in Alaska: Summary of available information
      http://www.dggs.alaska.gov/pubs/id/24264
- Created a multi-state agency and minerals industry working group to discuss and recommend future content, format, and data collection methodology for *Alaska's Mineral Industry Report,* a joint DGGS–DCCED Special Report in its 32nd year of publication. Findings of the working group were submitted to DNR (DGGS, DMLW) and DCCED for review and continued action.
- Continued to develop, revise, and plan for significant future expansion, and manage data for five additional web-mapping applications:
    - Airborne GeophysWeb, a web-based visual guide of Alaska geophysical publications, images, and supporting data.
    - *Geologic Map Index of Alaska,* a spatially enabled application to discover geology-related maps published by State and federal agencies. Have uploaded 96 percent of DGGS geologic map outlines to the Division's Enterprise Database. The outlines will be used to show the coverage areas of maps in the web map application.

  - Alaska Paleontology Database, a web-based guide to more than 15,000 samples connecting more than 1,900 citations of Alaska fossils.
  - LiDAR application to download large raw LAS data files.
- Interactive generalized geologic map of Alaska based on Helen Beikman's 1:2,500,000-scale geologic map published in 1980 by the U.S. Geological Survey.
- Updated WebGeochem application with 5,566 samples from 35 U.S. Bureau of Mines and U.S. Geological Survey publications. This many-years-old application is having difficulty dealing with the amount of data it contains and is scheduled to be updated in FY14 if programming resources are available.
- Maintained and continued to develop the DGGS website and other websites managed by DGGS.
- Worked with the Engineering Geology Section to develop the Alaska Tidal Datum Portal (http://www.dggs.alaska.gov/sections/engineering/ak-tidal-datum-portal/), which provides an educational discussion of tidal datum calculation issues that are specific to Alaska, as well as a calculator tool.
- DGGS also runs the Alaska Seismic Hazards Safety Commission (ASHSC) and Association of American State Geologists (AASG) websites. The ASHSC website provides information about the Commission's work to develop seismic risk mitigation recommendations to improve public safety in Alaska. For the AASG site, in addition to fulfilling information requests and completing general maintenance and content management tasks, DGGS is working with the executive committee to implement their long-term document management and information retention plan.
- Significantly upgraded the primary file server to replace aging hard drives and provide more storage and archive space for geologic data. An additional 33 terabytes of drive space will allow for greater expansion. Reconfigured the backup systems and consistently provided backups, disaster recovery, and physical data distribution. New software allowed reconfiguration of drive arrays on backup servers to cut in half the daily, weekly, and monthly backup processing time.
- Completed a major recabling project in the main server room, and upgraded the Oracle Enterprise Database. Also provided standard IT support such as purchasing and installing new software, upgrading end-of-life hardware, tracking inventory, and responding to hardware issues.
- Updated field safety manual and communication practices to reflect updated technology. Organized and checked in and out 60 new radios, chargers, and accessories; 4 base station radios; 28 satellite phones; 4 new repeaters with antennas and mast systems; 4 handguns and 1 rifle; 26 SPOT devices; 16 helicopter helmets equipped for communication with pilot; 2 cell phones; and 32 "survival packs", consisting of a bivy sack, fire-starting kit, first aid kit, and 3,000 calories of emergency food supplies.
- Provided programming resources to the Geologic Materials Center to review and evaluate their current databases and begin the rebuild into a single, cohesive database that will be used to organize their complete inventory and relevant data, enable their move into a new facility, and offer new and useful features to the public.
- Provided input and guidance as part of USGS–state geological survey working group on the USGS's U.S. Topo project (new topographic map series) and other national data efforts affecting the geologic community.
- Collaborated with the USGS on digital Alaska and nationwide geologic map collections by compiling and providing map images of our entire DGGS and Alaska USGS publication collection to the USGS's NGMDB project for inclusion in "mapView", a nationwide image viewing service for geologic maps (http://ngmdb.usgs.gov/maps/MapView/). In turn, the USGS provides DGGS with spatially-registered USGS geologic maps for inclusion in DGGS's *Geologic Map Index of Alaska* application. Also provided bibliographic and indexed information on 28 new DGGS publications for inclusion in the USGS's *National Geologic Map Database* map catalog (http://ngmdb.usgs.gov/ngm-bin/ngm_compsearch.pl).
- Entire Geologic Communications Section reviewed the section's business practices to ensure efficient incorporation of an additional GIS staff member and to accommodate changing publications methods.

GEOLOGIC MATERIALS CENTER

- Began a major, year-long project with DGGS programmers and IT staff to completely redesign the GMC inventory database and sample-tracking system. The new database system will: (1) provide clients with the ability to view and query the inventory in near real-time via a web-map interface; (2) create a real-time inventory tracking, redundancy, and backup capabilities; and (3) produce a more efficient framework to manage the expected increase in client scheduling, visitor information, and service fees as a result of expanded public usage and services at the new GMC facility.
- Collaboration between DGGS management, the Department of Natural Resources Commissioner's Office, the Department of Administration, ECI/Hyer, and the Governor's Office helped secure a new building for the GMC. The new facility will help safeguard the future accessibility and security of the valuable geologic samples currently archived by the State. Preparations are underway to move the current collection in late summer and fall 2014, with an opening date slated for mid-September 2014.
- GMC interns completed 33 percent of a large-scale inventory project to drastically improve the quality of the DGGS and oil and gas outcrop collections. The project involves confirming the samples inside every box and linking re-

lated spatial, fossil, and description information to each sample. Approximately 1,275 boxes have been inventoried, generating 19,585 sample records.

- The GMC hosted 362 visits by industry, government, and academic personnel to examine rock samples and processed materials. Collaboration from these visits helped acquire 1,026 processed slides; oil and gas samples representing 628,541 feet from 88 wells; hard-rock mineral core representing 9,000 feet from one mining prospect; and publish six new laboratory data reports (**http://www.dggs.alaska.gov/gmc-data-reports**) derived from third-party analyses.
- The GMC served 3,599 downloads of the GMC online inventory (**http://www.dggs.alaska.gov/gmc/inventory.php**), which was released to the public in April 2010. Since the release, the inventory files have been downloaded 11,926 times. This dataset, available in Google Earth and PDF formats, includes oil and gas well locations, mineral prospect locations, sample types, and box-level details for over 85 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.
- In-kind sample and data donations were provided by Kinross Gold Corp. (who delivered ~1.7 miles of core), the Bureau of Land Management, Redstar Gold Corp., the IRF Group, and Calista Corp., whose generosity helped increase and improve the GMC sample archive.
- Contract curator and former Alaska State Geologist Don Hartman completed the first step of a major inventory project involving the GMC's Irv Tailleur U.S. Geological Survey Rock Collection. The contents of all 37 cabinets, totaling 333 drawers and thousands of samples collected between 1950 and 1991, have been documented and indexed.

KEY ISSUES FOR FY2014–2015

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 geological and geophysical 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 geologic data to these resource exploration and development industries 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 Division personnel count and our inability to meet the rapidly changing needs of the resource development community with the current number of personnel. An additional key challenge will be to continue gathering required new field information in the face of rising operating costs.
- Numerous areas in the state have world-class minerals and energy resource potential. Consequently, development of those resources is a key component to both local and statewide economic health. DGGS will be challenged to maintain constant data acquisition and timely publication of results in multiple areas of the state, addressing multiple types of geologically hosted resources.
- There is growing national awareness and concern regarding the United States' reliance on imports of raw materials. The United States now imports 100 percent of 20 key mineral commodities and more than 50 percent of an additional 24. Many of these elements are included on a list of strategic and critical minerals maintained by the USGS, and are considered critical to the economy and national security. Alaska has historical production of 13 of these minerals, and potential for production of all but three of the 44 minerals that are imported at greater than 50 percent. DGGS will be challenged to provide sufficient new data and interpretations on the occurrence of these minerals deposits for industry and land managers.
- Both the North Slope and Cook Inlet are mature hydrocarbon-producing basins. Like all mature hydrocarbon basins, the 'easy' prospects have been drilled and tested and what remains are plays that require significant investment to reach discovery and production. One of the key links in that investment chain is the acquisition of new geologic data using modern technology. DGGS will continue to be challenged to provide new information on petroleum systems that will lead to new discoveries.
- As Alaska's vast potential for unconventional energy resources comes into focus DGGS will be challenged to provide the necessary information to assist in developing these new resources.
- High commodity prices create spikes in the exploration cycle, during which high-paying, private-sector jobs become abundant, and opportunities for experienced geoscientists become commonplace. The State must remain diligent in order to remain competitive in recruitment and keep our best and brightest employees.
- DGGS must continue developing and optimizing its data acquisition and distribution 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 resource base requires access to world markets. Providing geologic data for infrastructure maintenance and development will remain a key challenge for DGGS.
- Large projects to develop Alaska's huge natural-resource base and sustain the state's economy require baseline data and hazards analysis to enable engineering and permitting to be completed in a reasonable timeframe and the environment to 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 Alaska's rail and highway systems. Identifying geologic hazards and areas prone to failure will be necessary to mitigate this change. Increased materials requirements will likewise strain Department of Transportation & 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 many of those regions have essentially no baseline data on which to base zoning efforts and restrictions. Likewise, many areas where resource development is occurring 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, residential, and economic development, as well as for transitioning from 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, retooling 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 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 closely involved in reviewing the proposals for resource and hazards potential, methodology, and data accuracy. DNR will be tasked with the substantial job of regulating and permitting the hundreds of projects that have 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 communities.
- Many remote areas of the state lack sufficient geologic information about potential alternate forms of energy such as shallow natural gas, coal, geothermal, and conventional gas. The cost associated with developing these alternatives is often prohibitive on a small scale, but in some cases will be necessary to replace even higher-cost diesel fuel. Helping local governments grapple with increasing energy costs will remain a key challenge.
- Misinformation about viable alternative energy sources is rampant and many expensive mistakes can be avoided by getting accurate information in the hands of local governments and decision makers.
- DGGS will be challenged to provide pertinent and timely data on numerous fronts, and address the occurrence of locally available energy sources. DGGS will continue to strive to make data available to those who need it, moving Alaska toward a more secure energy future.

RESPONSE TO DATA NEEDS FOR ADAPTATION TO A CHANGING ARCTIC CLIMATE

- Over the coming years Alaska will be a national focal point 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 risks 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 essential in areas of coastal development and critical infrastructure where ground settlement from thawing permafrost, erosion and landslide hazards, and changes in hydrologic systems (both surface and subsurface aquifers) will be prevalent.
- The State has historically relied on site-specific hazards analyses related to ongoing development or permit approval. The recognition of significant change across the Arctic will require that up-to-date regional baseline data be gathered and made available. Ongoing 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 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 these data available in crisis situations.

- DGGS will work with numerous agencies (with a wide range of mandates) in a coordinated effort so that the most important needs are addressed, and redundancy is minimized.
- A key objective will be the prioritization of study areas; because of Alaska's size and the lack of existing data there is much more need for data than there are personnel and funding to acquire it.

UPDATING AND IMPROVING THE ALASKA GEOLOGIC MATERIALS CENTER

- Our ability to develop the state's natural resources and maintain a robust economic engine is continually challenged on many fronts. Significant investment will be required in the coming years to advance exploration and development efforts statewide. The Geologic Materials Center (GMC) is a key component of these efforts 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 of drilled core; samples from 1,650 oil and gas exploration and development wells; 300,000 feet of mineral core holes; and irreplaceable samples from geologic research performed and mapping completed in every corner of the state. 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 such a rich repository of mineral and material knowledge is critically important for viable exploration programs, for both seasoned Alaska exploration companies and new companies that are trying to identify potential exploration areas. Any one piece of core from this archive has the potential to identify a resource prospect that could bring billions of dollars to the state. Investment in the GMC upgrade is an investment in future revenue generation.
- The GMC currently utilizes 60 portable shipping containers as storage facilities for newer sample acquisitions. These containers are unlighted, unheated, and house thousands of feet of core, some of which will disintegrate with repeated freeze-thaw cycles. The current core and sample observation area is essentially unusable for confidential work and examination of more than a few feet of core. These factors result in reluctance by some companies to make use of the facility because they must go through an onerous process of transporting and unnecessarily handling the material at risk.
- The GMC is being maintained in its current condition, but the facility is filled to more than 70 percent *above* its maximum sample-storage capacity and is very poorly designed to handle the frequent requests for reasonable access to the material.
- The Governor's FY14 budget included a capital appropriation to begin the process of replacing the aging facility. As a result, the State purchased an existing building in July 2013 that has more than 100,000 square feet of indoor heated warehouse space. Upgrades to the building, office, and sample processing areas will occur during summer 2014. Upgrades to the building and relocation of the collection from the existing GMC are projected to be completed in September 2014.
- A key challenge will be to safely and efficiently relocate the entire 35,000-square-foot archive from its current location in Eagle River to the new site on Penland Parkway in Anchorage with minimal disruption to users, and complete the project in time for the ribbon-cutting. GMC staff is working with DGGS management and programmers, ECI/Hyer, and DOA to finalize a plan to organize and transfer the nearly 85,000 cubic feet of samples and equipment to the new facility. This project is a unique opportunity to begin anew, redefine the GMC's mission and vision, and revitalize research in our state's world-class, discovered and undiscovered natural resources.

FY 2014 DIVISION EXPENSE BUDGET
(estimated expenses in thousands of dollars)

Program	General Fund	CIP	Federal	Interagency & Program Receipts	Total
Energy Resources	$ 848.8	$ 440.9	$ 309.8	$ 303.9	$ 1,903.4
Mineral Resources	$ 1,590.3	$ 2,363.3	$ -	$ 60.0	$ 4,013.6
Engineering Geology	$ 531.8	$ 360.0	$ 321.0	$ 1,099.0	$ 2,311.8
Volcanology	$ -	$ -	$ 773.1	$ -	$ 773.1
Geologic Communications	$ 1,088.1	$ -	$ -	$ 10.0	$ 1,098.1
Geologic Materials Center	$ 333.6	$ 35.9	$ 26.4	$ 50.0	$ 445.9
Administrative Services	$ 462.9	$ 30.0	$ -	$ -	$ 492.9
Seismic Hazards Safety Commission	$ 10.0		$ -	$ -	$ 10.0
Total by funding source	**$ 4,865.5**	**$ 3,230.1**	**$ 1,430.3**	**$ 1,522.9**	**$ 11,048.8**

DGGS FY2014 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 FY14 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 state's economy will continue to depend on developing 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 land-use, 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; civil engineers; air carriers; other DNR agencies; Department of Commerce, Community & Economic Development; Department of Transportation & Public Facilities; Division of Homeland Security & Emergency Management; U.S. Geological Survey; 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.

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 geologic hazards.
4. Provide secure archival storage and efficient public access to the state's growing collection of geologic information, and energy and minerals-related cores and samples.

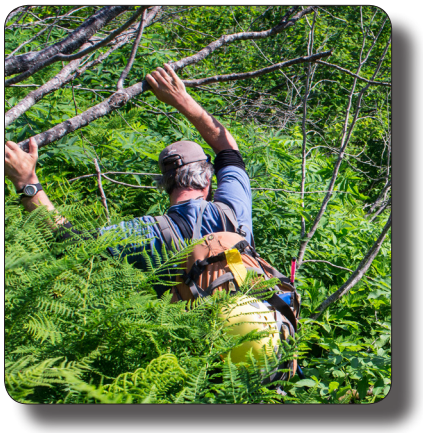
Tasks

- Prepare annual Division funding plan including Alaska general fund base budget, Capital Improvement Project budgets, 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. With the continued decline in the state's conventional oil reserves on the North Slope and the potential for natural gas shortfalls in south-central Alaska, it has become exceedingly important that new energy resources be identified to help offset declining conventional reserves and State income. An additional short-term need that must be addressed is the identification of 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 proposed natural gas pipelines. DGGS is in the process of compiling recent field mapping in the Umiat–Gubik area, and integrating this surface data with available subsurface information. We also initiated a collaborative project with the U.S. Geological Survey and the University of Alaska Fairbanks to evaluate the geology of potential shale oil units on the North Slope. Initial fieldwork has focused on the stratigraphy and geochemistry of the prolific oil-prone Shublik Formation exposed in the eastern Brooks Range foothills; subsequent work will evaluate the organic-rich Cretaceous Hue Shale.

Exploration for gas in the Cook Inlet basin continues to be of high interest for the oil and gas industry due to potential deliverability shortfalls in the south-central Alaska gas market. Additionally, over the last few years several companies new to Alaska have expressed significant interest in exploring the basin's oil potential. This new interest is focusing attention on undiscovered conventional oil and gas reservoirs and the possibility of unconventional reservoirs (such as tight gas sands, fractured reservoirs, and source-reservoired oil and gas). To stimulate sustained exploration interest DGGS initiated a multiyear study of this basin in 2007, providing relevant high-quality data to help evaluate its resource potential. 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 summer 2012 DGGS resumed stratigraphic and structural studies along the western margin of lower Cook Inlet in the Iniskin and Tuxedni Bay areas, along with new locations on the upper Alaska Peninsula. Strata in these areas represent the Mesozoic oil source rocks for the Cook Inlet petroleum system and virtually unexplored potential reservoir rocks underlying currently producing areas of the basin. In summer 2013 DGGS conducted detailed geologic mapping (1:63,360-scale) of more than 250 square miles on the Iniskin Peninsula of western Cook Inlet.



There are many sedimentary basins in Alaska whose geologic characteristics are conducive to 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 and Nenana basins suggests they could host natural gas in quantities that could be exploited for in-state use. In 2011 DGGS initiated a multi-year study of the natural gas potential of Interior basins, beginning with stratigraphic studies in the Susitna basin. Field studies continued in 2013 in the vicinity of the Nenana basin, where interest in exploration for natural gas has increased in recent years. Analysis of data from these initial studies is ongoing; information obtained from this work will add to the database of publicly available information on the petroleum geology of these basins, which will help stimulate private-sector exploration activity.

There has been an increased interest in Alaska coal for export, conventional power production, and metallurgical uses, and in possible underground coal gasification to help meet south-central Alaska's energy needs. The Statewide Energy Resource Assessment program has published information on Alaska's coal basins, evaluated coal lease applications, and continues to collect new coal-quality and stratigraphic data. Field studies continued in 2012 in the vicinity of the Nenana basin, where interest in exploration for natural gas has increased in recent years. Analysis of data from these initial studies is ongoing; information obtained from this work will add to the database of publicly available information on the petroleum geology of these basins, which will help stimulate private-sector exploration activity. As part of an integrated DGGS geologic data management system, the Energy Resources Section is continuing to build its comprehensive statewide coal resource data files and creating a new GIS-based coal resources map of Alaska.

As part of a multi-year, federally-funded program to build a comprehensive database for geothermal information in all 50 states, the Statewide Energy Resource Assessment program continued its efforts in 2013 and developed a new list of Alaska thermal springs and associated aqueous and gas chemistry, geothermal profile well data, bottom-hole temperature data from oil and gas exploration wells, and geothermal drill core descriptions. These data are being incorporated into a new geothermal map for Alaska that will also include Quaternary and younger volcanic vents, along with active faults.

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 and Nenana basins.
4. Collect new data and compile legacy published and unpublished geothermal data for Alaska to be incorporated into a new geothermal map of Alaska that will provide the industry and State agencies with accurate and current data in a comprehensive geothermal information database for Alaska.
5. Provide DNR, other State agencies, and the public with authoritative information relating to the energy resources of the state so rational policy and investment decisions can be made.

FY2014 Energy Resources Projects

Detailed summaries for the following Energy Resources projects appear in the section *Project Summaries—FY2014:*

- Brooks Range foothills and North Slope program – p. 34
- Framework geology of prospective North Slope shale oil targets – p. 35
- Cook Inlet geology and hydrocarbon potential – p. 36
- Geologic mapping of the Iniskin Peninsula, lower Cook Inlet – p. 37
- Natural gas potential of the Susitna and Nenana basins – p. 38
- State of Alaska contributions to the National Geothermal Data System – p. 39
- Alaska coal database—National Coal Resource Database System – p. 40

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 & Water.
- Respond to requests from other State agencies, federal agencies, industry, local government, and the public for information on energy-related geologic framework and oil, gas, coal, and geothermal 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 precious, base-metal, and strategic minerals is at an all-time high and Alaska's mineral resources will play a significant role in helping to meet that rising demand. The minerals industry, however, has historically been reluctant to commit significant company resources to exploration anywhere without sufficient understanding of the geologic framework of their areas of interest. To attract exploration interest 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. Since the early 1990s a DNR/DGGS program of integrated geological and geophysical mapping has been effective in attracting new private-sector mineral investment capital to Alaska. Projects conducted by the Mineral Resources Section are designed to produce, on a prioritized schedule, the critical new geophysical surveys, geologic maps, and reports needed to sustain Alaska's mineral industry investments and provide management agencies with information needed to formulate rational management policy.

A significant recent addition to the DGGS Mineral Resources program, initiated by the Governor and Legislature with Capital Improvement Project funding, is the Strategic and Critical Minerals Assessment program. The intent of this multi-year undertaking is to determine Alaska's geologic potential for rare-earth elements and other minerals that are essential for our modern, technology-based society. These include military and high-technology applications and clean/renewable-energy applications (such as wind turbines, solar panels, and batteries for electric vehicles, among many other uses) for which the U.S. is overly dependent on foreign sources for the required minerals. This program began in FY12 with a survey and compilation of existing data on rare-earth-element occurrences in the state and expanded significantly in FY13 to include additional critical minerals, re-analyses of existing samples, and obtaining new field and analytical data, including airborne geophysics.

The numerous components of the Mineral Resources Section are financed by a mixture of sources: General funds, Capital Improvement 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 data regarding the geologic framework and mineral resources of the state, to support informed land-use policy and investment decisions.
3. Provide, in cooperation with the Department of Commerce, Community and Economic Development, accurate annual statistical and descriptive summaries of the status of Alaska's mineral industry.

FY2014 Mineral Resources Projects

Detailed summaries for the following Mineral Resources projects appear in the section *Project Summaries—FY2014:*

- Airborne geophysical survey of Wrangellia, south-central Alaska – p. 41
- Airborne geophysical survey of the East Styx area, south-central Alaska – p. 42
- Airborne geophysical surveys of southern Dishna River, Fox Hills, and Beaver Creek areas, western Alaska – p. 43
- Airborne geophysical surveys of the Farewell area, south-central Alaska – p. 44
- Geologic mapping in the Styx River area, western Alaska Range – p. 45
- Annual Alaska mineral industry report – p. 46
- Strategic and critical minerals assessment project – p. 47
- Strategic and critical minerals assessment in the western Wrangellia terrane – p. 48
- Strategic and critical minerals assessment in the Ray Mountains area, north-central Alaska – p. 49
- Geologic mapping in the eastern Moran area, Tanana and Melozitna quadrangles, Alaska – p. 50
- Bedrock geologic mapping in the Tolovana mining district, Livengood Quadrangle, Alaska – p. 51
- Bedrock geology and mineral resource assessment along the Alaska Highway corridor from Delta Junction to the Canada border – p. 52

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 Section addresses major engineering-geology and geologic-hazards issues that affect 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 hazards 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 hazards 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 and building infrastructure to support energy resource exploration and development. For this reason, engineering-geology personnel often participate in teams with DGGS's Mineral Resources and Energy Resources geologists to map areas of interest for minerals and oil and gas exploration.

A new hydrogeology program was initiated in 2013 to collect and interpret data needed for managing Alaska's groundwater resources. This is an exciting development that re-institutes DGGS's capability to meet its statutorily-mandated responsibility to determine the locations and supplies of groundwater, a capability that was lost during budget cuts and government restructuring in the mid-1980s. The DGGS Hydrogeology program aims to lead research efforts that focus on understanding groundwater-related issues impacting resource development and communities. In collaboration with the University of Alaska Fairbanks and with input from DNR's Division of Mining, Land & Water, several projects are underway and baseline data are being gathered to guide future DGGS research.

Major projects that were developed in response to the overwhelming need for baseline geologic mapping and natural hazards evaluations in and near communities and important infrastructure that are being affected by severe problems have grown and matured. Funded by the federal Coastal Impact Assistance Program, the DGGS Coastal Hazards program is undertaking an ambitious 5-year mission to evaluate surficial geology and geologic hazards in up to 19 Alaskan coastal communities that are at risk for serious storm-wave erosion and flooding. 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. The Climate Change Hazards program performs geologic studies to identify high-risk areas where proactive mitigation efforts will be needed and useful for minimizing possible impacts. As part of this program, DGGS completed the first year of a multi-year glacier change and hydrology study of the upper Susitna drainage basin as part of pre-licensing studies for the Susitna–Watana Hydroelectric Project. The focus is on modeling the effects of future climate variability and change, permafrost thaw, and glacier wastage and retreat on runoff, and whether those changes will threaten the long-term viability of power generation by impacting the project's critical resource—the Susitna River. Additionally, Division expertise in the field of neotectonics (active faulting) is dedicated to identifying and understanding active

faults and earthquake hazards in developing areas of the state. The Active Faulting/Earthquake Hazards program is engaged in significant work in support of proposed infrastructure projects and makes major contributions to community tsunami hazards studies and collaborative projects with the U.S. Geological Survey and university researchers from across the country to study and understand the fault-related hazards in Alaska.

A 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 proposed gas pipeline corridors. The original purpose of this multi-year project was 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. This was largely complete by 2010, with a minor amount of additional field assessment in 2011–2013, and final reports and maps will be published in 2014. The scope of this project was expanded in 2009 to include the assessment of surficial geology and geologic hazards along all proposed natural gas pipeline routes statewide. With federal and State support, DGGS contracted for high-resolution LiDAR (Light Detection and Ranging) surveys of all the corridors in 2010–2011. Analysis of these data is ongoing, but has provided significant new insights into the surficial geology and hazards that will be incorporated into the final reports.

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 and hydrogeologic 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.

FY2014 Engineering Resources Projects

Detailed summaries for the following Engineering Geology projects appear in the section *Project Summaries—FY2014:*

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, and other proposed development projects, and respond to verbal requests for information from other State agencies, local government, and the general public.
- When appropriate, conduct post-event hazard evaluations in response to unexpected major geologic events (such as earthquakes and severe coastal flooding and erosion), 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 Section of DGGS is part of the Alaska Volcano Observatory (AVO), an interagency consortium that monitors, evaluates, and mitigates hazards from Alaska volcanoes. AVO was formed in 1988 by Memorandum of Understanding, and is a partnership between DGGS, the U.S. Geological Survey (USGS), and the University of Alaska Fairbanks Geophysical Institute (UAF/GI). Funding comes principally through the USGS. The Director of DGGS established Volcanology as a separate section in 2007.

AVO studies volcanoes to increase understanding of hazards at particular volcanoes and volcanic processes 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 reports. The vulnerability of local infrastructure to active volcanoes was illustrated by the near flooding of the Drift River Oil Terminal on the west side of Cook Inlet 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 a new 4,500-foot airstrip 15 miles downwind from Akutan volcano was opened in September 2012. The eruption of Pavlof volcano in May and June of this year caused flight cancellations in the region and ash fell on the communities of Sand Point, Nelson Lagoon, Cold Bay, and King Cove.

The three component agencies of AVO each bring particular strengths to the observatory while sharing general expertise in volcanology. Among these agencies DGGS has particular strengths in database management, web outreach, and geologic, petrologic, and geochemical studies. DGGS builds and maintains the AVO website, serving a large database of descriptive material about volcanoes, providing a cutting-edge system for intraobservatory 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 among volcano observatories worldwide, and portions of the software designed and written at DGGS are in use at other observatories, both nationally and internationally. Particular strengths of the USGS are the federal hazards mandate and direct ties with federal agencies. UAF/GI brings a research focus 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 through the USGS Volcano Hazards Program. In the past, additional funding has come through congressionally-authorized programs in other federal departments, including Transportation (DOT) and Defense (DOD), as well as the American Reinvestment and Recovery Act (ARRA).

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 in 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.

FY2014 Volcanology Projects

Detailed summaries for the following Volcanology projects appear in the section *Project Summaries—FY2014:*

- Volcanic eruption response: Cleveland, Pavlof, and Veniaminof volcanoes – p. 66
- Alaska tephra database – p. 67
- Holocene eruption history of Makushin Volcano – p. 68

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. DGGS assists in volcano monitoring when needed during responses to eruption events.
- 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. Having all the contracting done by a single agency results in significant budgetary and logistical efficiencies.
- Perform geochemical data procurement and archiving, coordinate geochemical analyses, and maintain the archive of those data. The 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 information technology, publication, and outreach services to make Alaska geologic and earth science information accessible to the public, private industry, government, and academia. 'GeoComm' team members work together to complete final design and production of reports and maps, maintain and upgrade the Division's digital geologic database, update and improve the DGGS website, and ensure the entire Division has the infrastructure (Geographic Information System [GIS] tools, network, computer equipment, etc.) and skills necessary to efficiently carry out their responsibilities.

The section's publications specialists and GIS analysts edit, design, publish, and distribute technical and summary reports and maps, generated by staff from the Division's technical projects, describing Alaska's geologic resources and hazards. The maps and reports released with the assistance of this group are the State's primary means of widely disseminating detailed information and data relating to Alaska's subsurface mineral and energy wealth, construction materials and water resources, and geologic hazards. These printed or digital-format documents and datasets focus on Alaska's most geologically prospective and developable 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 and job opportunities. Timely availability of geologic information from DGGS encourages investment in Alaska's economy, promotes wise land-use management, and helps mitigate the adverse effects of geologic hazards.

The section's geologic information center ensures that information produced by the Division on a wide range of topics, including mineral, energy, and water resources; and construction materials, earthquakes, volcanoes, permafrost, and other hazards; is delivered to the public. Information center staff assist customers in finding and understanding geological and geophysical maps, and manage sales and inventories of geologic reports, maps, and digital data. Staff also prepare displays for and represent the Division at geologic conferences and events.

The Geologic Communications Section produces this annual report, which presents a summary of Division activities and accomplishments; publishes newsletters to communicate Division progress and announce recent publications; designs, edits, and produces technical and educational geologic maps and reports in printed and digital formats; manages the DGGS library/ repository of printed literature so that reports (by DGGS and other agencies) are available as resources for geologic staff and visitors; and participates in or organizes outreach activities such as classroom presentations, science fair judging, and providing resources for teachers to help with preparing earth science learning units.

DGGS's digital geologic database has three primary objectives: (1) Maintain this spatially referenced geologic database system in a centralized data and information architecture with networked access for new DGGS geologic data; (2) create a functional, map-based, online system that allows the public to find and identify the type and geographic locations of geologic data available from DGGS and then retrieve and view or download the selected data along with national-standard metadata (http://www.dggs.alaska.gov/pubs/); and (3) integrate DGGS data with data from other, related geoscience agencies through a multi-agency web portal (http://www.akgeology.info/).

The Geologic Communications Section sets up and maintains microcomputer and server hardware and software, supports the Division's local area network, provides GIS services and training 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 FY98 to increase the availability of the Division's information and to provide worldwide access to 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 provided several years of support for an extensive effort to scan, convert to digital format, and post the entire hardcopy DGGS collection of publications on our website. The U.S. Geological Survey (USGS) 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 former U.S. Bureau of Mines, additional USGS publications, and publications produced by the Mineral Industry Research Laboratory (MIRL) at the University of Alaska Fairbanks.

The Geologic Communications Section is supported by the State general fund, program receipts from publication sales, and federal receipts.

Objectives

1. Timely dissemination of new, accurate, unbiased, Division-generated geoscientific data describing Alaska's geology, as well as selected pertinent geoscientific data from other sources, formatted and packaged to optimize ease-of-use and maximize compatibility with users' systems.
2. Preserve and manage the data and knowledge generated by the Division's special and ongoing projects in an organized, digital, readily-retrievable, and reproducible form consistent with applicable professional standards and documented with national-standard metadata.
3. Enhance public awareness of Alaska's prospective mineral, energy and water resources and geologic hazards.

FY2014 GEOLOGIC COMMUNICATIONS PROJECTS

Detailed summaries for the following Geologic Communications projects appear in the section *Project Summaries—FY2014*:

- Publications and outreach project – p. 76
- Geographic Information System (GIS) projects – p. 77
- Geologic Map Index of Alaska – p. 78
- Online map applications – p. 79
- Discovering online Alaska geophysical data: Airborne GeophysWeb – p. 80
- Website development and digital geologic database – p. 81

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 analyzed by government and private-sector geoscientists with the goal of improving 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 is supported by the State general fund 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 GMC holdings are a continually growing asset that is compounding in value over time at little cost to the State. Three Division geologists, a contract geologist, two student interns, and several volunteers staff the facility. The GMC has formal cooperative agreements with the U.S. Geological Survey, the U.S. Bureau of Ocean Energy Management, and U.S. Bureau of Land Management to house and control their geologic materials from Alaska. A volunteer 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 Alaska Department of Transportation & Public Facilities (DOT&PF), DGGS completed a concept study in 2006 for construction of a new materials center to replace the existing GMC facility. The State began to accelerate design and engineering work for a new facility in 2011 through a project managed by the Department of Administration (DOA) with support of Capital Improvement Project (CIP) funds, and in July 2013 officially acquired a building to house the new GMC (http://doa.alaska.gov/newsEvents/PR13-07-geologic-materials-center.html). DGGS managers, working with others in the Department of Natural Resources, DOA, ECI/Hyer Inc., and GMC staff, are working on preparations to move the current collection in late summer and fall 2014, with an opening date for the new facility slated for mid-September 2014. Access to the current collection will likely be severely limited during the two-month transition period. The new, 100,000-square foot facility will help safeguard the future accessibility and security of the valuable geologic samples currently stored at the GMC.

Please see a more detailed briefing summary for the GMC on page 82.

Objectives

- 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.
- Advance the knowledge of the geology and resources in Alaska's structural basins favorable for oil or gas discovery.
- Advance the knowledge of Alaska's mineral potential by making available representative samples of ores and drill cores from mineral deposits throughout the state.

ADMINISTRATIVE SERVICES

The Administrative Services group provides financial control and administrative support for all other projects in DGGS by: securing lowest costs for goods and services; coordinating maintenance for State equipment fleet vehicles, 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; providing mail/courier services; providing 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, CIP, 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; ensure progress reports and financial paperwork are submitted accurately and on time.
- Provide accurate, timely reporting of project expenditures and current balances to project managers; encourage prudent money management.

- Provide accurate, timely processing of employee timesheets, vendor 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 staff 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 most cost-effective travel options.
- Assist staff with personnel matters; inform staff of 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

GOOD-BYE

Bob Swenson received degrees in geology from the University of Montana, and the University of Wyoming in structural geology and tectonics. He began his geologic pursuits in Alaska in 1991 analyzing oil and gas resource potential in frontier areas of Alaska for ARCO, ConocoPhillips, and later as exploration manager for Denali Oil & Gas. Bob left the industry in 2004 to become deputy director of geologic research for the Department of Natural Resources and in 2005 became the Alaska State Geologist and Director of the Division of Geological & Geophysical Surveys. In this capacity, Bob led the geological research effort for the Department of Natural Resources, as well as serving on federal and state advisory boards that deal with energy and mineral resources and geologic hazards. Board appointments include: the Department of Energy Hydrates Research Advisory Board since 2009; UAF Petroleum Engineering Department Advisory Board; Climate Change Research Needs Advisory Group; Federal Geologic Mapping Advisory Board; Vice President, Association of American State Geologists; and the Western States Seismic Hazards Policy Council.

Bob recently accepted a new position as the Deputy Commissioner of Natural Resources and resigned his post at DGGS. As of December 2013, he will be overseeing the activities of the Division of Oil & Gas, State Pipeline Coordinator's Office, Mental Health Trust Land Office, Gas Pipeline Project Office, and the Division of Geological & Geophysical Surveys. As Bob puts it, "I am very happy to take on these new responsibilities for the state, but keeping my working relationship with DGGS is one of the more positive aspects of the job. I never want to lose my connection with the rocks, and the 'grounding' to reality that connection provides. I am very proud of the staff at DGGS, and what we have been able to accomplish over the last decade. The future looks bright for DGGS and Alaska, and I am very happy to continue my participation in efforts to address the challenges, and make good things happen for the state."

Rod Combellick retired from the State of Alaska in July 2013 after a geology career spanning 40 years, of which 32 were with the Division of Geological & Geophysical Surveys (DGGS). Rod joined DGGS as a graduate student intern in 1981, then as a Geologist III in 1982. He became chief of the Engineering Geology Section in 1987, Deputy Director in 2002, and served as Acting Director from 2003 to 2004. He earned a Bachelor of Science degree in Geology from the University of Washington and a Master of Science degree in Geology from the University of Southern California. His own project work with DGGS focused on Quaternary geology, engineering geology, and earthquake and tsunami hazards in Alaska. He helped establish the state Seismic Hazards Safety Commission, on which he served from 2005 to 2010. Rod was the Alaska geoscience delegate to the Western States Seismic Policy Council for more than 20 years.

In addition to occasional geologic work, Rod is looking forward to pursuing his long-time interests in flying, music (he plays classical organ), photography, fishing, bicycling, skiing, and volunteer work. He and his wife, Carolyn Comiskey, were married in 2010. They plan to stay in Fairbanks and do lots of traveling together. Rod has two grown children–Jennifer in San Diego, California, and Ryan in Fairbanks, Alaska.

After 30 years of service, geologist **Christopher Nye** retired in October 2013 from his position as chief of DGGS's Volcanology Section. Chris grew up in Vermont and went to grade school across the street and high school across the river. He first came to Fairbanks in early January 1973 and, other than a five-winter stint at UC Santa Cruz, has remained in Fairbanks. At UAF he earned a B.S. in Geology and an M.S. in Geology. His M.S. thesis involved mapping ~60-million-year-old volcanic rocks, in what was then Mt. McKinley National Park, under the direction of Wyatt Gilbert, a DGGS stalwart of the 1970s. Chris's Ph.D. thesis (UC Santa Cruz) revolved around detailed geochemistry and magma-genesis at two Alaska volcanoes, Wrangell and Okmok. Both volcanoes turned out to be archetypal in at least one major aspect of volcanism, and served as robust bookends for his growing shelf of diverse volcanological understanding.

In July 1983 Chris started his career with DGGS in the geothermal resource evaluation program, charged with folding the geologic perspective of volcano-hosted geothermal systems into the picture sketched by hot springs and their chemistry. His work was well underway when interrupted by 'The Great Alaska Budget Catastrophe of 1986.' A 50 percent drop in oil prices resulted in an 85 percent downsizing of DGGS—mostly through restructuring and, in Chris's case, layoff. He got married and moved himself and his geothermal project to the UAF Geophysical Institute. Unfortunately, the same drop in oil prices that had been catastrophic for the Alaska budget ultimately resulted in a national hiatus in alternative energy development—and the termination of funding for the federal programs that had supported the geothermal work.

At this point, Chris returned to DGGS to lead an EPA-funded study of indoor radon. This project used techniques new to Chris—a statistically representative statewide survey implemented using 10 telephone operators and thousands of pieces of mail. As the radon project was winding down in 1989, serendipity struck again—Redoubt Volcano erupted. Appropriately enough, Chris's twins were born in May 1990—the second major 'eruption' of that year—bringing a life change with a lasting, engrossing, and rewarding impact.

After the ash had settled, the 1989–1990 Redoubt eruption emerged as the second-most-costly eruption in U.S. history. Chris became the State of Alaska's representative to the newly created Alaska Volcano Observatory (AVO), which had been formed as a cooperative interagency program (USGS, UAFGI, DGGS) in 1988. With the Redoubt eruption, AVO's annual budget leapt from hundreds of thousands to millions of dollars, and the modern AVO was born. AVO has been busy ever since, monitoring more active volcanoes and more eruptions than any other volcano observatory on earth. Chris has led DGGS participation in AVO for the past 20+ years, and represented the state's interests among the federal and university interests that form the other legs of the three-legged stool that is AVO.

Chris has found myriad satisfactions in his job: Intellectual stimulation; societal relevance; an intriguing labyrinth of an organizational structure; time to study one of the few aspects of geology where the mantle-deep evolution of the planet acts on a human timescale; and the fantastic fun of exploding mountains. Within DGGS he found organizational flexibility and the autonomy that comes with sustained external support.

We wish the best for Chris and his family and are very happy to still have him here at DGGS as a volunteer—with finally no bureaucratic distractions from his focus on those projects he has been wanting to finish for lo these many years!

Vickie Butherus started working for the State of Alaska in 1991, and worked for the Division of Geological & Geophysical Surveys (DGGS) from 1997 through 2013 in a variety of positions, beginning as the Director's Secretary and ending as the Division's Administrative Officer. As Administrative Officer, Vickie was responsible for analyzing, coordinating, and planning the Division's budgeting, financial, and administrative activities. Vickie prepared and implemented the Division's annual Operating and CIP budgets to reflect the goals of the agency business plan, the Director's priorities, service goals, and financial and human resource needs. She developed budget strategies, made recommendations to the Division Director and program staff, provided personal services projections, and tracked expenditure trends. Vickie was the Division's chief contracting officer, responsible for preparing and overseeing grant proposal packages, purchase requisitions, invitations to bid, and contract documents. She also prepared quarterly financial reports for federally funded projects and oversaw reimbursable services agreements, grants, and contracts.

Vickie very much enjoyed her job at DGGS. She loved helping the Division staff and DNR coworkers in any way she could. She always went out of her way to be helpful, generous, and kind, and to share her cheer and good humor with everyone with whom she did business. She was a favorite among the staff.

Vickie's retirement plans include: Spending quality time with her children and grandchildren; doing some traveling and lots of hiking; and photography. Her first big retirement trip was a 17-day Dories trip down the Colorado River through the Grand Canyon—wouldn't you know she made it just before the federal government closed down! Two of her favorite vacation places are Denali National Park (where she's managed to take countless AWESOME photos of the park wildlife without being consumed), and Maui, Hawaii.

One of the first things Vickie did after retiring was sign up as a volunteer with a DGGS field project. She joined the Coastal Hazards team in Gambell and Savoonga to make sure they were well-fed (she cooked them three meals a day!), watched over, and offered a healthy daily dose of good cheer. She was a standout as a camp hand, and is sure to be in high demand on future field projects.

We wish Vickie as much fun in retirement as she provided to us while we had the privilege of working with her. And she can come make cinnamon rolls for our field crews any time she wants.

WELCOME

Paul Betka joined DGGS in June 2013 and is working as a structural geologist with the Energy Resources Section. Immediately after starting, he participated in his first Alaska field season and spent five weeks mapping part of the Iniskin Peninsula for the Cook Inlet forearc basin program. After the summer field program Paul returned to Austin, Texas, where he finished his Ph.D. in Geosciences at the University of Texas in December 2013.

Paul grew up in Grand Rapids, Michigan. He attended college at Virginia Tech and earned a B.S. in Geology in 2006. His interest in the geosciences stemmed from taking an introductory geology course as a freshman in college, knowing that he wanted to be in a field that would keep him outdoors for his career, and having an intrinsic fascination for mountains. After completing his degree at Virginia Tech, which included participating in summer field courses in coastal Maine and the American southwest, he knew that he picked the right field. Paul continued on to pursue an M.S. in Geology at the University of Vermont, where his thesis research involved understanding the significance of ductile extensional shear zones that form in the lower crust. He studied natural examples of such shear zones where they are exposed in Fiordland, New Zealand. After finishing his M.S. in 2008, Paul went to the University of Texas to begin his Ph.D. research studying the Patagonian fold-thrust belt in southern Chile. Having returned to Fairbanks, he is looking forward to studying the impressive and complex geology of Alaska. When not working on geology, Paul enjoys hiking, riding his bike(s), skiing, traveling, and having a good time with friends.

Ronald Daanen joined DGGS's Engineering Geology Section in July 2013 to develop and lead the division's new Hydrogeology Program. He is a cold-climate hydrologist with research interests in permafrost and vadose zone physical, chemical and biological processes, including vegetation and microbial interactions, coupled heat and moisture transfer with phase change, redox processes, and plant nutrition. He is studying hydrology-related topics throughout Alaska, where permafrost is a key component. He also focuses on permafrost slope stability in response to a warming Arctic.

Originally from Holland, Ronnie is married and has twins who were born in Germany, where his wife is from. The family spent seven years in Minnesota, where Ronnie earned his Ph.D., then moved to Alaska in 2004 so Ronnie could join the faculty at the University of Alaska Fairbanks. Ronnie likes Alaska very much, especially the nice view of the Alaska Range and Denali.

Alex Gould joined DGGS's Engineering Geology Section in July 2013 as part of the Coastal Science Program. As a geologist, he assists in coastal vulnerability assessments for communities in Alaska. The 2013 field season involved Quaternary mapping, GPS surveying, sample collection, and documenting rates of shoreline retreat. His other responsibilities include sample preparation, GIS database creation and management, and remote sensing imagery processing and interpretation.

Alex attended Colorado College and graduated in 2011 with a B.A. in Geology. As part of his studies, he assisted with research in a variety of fields including seismology, paleoseismology, sedimentology, and stratigraphy. After graduating he spent time traveling, working for the U.S. Forest Service as a hydrologist, and as a technician in a geochemical lab.

During his free time, Alex enjoys snowboarding, climbing, paddling, and exploring the Alaska backcountry.

Steve Masterman arrived in Alaska in June 1983 and has made it his home for most of the past 30 years. He earned a BSc in Mining Geology from the Royal School of Mines, Imperial College of Science and Technology, London, and a MSc in Geological Engineering from the University of Alaska Fairbanks. Prior to 2004 all his experience was in mineral resources, primarily gold, working on projects ranging from generative exploration in Alaska to near-mine exploration in Peru and mine geology in Nevada. He made many friends Outside but found the longing for home too strong to resist. So, in 2004 he returned to Fairbanks from Nevada and joined the State of Alaska's Department of Transportation where he worked as Regional Engineering Geologist until joining DGGS this past summer as Division Operations Manager.

Steve married Sarah in 1995 and they have two great children and live in a home they built. They have a wide circle of friends and love living the Alaskan lifestyle.

Geologist **David Reioux** joined DGGS's Mineral Resources section in March 2013 to work on the Strategic and Critical Minerals project, specifically to assist in the completion of a statewide, digital geochemical database of strategic and critical minerals. He also participated in the Styx and Wrangellia field projects. David's duties during the field season included geologic field mapping and sample collection, GIS database creation and management, sample preparation, and sample processing.

David grew up in northern California, where his passion for geology grew as he explored the gold country in the Sierra Nevada Mountains. He attended California State University, Chico, where he received his B.S. in Geology. After graduating from California State University he enrolled at the University of Montana in Missoula, where he is currently working on his M.S. in Geosciences with a focus on metamorphic petrology.

In his free time David enjoys exploring the outdoors, hiking, camping, hunting, and fishing.

Shelly Showalter joined the Division of Geological & Geophysical Surveys (DGGS) as its Administrative Officer in April 2013. Shelly spent her childhood in Lancaster County, Pennsylvania, in the heart of Amish and Mennonite country. In 1979 she met and married Russ Showalter, who promptly transported her to his hometown of Fairbanks, Alaska. She immediately fell in love with Alaska and has considered it her home ever since.

After fifteen years working with Russ to build their family business, Shelly returned to school, and by 2004 had earned an Associate Degree, as well as Certificates in Organizational and Public Management, from the University of Alaska Fairbanks. Sign language fascinated her during her studies at UAF and she soon acquired the skills to work as a signing aide for the North Star Borough School District and later as the Operations Manager for Deaf Community Services. In 2001 Shelly began her career with the State of Alaska as an Administrative Clerk II with the Department of Corrections, and was the Business Manager for the Fairbanks International Airport from 2011 until she came to DGGS in 2013.

When Shelly is not working she enjoys spending time with her three sons and their spouses and children, traveling, photography, fishing, camping, and scrapbooking and quilting with friends, as well as baking and knitting during the long winter nights.

Karri Sicard joined the Mineral Resources Section of DGGS in January 2013 as a Geologist III with a focus in mapping and structural geology. She is filling a permanent position and immediately jumped into managing the Styx River geologic mapping project for her first field season in Alaska.

Karri grew up in the Green Mountains of Vermont. She earned her undergraduate degree in geology from Colorado College, in Colorado Springs, where she developed a keen interest in field work through the College's unique Block Plan—taking one class at a time. Her enthusiasm for geology grew through countless field trips studying the geology of the American Southwest both as a student and as a Paraprofessional for the Geology Department following graduation. During the summers she mapped in the high country of Colorado with the Colorado Geological Survey, contributing to the Dakan, Climax, and Minturn quadrangle maps. Moving north to Laramie, she attended the University of Wyoming, where she received her Master's degree in December 2012. Her thesis project involved mapping in the Ruby–East Humboldt Range in Nevada where she studied the evolution of the metamorphic core complex through thermobarometry, geochemistry, structural analysis, and petrography.

Karri loves traveling and being active outdoors—hiking, biking, skiing, kayaking, camping, and generally exploring throughout Alaska. She also enjoys pursuing creative outlets such as baking, brewing, knitting, crocheting, and crafting.

Ellie Spangler joined DGGS's Engineering Geology Section in January 2013 to revise surficial-geologic maps along the Alaska Highway between Delta Junction and the Canada border as part of preparation for the Gas Pipeline corridor project final, comprehensive report. Ellie has also supported other DGGS projects such as geologic mapping of frozen debris lobe catchments along the Dalton Highway corridor, assisting in a landslide hazard investigation near the Yukon River bridge, and assisting in a geologic hazards assessment along a segment of a proposed natural gas pipeline from Livengood to Prudhoe Bay. In addition to working for DGGS, Ellie has worked as a hydrologic technician for the U.S. Forest Service and as a research assistant at California State University, Chico, and spent a year mapping in the Olympic Peninsula of Washington as a geologist for the Washington Department of Natural Resources.

Born and raised in northern California, Ellie spent much of her youth camping and hiking in the Sierra Nevada mountains. In 2004 Ellie moved to Chico, California, where she attended California

State University, Chico. She graduated in 2008 with a B.S. in Geology. Ellie then moved to Missoula, Montana, to pursue a graduate degree at the University of Montana. For her master's research she conducted a sedimentologic and stratigraphic study of a sandstone unit in the Upper Cretaceous Eagle Formation in south-central Montana. Ellie earned an M.S. in Geosciences in 2012.

In her free time, Ellie enjoys cooking, baking, and spending time outdoors participating in activities such as running, hiking, camping, fishing, and gardening.

Evan Twelker began work as a geologist with the Mineral Resources Section's bedrock mapping group in January 2013. A native of Fairbanks and Juneau, Evan left home to experience the east coast at Middlebury College, but upon graduation returned to Alaska to study economic geology with Professor Rainer Newberry at the University of Alaska Fairbanks. In 2007 he completed his Master's degree research on the Copper Canyon copper–gold porphyry deposit in northwestern British Columbia.

During ten field seasons in the minerals industry Evan has had the opportunity to work throughout Alaska and to contribute to some of the state's most significant projects. After an internship at the Greens Creek Mine he did copper porphyry reconnaissance around the Pebble deposit, gold exploration on the Seward Peninsula, and detailed interpretation and structural analysis of the intrusion-related gold system at Livengood. Most recently Evan worked for NovaGold Resources Inc. and NovaCopper Inc. in the southwestern Brooks Range, where he was involved in geological modeling of the Arctic volcanogenic massive sulfide deposit and the discovery of substantial new high-grade copper resources at Bornite.

In addition to summer fieldwork, Evan and his girlfriend, Fleur, also a field scientist, enjoy a good "busman's holiday" hiking, floating, or skiing around Alaska. The novelty of Fairbanks in January having worn off, the pair make an effort to explore the remote corners of warmer climatic zones each winter.

Erin Whorton joined DGGS in August 2013 as a Geologist I with the Climate and Cryosphere Hazards Program to assist with glacier runoff studies in support of the Susitna–Watana Hydroelectric Project. Born and raised in Washington state, Erin first encountered Alaska's glaciers as a participant in the Juneau Icefield Research Program while earning her bachelor's degree in geology from the University of Washington. Inspired by this experience, she pursued a master's degree at UW focused on polar glacier ice dynamics, and participated in two field expeditions to Antarctica.

After graduating in 2008, Erin joined a small geologic consulting firm as a wellsite geologist specializing in unconventional hydrocarbon reservoir exploration. As a liaison between the geologic and drilling engineer teams, her primary responsibilities were to geosteer horizontal wells using a variety of formation evaluation techniques. She later successfully applied this knowledge to solution mining muriate of potash in Utah.

In her free time, Erin travels extensively and enjoys climbing, mountain biking, sailing, and hiking in new places with friends and family.

Alicja Wypych joined the Division of Geological & Geophysical Surveys (DGGS) in November 2013 for a non-permanent position as a Geologist III in the Mineral Resources Section. She grew up in Poland, where she completed her Master's degree in metamorphic petrology. Her Master's thesis focused on contact of mafic dikes with varying facies of metamorphic rocks from Wedel–Jarlsberg Land (Spitsbergen), to determine the degree to which relatively small basaltic injections can change already metamorphosed wall-rocks. This work gave her an excellent opportunity to experience fieldwork in an Arctic environment on Spitsbergen (and see polar bears in the wild).

Alicja's adventures in the U.S. started in 2007, when she moved to Oxford, Ohio, to pursue a Ph.D. in igneous petrology at Miami University. She worked on petrology, geochemical and isotopic composition, and field relations of high-silica rhyolites from the Idaho–Oregon–Nevada region to better understand the processes controlling the formation of continental crust.

Alicja's tasks at DGGS include petrographic and petrologic studies of metamorphic and igneous rock (both types are her favorites) and interpretation of geochemical data to better understand petrogenesis of strategic and critical minerals across Alaska, especially platinum–palladium–nickel (Pt–Pd–Ni) deposits in the Talkeetna Mountains and as and rare-earth-element deposits elsewhere. She will also assist with the completion of geologic mapping projects including the Styx River project, and is excited about joining the group for the field season in the Talkeetna Mountains next summer!

In her free time, Alicja loves to hike and visit new places (either nature or cities), she polishes her marksmanship skills (not quite league status yet, but she is determined to achieve that level), and when she is not outdoors she enjoys reading a good book, crocheting, or solving Sudoku.

PROJECT SUMMARIES—FY2014

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 49 projects that DGGS is pursuing in FY2014 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 arrangements so that the Division's work provides the greatest possible benefit from the public's investment.

ENERGY RESOURCES

MINERAL RESOURCES

ENGINEERING GEOLOGY

VOLCANOLOGY

GEOLOGIC COMMUNICATIONS

GEOLOGIC MATERIALS CENTER

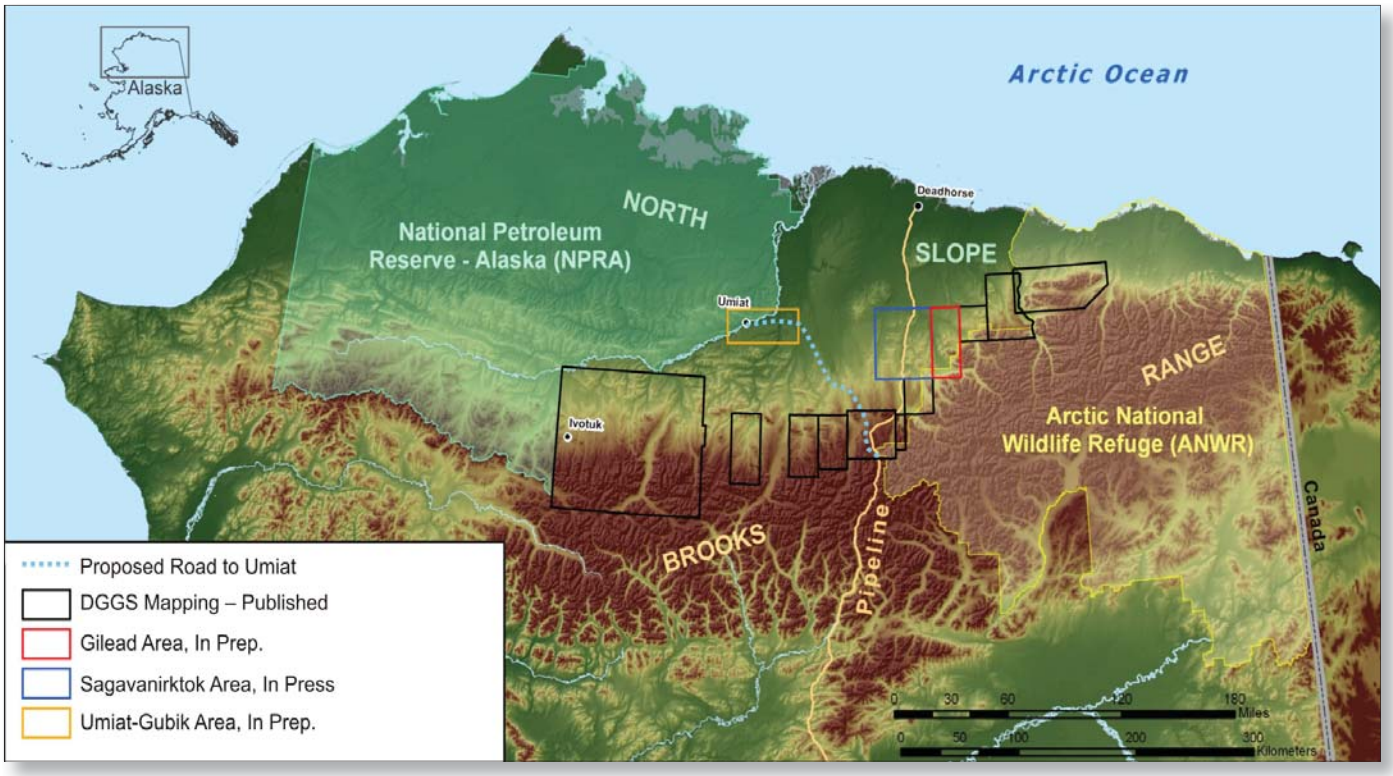
BROOKS RANGE FOOTHILLS AND NORTH SLOPE PROGRAM

Northern Alaska is a world-class petroleum province that includes some of the most prospective onshore regions remaining in North America. Despite this potential, the North Slope remains underexplored relative to other sedimentary basins around the world. New exploration ventures are hampered by the limited amount of published geologic data, much of it reconnaissance in nature. This problem is particularly acute for smaller companies with limited access to proprietary industry data. In an effort to stimulate exploration for hydrocarbons in northern Alaska, the Alaska Division of Geological & Geophysical Surveys (DGGS) developed a program to acquire and publish high-quality geologic data to improve our understanding of regional petroleum systems and entice new exploration investment. 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 U.S. Geological Survey (USGS), the University of Alaska Fairbanks (UAF), and others.


Cretaceous deltaic sediments along the Colville River--an analogue for potential subsurface reservoirs

DGGS regularly conducts bedrock geologic mapping as an integral component of the Brooks Range Foothills and North Slope mapping program (see map). Our long-range objective is to eventually produce a contiguous series of detailed geologic maps along the entire foothills belt, thereby establishing the regional geologic framework necessary to understand the evolution of the petroleum system. Our work also includes examination of the sedimentology and stratigraphy of key Cretaceous-age reservoir and source-rock intervals, providing new constraints on the depositional history and correlation of units. Over the last several years we have also collaborated closely with DOG to interpret available seismic and well data on the North Slope. The integration of our surface structural and stratigraphic observations with subsurface data has allowed for an improved understanding of basin evolution and regional exploration potential.

Two new 1:63,360-scale geologic maps will be published through DGGS in the upcoming year as well as a collection of papers summarizing recent structural and stratigraphic studies.



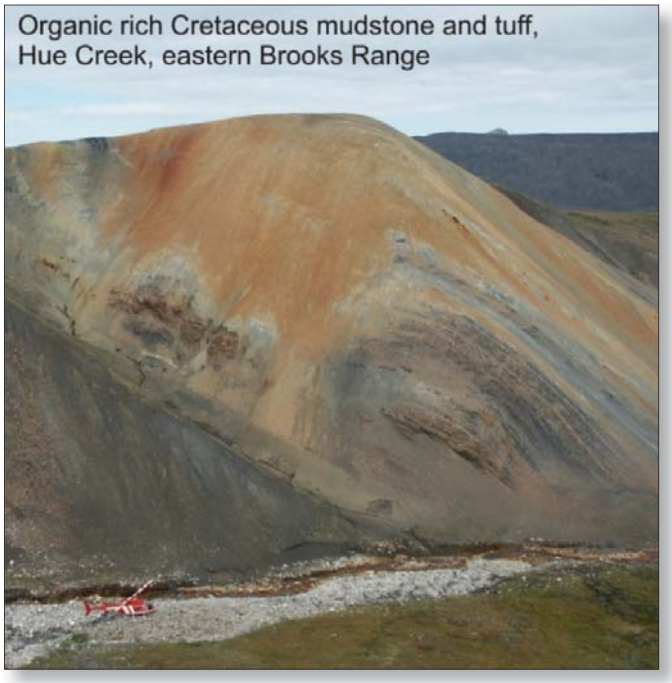
Contact: Marwan A. Wartes, 907-451-5056, marwan.wartes@alaska.gov

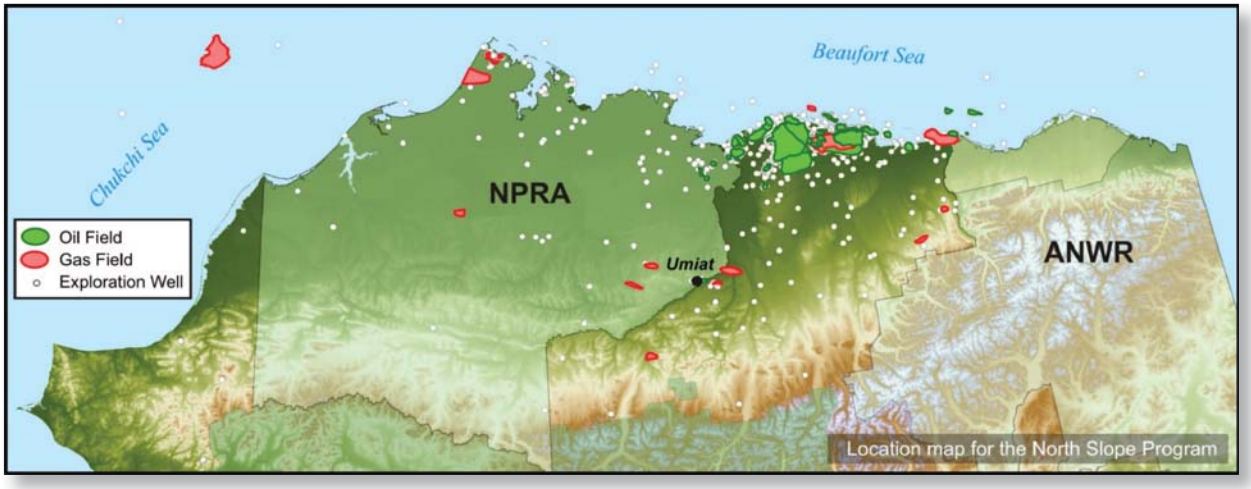
FRAMEWORK GEOLOGY OF PROSPECTIVE NORTH SLOPE SHALE OIL TARGETS

North Slope oil production is in decline as the main conventional fields mature, highlighting the need for new exploration and production (see map). Maturing petroleum basins in the Lower 48 have recently been rejuvenated by the advent of shale oil and shale gas exploration. The North Slope petroleum system includes three excellent organic-rich source rock intervals—a characteristic that is required for the successful creation of shale oil accumulations. Although the play is unproven in Alaska, industry has recently recognized its potential, as indicated by their investment in expansive lease tracts of prospective State-owned acreage south of the producing areas.

The main source rock of interest in northern Alaska is the Upper Triassic Shublik Formation (see photo), an interval known to have generated the oil that migrated into many of the conventional accumulations on the North Slope. The overlying Lower Jurassic Kingak Formation is also recognized as an oil-prone source, particularly the condensed basal part of the unit. Finally, the Cretaceous Hue Shale (see photo) includes significant organic-rich mudstone deposited in distal parts of the Colville foreland basin.

Numerous geologic factors influence the productivity of shale oil systems. Organic geochemical properties, thermal and tectonic history, porosity and permeability characteristics, and mechanical properties (brittleness) can each control whether the resource can be commercially produced. These key characteristics are poorly understood on the North Slope. In order to contribute to an improved understanding of this prospective hydrocarbon play, the Alaska Division of Geological & Geophysical Surveys (DGGS) recently initiated a collaborative study with the University of Alaska Fairbanks and the U.S. Geological Survey to evaluate the geology of targeted shale oil units. This project aims to acquire key subsurface and surface data, including the collection of a diverse suite of samples for laboratory analysis.





Contact: Marwan A. Wartes, 907-451-5056, marwan.wartes@alaska.gov

COOK INLET GEOLOGY AND HYDROCARBON POTENTIAL

The Alaska Division of Geological & Geophysical Surveys (DGGS) has led a multi-agency program of applied geologic research in Cook Inlet basin since 2006 to promote new petroleum exploration investment and support responsible resource and land-use management. The program was developed in response to predicted deliverability shortfalls for Cook Inlet gas supply to south-central Alaska customers and significant declines in oil production in recent decades that pose potential threats to the region's economy. This collaborative effort involving DGGS, the Alaska Division of Oil & Gas (DOG), the University of Alaska Fairbanks, and the U.S. Geological Survey relies heavily on performing detailed field studies to develop a better understanding of the basin's hydrocarbon system.

Historically, Cook Inlet exploration has focused on locating conventional plays in structural traps in younger, shallower Cenozoic rocks. Most of these large, relatively shallow structures have been found and tested, but the older, deeper Mesozoic strata that underlie the basin and contain Cook Inlet basin oil source rocks remain virtually unexplored. One of the challenges facing new exploration of the Mesozoic petroleum system in Cook Inlet is the identification of reservoir rocks capable of hosting oil and gas.

Beginning in 2009, DGGS and DOG initiated field studies of Mesozoic rocks in lower Cook Inlet to improve understanding reservoir type and quality, and geologic and structural controls on Mesozoic depositional systems in the older parts of the basin.

Work in the Kamishak Bay and Iniskin Peninsula areas (figs. 1 and 2) focused on Jurassic- and Cretaceous-age rocks, both of which contained intervals that are oil saturated, indicating that they had sufficient conventional permeability and porosity to pass and retain liquid hydrocarbons in the past. Samples collected at both locations will help to identify the hydrocarbon source rocks and determine whether the sandstone composition or other factors were responsible for their enhanced reservoir quality. Continued stratigraphic and structural studies in the Iniskin Peninsula and Tuxedni Bay areas, including new geologic mapping of the Iniskin Peninsula in summer 2013, focused on how major geologic structures such as the Bruin Bay fault influenced the basin's stratigraphic architecture, which has implications for predicting the distribution of reservoir and reservoir seal lithologies. We are continuing fracture studies of Mesozoic rocks in the Kamishak Bay and Iniskin Peninsula areas to understand the stratigraphic and structural controls on their development and gather baseline data about unconventional fracture porosity and hydrocarbon migration pathways.

This project is funded by the State of Alaska and the U.S. Geological Survey, with contributions from industry. Results of this work have been documented in a series of publications available from the DGGS website (http://www.dggs.alaska.gov), including a recently published edited volume highlighting the significant findings from our 2012 field season (http://www.dggs.alaska.gov/webpubs/dggs/pir/text/pir2013_001.pdf). Additional publications will be released as they become available, beginning in early 2014.

Figure 1. DGGS geologist Trystan Herriott measuring the orientation of a Jurassic sandstone bed on a high bluff overlooking Cook Inlet as part of a geologic mapping project on the Iniskin Peninsula.

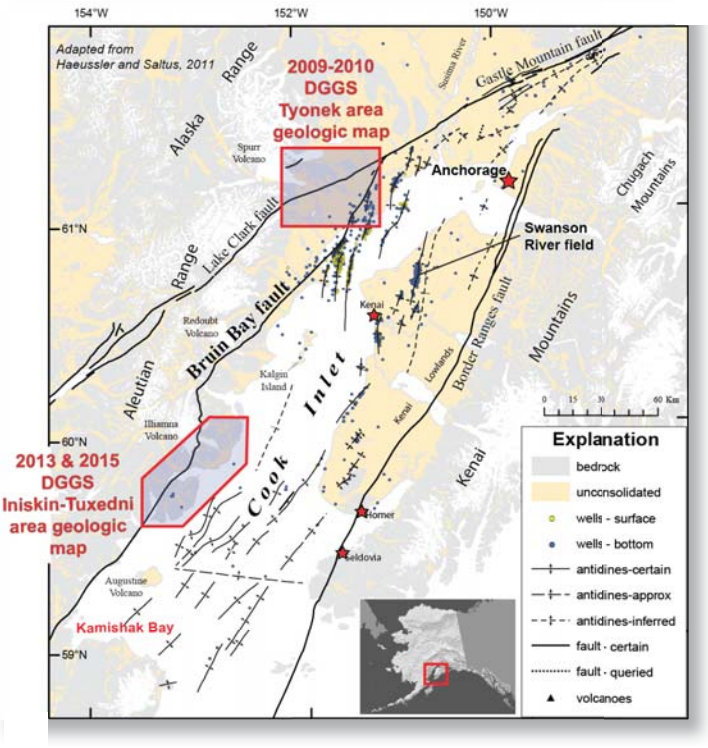


Figure 2. Generalized geologic map of Cook Inlet basin. Modified from Haeussler and Saltus, 2011, U.S. Geological Survey Professional Paper 1776-D.

Contact: Robert J. Gillis, 907-451-5024, robert.gillis@alaska.gov

GEOLOGIC MAPPING OF THE INISKIN PENINSULA, LOWER COOK INLET

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, Cook Inlet basin remains underexplored. The Division of Geological & Geophysical Surveys (DGGS) is responding by conducting a program in the basin focused on understanding how sediment composition, stratigraphic architecture, and geologic structure control potential conventional and unconventional (tight) reservoir systems (see briefing paper, facing page). This program includes detailed geologic mapping in Cenozoic and Mesozoic stratigraphic intervals where outcrop relations are complex, poorly understood, and important for understanding the potential for gas reservoirs.

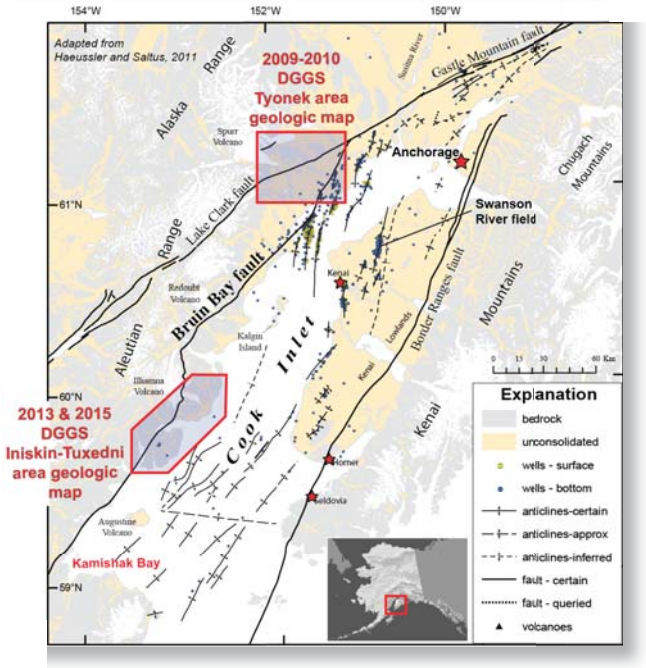


Figure 1. Regional map of the Cook Inlet region, showing the locations of previous and current DGGS geologic mapping projects in the Cook Inlet basin.

During summer 2013 DGGS, with help from the Division of Oil & Gas (DOG), completed 1:63,360-scale geologic mapping of approximately 260 square miles on the Iniskin Peninsula (fig. 1). This work represents the first year of a multi-year project to re-map the stratigraphic and structural relationships of the Mesozoic forearc basin interval from Iniskin Bay northeastward to Red Glacier by 2015. The Iniskin Peninsula area (fig. 2) hosts numerous oil seeps and was the site of some of the earliest oil exploration in Alaska from the early 1900s to the 1950s, but has remained idle since. A more thorough geologic understanding of the region is important because the entire Mesozoic stratigraphy, including the oil source rocks to the Cook Inlet basin, is well exposed in this region, yet reconnaissance work by DGGS in the area since 2009 suggested that the original mapping conducted five to six decades prior is in need of significant revision. Our new mapping is guided by nearly 20 new measured stratigraphic sections, new geochronology, and kinematic structural analysis, some of which will be detailed in a series of short progress reports published in early 2014. The final published product will be a new 1:63,360-scale geologic map encompassing approximately 500 square miles along the northwestern margin of Cook Inlet basin, and an accompanying report. 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. Our work in this area will help spur exploration interest and investment in Cook Inlet basin.

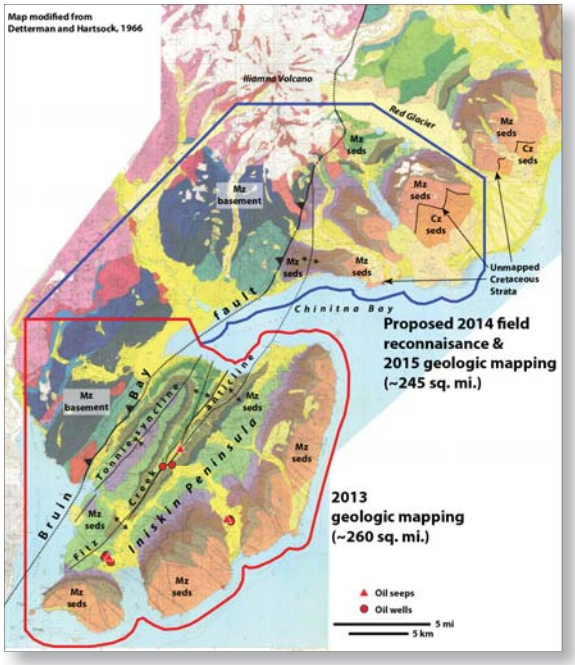


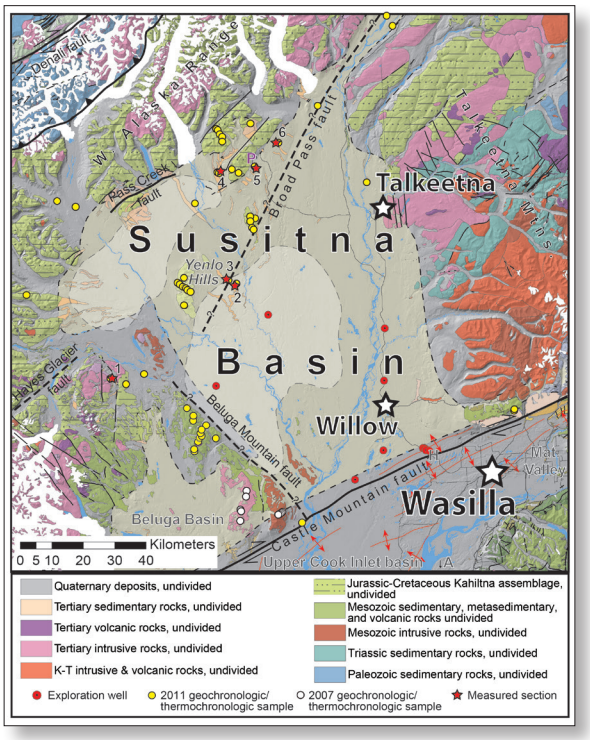
Figure 2. Locations of 2013 geologic mapping (red outline), and proposed geologic reconnaissance and mapping in 2014 and 2015 (blue outline).

Preliminary 2013 mapping was completed with partial funding from the U.S. Geological Survey's STATEMAP program; a preliminary map of the Iniskin Peninsula will be submitted to the USGS in spring 2014. Preliminary results from related stratigraphic and structural studies will be published as DGGS reports starting in early 2014.

Figure 3. DGGS geologist Marwan Wartes conducting field geologic mapping of a stratigraphic contact in Naknek Formation rocks on the Iniskin Peninsula (2013).

Contact: Robert J. Gillis, 907-451-5024, robert.gillis@alaska.gov

NATURAL GAS POTENTIAL OF THE SUSITNA AND NENANA BASINS



Geologic map of the Susitna basin region, showing sample collection locations and proximity of the potential gas-prospective basin to major population centers such as Wasilla.

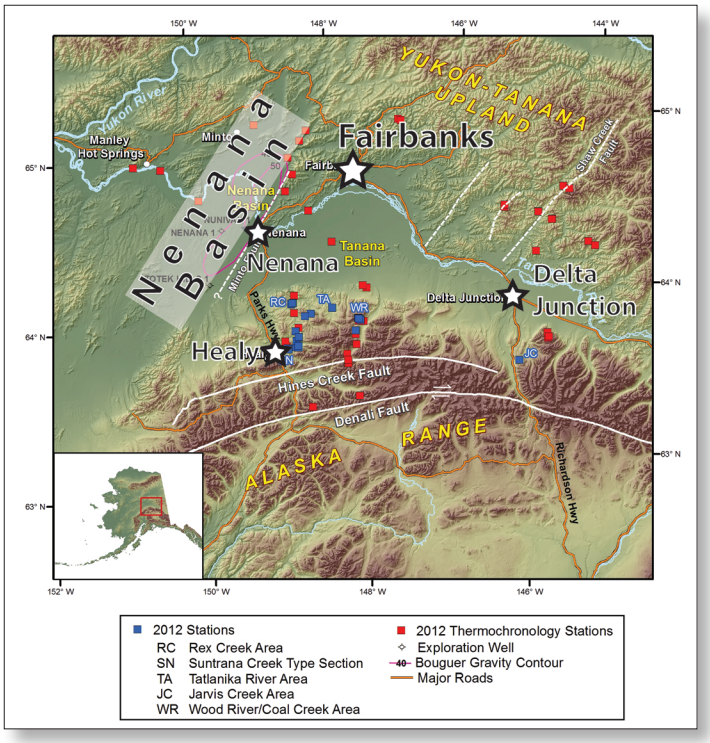
Alaska faces significant future challenges in supplying reliable, affordable domestic energy to a large percentage of the state's population, particularly in rural areas and interior regions. This is because adequate energy sources at reasonable cost have not been identified to serve domestic needs over the next few decades. These challenges can be mitigated by looking for local resources that have the potential to supply more affordable energy for nearby consumption.

The Alaska Division of Geological & Geophysical Surveys (DGGS) in collaboration with the Alaska Division of Oil & Gas (DOG), has responded to these challenges by reviewing publicly available data on sedimentary basins throughout Alaska to identify those whose geology suggests significant natural gas potential (see http://www.dggs.alaska.gov/webpubs/dggs/sr/text/sr066.PDF).

We have identified the Susitna basin in south-central Alaska and the Nenana basin in interior Alaska as having significant gas potential to help meet in-state needs based on geological grounds and proximity to infrastructure (figs. 1 and 2). However, neither of these basins has been adequately explored and little geologic data exist to help attract exploration interest. Basin analysis projects have been initiated in each basin aimed at better understanding the possible presence of functioning petroleum systems. Preliminary fieldwork has been completed in each basin, including progress reports published in 2013 (see http://www.dggs.alaska.gov/webpubs/dggs/pir/text/pir2013_004.pdf and http://www.dggs.alaska.gov/webpubs/dggs/pir/text/pir2013_002.pdf).

The Susitna basin (approximately 5,000 square miles) is thought to host some of the same gas-producing rocks as the neighboring Cook Inlet basin. DGGS and DOG studied and described stratigraphic exposures at several locations in the basin and collected more than 250 samples for various analyses related to evaluating reservoir quality and geologic development of the region. The Nenana basin lacks exposures of potential hydrocarbon-producing rocks at the surface, but the rocks in the subsurface are thought to be correlative to stratigraphy of similar age exposed in the foothills of the Alaska Range directly to the south. Similar to the Susitna basin, DGGS and DOG studied, described, and sampled selected stratigraphic intervals of these rocks at several locations during field studies in 2012. In addition, approximately 50 samples were collected from around the periphery of the Nenana and Tanana basins to develop a better understanding of how and when the basins began to form.

Additional fieldwork is scheduled in the Susitna basin in 2014, as well as compilation of publicly-available well data and additional analyses of well material from the recently drilled Nunivak wells in the Nenana basin.



Geologic map of the Nenana and Tanana basin regions, showing sample collection locations and proximity to Fairbanks and other communities.

Contact: Robert J. Gillis, 907-451-5024, robert.gillis@alaska.gov

STATE OF ALASKA 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 (http://www.stategeothermaldata.org/). This national project, involving all 50 states, is organized by the Association of American State Geologists and administered by the Arizona Geological Survey (fig. 1). The goal of the NGDS is to make large quantities of geothermal-relevant geoscience data available to the public and industry by creating a national, sustainable, distributed, and interoperable network of data providers. The state geological surveys develop, collect, serve, and maintain geothermal-relevant data as an integral component of NGDS. The project is digitizing at-risk, legacy geothermal-relevant data and publishing existing digital data by making state databases and directories available to the network.

Much of the risk of geothermal energy development is associated with exploring for, confirming, and characterizing 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 consolidating all geothermal data through a publicly-accessible data system, the NGDS supports research, stimulates public interest, promotes market acceptance and investment, and, in turn, supports the growth of the geothermal industry.

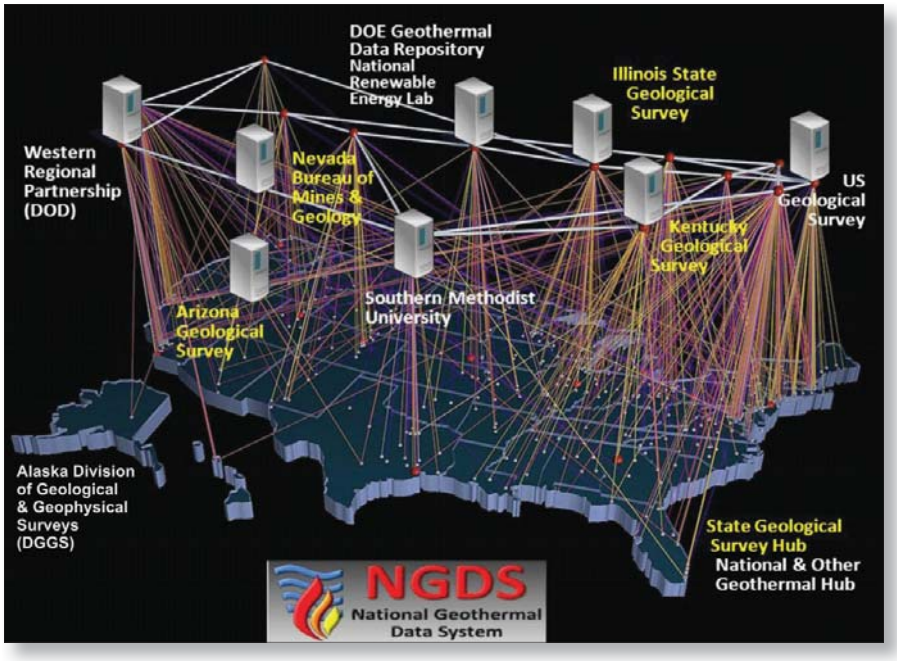


Figure 1. Fifty-state network of geothermal data providers to the NGDS, and the regional hubs (in yellow).

The Alaska Division of Geological & Geophysical Surveys (DGGS) is contributing Alaska 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. DGGS has submitted feature templates to the NGDS, contributing to the NGDS detailed information on Alaska's geothermal springs (97 sites), aqueous chemistry (815 analyses from 90 sites), Quaternary and younger volcanic vents (395), geothermal wells (122 wells drilled at nine sites), thermal profiles (239 profiles from 70 wells), bottom-hole temperature observations (from 338 oil and gas wells), direct-use applications of geothermal energy (15 sites), earthquake hypocenter data within 5 km of thermal springs (1,974 events), and a geothermal bibliography with 526 references. The project will culminate in the completion of a new ArcGIS-based Geothermal Sites of Alaska map that will incorporate shapefiles of all the related geothermal data sets submitted to the NGDS (fig. 2). This map will be available online for the public by spring of 2014.

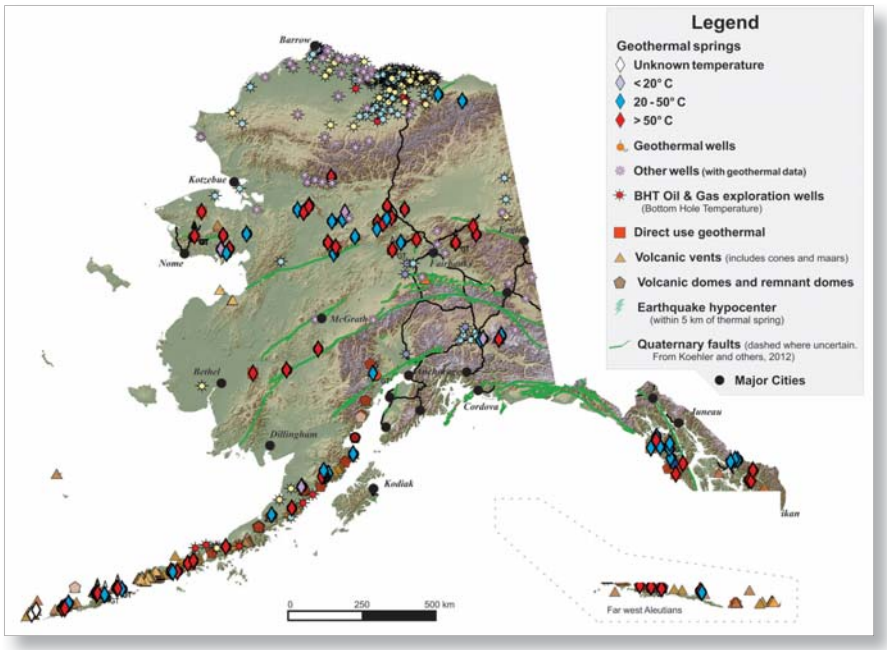


Figure 2. Preliminary draft of the new Geothermal Sites of Alaska map that will be available online in digital format.

Contact: James G. Clough, 907-451-5030, jim.clough@alaska.gov

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 website, 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 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 stratigraphic field data for previously described occurrences. Sometimes a coal occurrence described in 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.

We continue to submit coal samples collected by field crews conducting studies in both the Cook Inlet and North Slope coal provinces, for proximate and ultimate analyses. We focus only on thicker, potentially mineable coal seams that have not been sampled previously. During 2013 we conducted high-pressure gas adsorption analyses on well and outcrop samples from Cook Inlet, North Slope, and Nenana basins (fig. 1). This new data will provide information on the gas holding capacity and carbon sink potential for coal seams in these basins. The project continues to make progress rectifying for accuracy the legacy Alaska NCRDS data sent to DGGS by the USGS team.

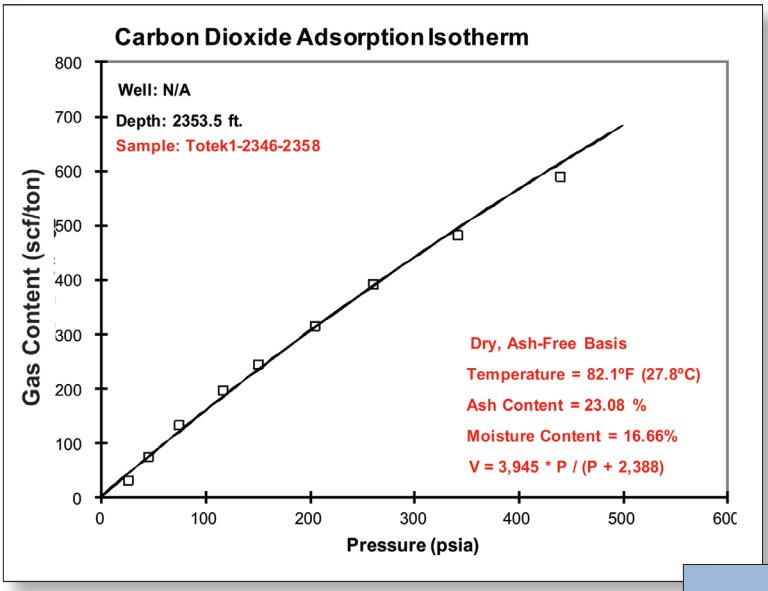


Figure 1. Example of carbon dioxide pressure isotherm from the Totek Hills well, Nenana basin, at a depth of 2,353 ft.

The database for Alaska coal quality and stratigraphic information continues to grow and we are incorporating these data and the appropriate GIS files into the new Coal Resources of Alaska GIS map. This new ArcGIS-based coal resources map of Alaska (fig. 2) meshes well with the NCRDS work by incorporating the coal data into a meaningful and useful format. The map contains compiled geology layers where available, and coal isopachs where calculated and available. We are also incorporating into this map the Alaska abandoned coal-mine inventory data, which has never before been available in a digital format. The new GIS map will allow for calculations of coal resources in areas with sufficient coal-thickness point-source data. This map will be completed at the end of the current 5-year NCRDS project in fall 2015. The final GIS map product will be posted on the DGGS website.

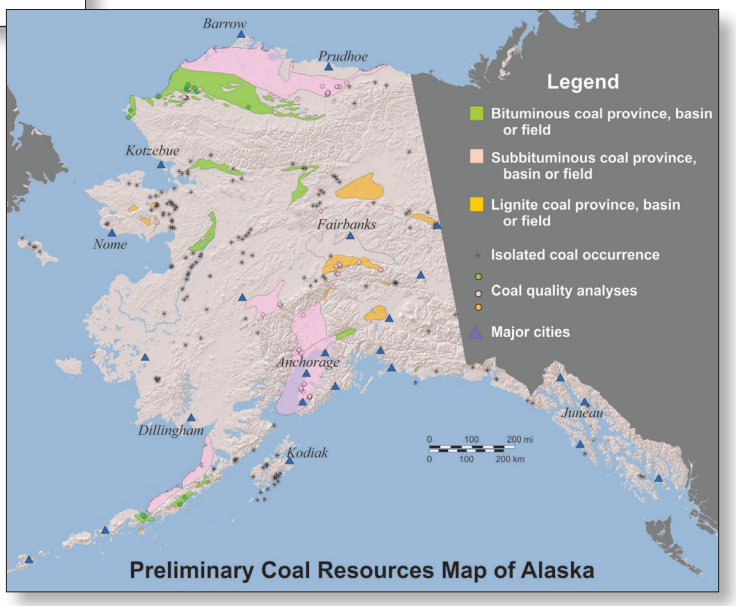


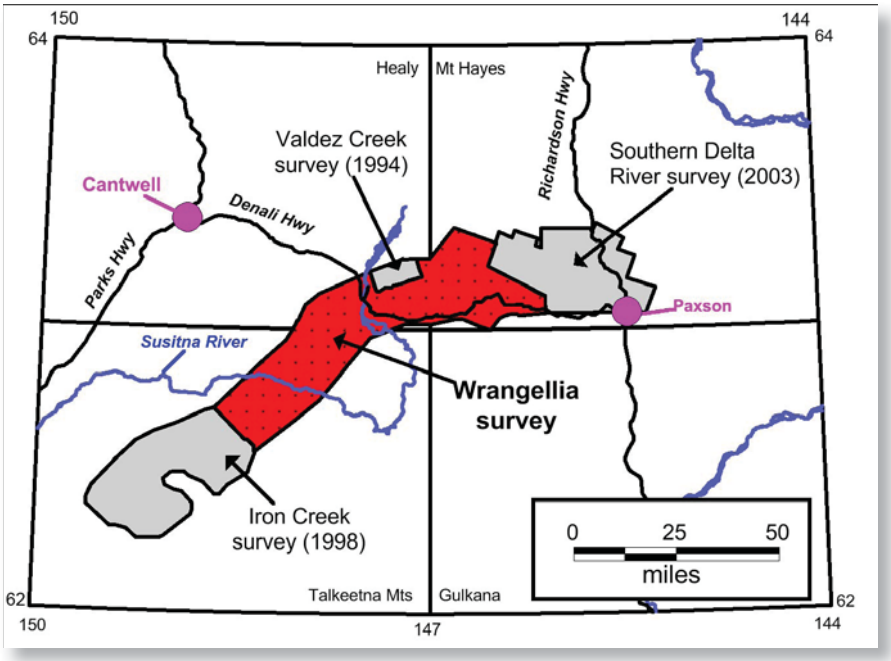
Figure 2. Preliminary draft version of GIS-based Coal Resources of Alaska map that displays coal provinces, basins, coal fields, and isolated coal occurrences and incorporates NCRDS coal quality point source data.

Contact: James G. Clough, 907-451-5086, jim.clough@alaska.gov

AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF WRANGELLIA, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys' (DGGS) 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 program 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 on the basis of 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.

As part of the state-funded AGGMI program, the Strategic and Critical Minerals Assessment Project is geophysically surveying 1,400 square miles in the Talkeetna Mountains, Healy, and Mount Hayes quadrangles, termed the Wrangellia survey (see figure). The survey area lies 150 miles north–northeast of Anchorage, and encompasses portions of the Clearwater Mountains, the Talkeetna Mountains, and lowlands of the Susitna and Maclaren river valleys. The new survey is adjacent to three surveys previously released by DGGS. The area is composed mainly of State lands, with lesser areas of BLM-managed State selected land, and minor amounts of Native and Native selected land. Geophysical information being acquired for the Wrangellia survey includes aeromagnetic and electromagnetic data. Millrock Exploration Corporation is contributing additional, privately funded airborne geophysical data to be combined and published with the DGGS survey.



The majority of the Wrangellia survey area is underlain by upper Paleozoic to Late Triassic sedimentary and volcanic rocks of the Wrangellia terrane. These strata are intruded by Late Triassic gabbroic to ultramafic dikes and sills; similar intrusions are associated with nickel, copper, and platinum-group-element mineralization where they have been explored in the Paxson area and at the Wellgreen prospect in the Yukon Territory. The survey also covers the Butte Creek placer gold mining area, underlain by Kahiltna Assemblage sedimentary rocks and Cretaceous to Early Tertiary granitic intrusions.

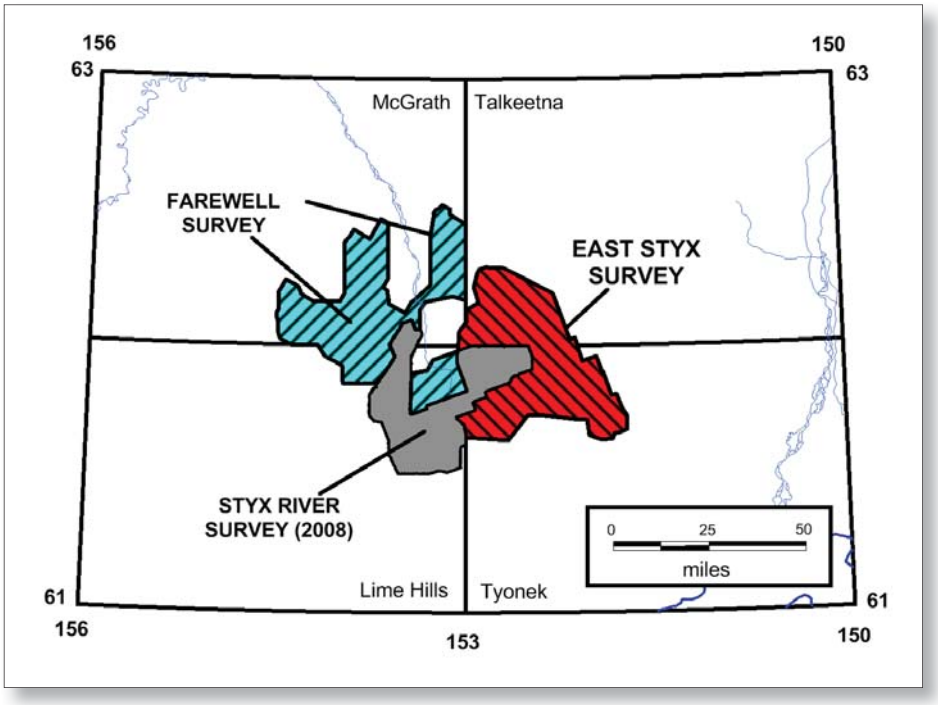
Airborne geophysical surveys enable users to delineate regional structures and identify metamorphic–stratigraphic lithologies and plutonic rock types on the basis of their geophysical characteristics. Follow-up geologic mapping tests geophysical anomalies and interpretations, and provides detailed documentation 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.

Maps and digital data will be released as DGGS Geophysical Reports by February 2014. A second publication, containing a project report, interpretation, and electromagnetic anomalies, is expected to be released by summer 2014. DGGS believes these data will lead to a better understanding of the geologic framework of the area and will stimulate increased mineral exploration investment in the survey boundary and the surrounding area.

Contact: Laurel Burns, 907-451-5021, laurel.burns@alaska.gov

AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE EAST STYX AREA, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is a special multi-year investment to expand the knowledge base of Alaska's mineral resources and catalyze private-sector mineral development. The program 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 Alaskans; and (3) will provide economic diversification to help offset the loss of Prudhoe Bay oil revenue. Candidate lands for this program are identified on the basis of existing geologic knowledge, land ownership, and responses to solicitations for nominations from Alaska's geologic community. Products resulting from this program generally include: (1) 1:63,360-scale aeromagnetic and airborne-electromagnetic maps; (2) 1:63,360-scale bedrock geologic maps; and (3) various other geological, geochemical, and geophysical data compilations. As a result of the AGGMI 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 state-funded AGGMI program, DGGS is geophysically surveying 1,052 square miles in the northwestern Tyonek, southwestern Talkeetna, and eastern Lime Hills quadrangles in 2013 and 2014 (see figure). The East Styx survey is centered about 95 miles northwest of Anchorage and is adjacent to the Styx River survey released in 2008. The East Styx area is State-owned land and is mostly in the Yentna mining district. Aeromagnetic, electromagnetic, and radiometric data are being acquired. These data will be released in 2014. A later publication will contain merged aeromagnetic and merged resistivity grids for the East Styx, Styx River, and Farewell surveys.

Reconnaissance geologic mapping suggests the area consists mainly of Juro–Cretaceous sedimentary rocks of the Kahiltna terrrane, mafic volcanic rocks of possible Talkeetna Formation (Jurassic), and numerous plutons of mafic to felsic composition of Cretaceous to Tertiary age. Tertiary coal-bearing sediments lie unconformably on the Juro–Cretaceous sedimentary rocks. Many prospects are present in the survey area and are thought to represent several different deposit types, including polymetallic veins, epithermal veins, and porphyry copper deposits. Many prospects are near the plutonic rocks. The structural history is complex and poorly understood.

Airborne geophysical surveys, in combination with detailed geologic mapping, provide a way to differentiate various rock units, especially distinguishing between granitic rocks and the various metamorphic rocks, and to delineate regional structures. 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. DGGS believes that geophysical and geological data, which lead to a better understanding of the geologic framework hosting identified and potential ore deposits in these districts, will stimulate increased mineral exploration investment in these belts of rocks and the surrounding areas, and will provide information useful for state resource management and land-use planning.

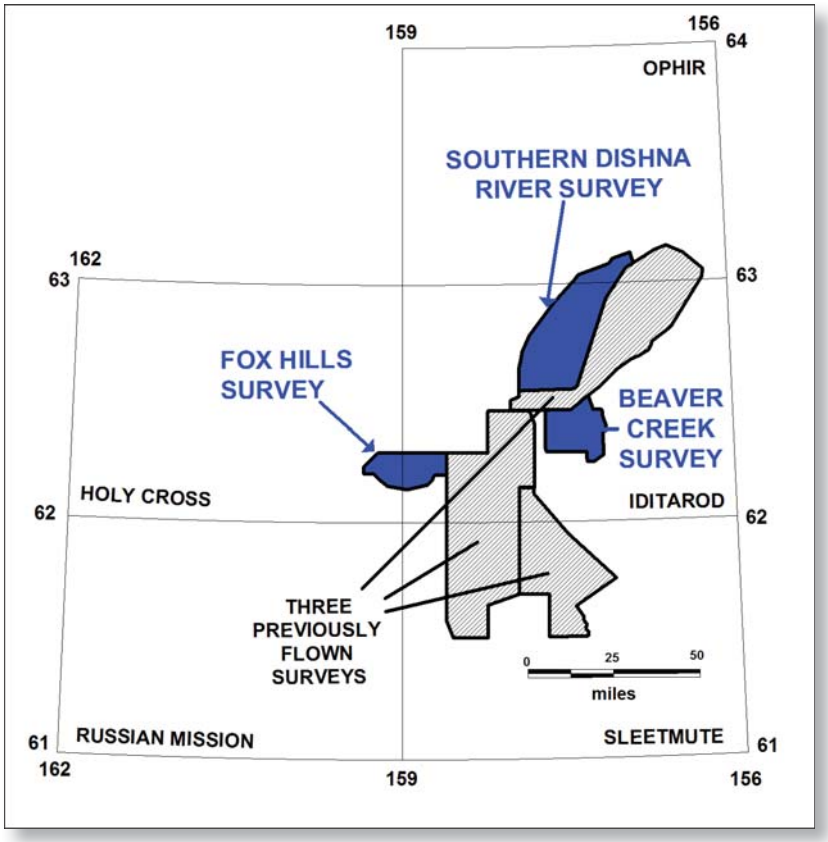
Contact: Laurel Burns, 907-451-5021, laurel.burns@alaska.gov

AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEYS OF SOUTHERN DISHNA RIVER, FOX HILLS, AND BEAVER CREEK AREAS, WESTERN ALASKA

The Alaska Division of Geological & Geophysical Surveys' (DGGS) 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 program seeks to delineate mineral zones on Alaska State-owned 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 on the basis of 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 State-funded AGGMI program, DGGS acquired airborne-geophysical data for three blocks in the Iditarod, Ophir, Sleetmute, and Holy Cross quadrangles in FY13 (see figure). The new blocks are adjacent to the previous Iditarod and Aniak surveys. The three areas of this survey total 1,029 square miles and are roughly centered on Flat, Alaska, about 85 miles southwest of McGrath and 275 miles west–northwest of Anchorage. Two-thirds of the area is State-owned land, and the remainder is Federal land. Most of the survey area is part of the Iditarod and 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 33 million ounces of gold associated with a Late Cretaceous dike swarm at the Donlin gold deposit, south of the area in the western Sleetmute Quadrangle, has kept mineral exploration activity high in the region.

Like the Donlin gold 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 on the basis of 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.

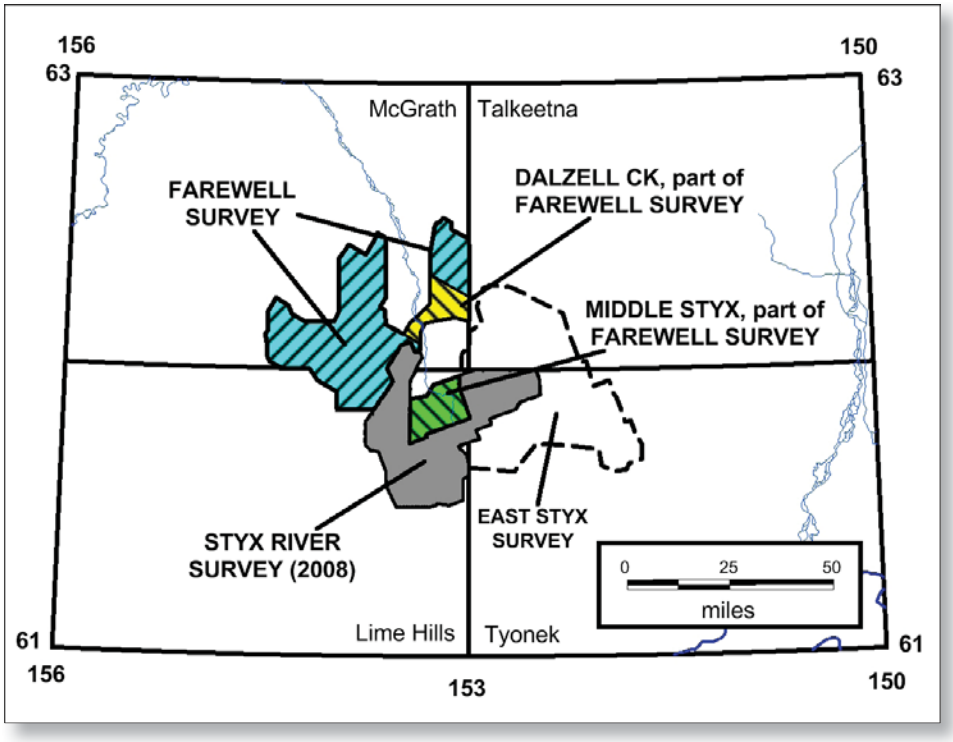
Geophysical information being acquired for these three areas includes aeromagnetic and electromagnetic data. Processed digital data and maps acquired for these three areas were released as DGGS Geophysical Reports in November 2013. A second publication, containing a project report, interpretation, and electromagnetic anomalies, will be released in mid- to late 2014. 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.

Contact: Laurel Burns, 907-451-5021, laurel.burns@alaska.gov

AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE FAREWELL AREA, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is a special multi-year investment to expand the knowledge base of Alaska's mineral resources and catalyze private-sector mineral development. The program 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 Alaskans; and (3) will provide economic diversification to help offset the loss of Prudhoe Bay oil revenue. Candidate lands for this program are identified on the basis of existing geologic knowledge, land ownership, and responses to solicitations for nominations from Alaska's geologic community. Products resulting from this program generally include: (1) 1:63,360-scale aeromagnetic and airborne-electromagnetic maps; (2) 1:63,360-scale bedrock geologic maps; and (3) various other geological, geochemical, and geophysical data compilations. As a result of the AGGMI 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.

As part of the state-funded AGGMI program, the Strategic and Critical Minerals Assessment project geophysically surveyed 1,092 square miles in the southeastern McGrath and northeastern Lime Hills quadrangles in 2012 and 2013 (see figure). The Farewell survey blocks, about 135 miles northwest of Anchorage, are in State-owned land except for almost 100 square miles of Native-owned land. Cook Inlet Region, Inc. (CIRI) contributed additional money for data acquisition over an extension of Native land immediately to the north of the planned survey area. These data will be included with the DGGS data. Most of the land is in the McGrath mining district, and about 18 square miles is in the Yentna mining district.



The Farewell survey is adjacent to the Styx River survey that was released in 2008. Aeromagnetic, electromagnetic, and radiometric data are being acquired. Two subsets of the Farewell survey, the Middle Styx and Dalzell Creek surveys, were released in fall 2013 and comprise about 240 square miles of data. The remaining areas of the Farewell survey were flown in summer of 2013. All data from 2013 will be merged with the Dalzell Creek data and are expected to be released in mid to late winter 2014.

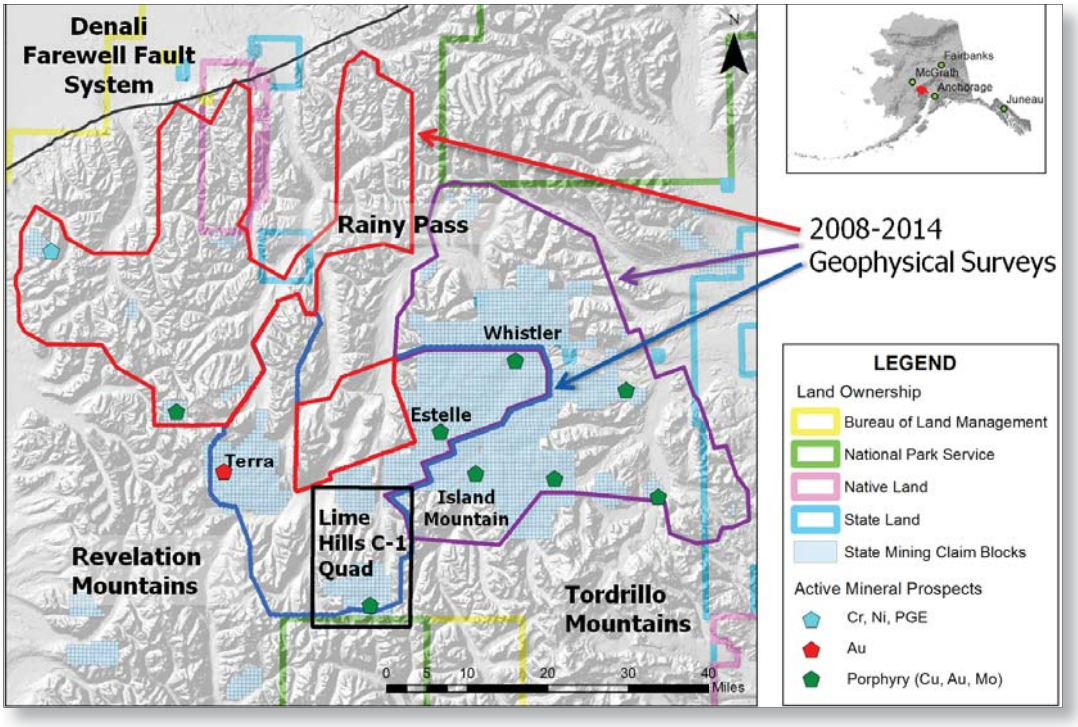
The Farewell geophysical survey area is just south of the Denali–Farewell fault system and is underlain by structurally deformed rocks of the Dillinger and Mystic subterranes. The region contains numerous Cretaceous- and Tertiary-age plutonic complexes, dike swarms, and volcanic fields, many of which are spatially and genetically associated with mineral occurrences. Most of the mineral prospects and occurrences are porphyry copper ± molybdenum ± gold deposits and polymetallic veins. Lead–zinc skarns, molybdenum-bearing quartz veins, sediment-hosted base-metal, platinum-group-element (PGE), and rare-earth-element (REE) deposit types are also present. The areas around Bowser Creek and the Chip–Loy and Robert's PGM prospects are currently being actively explored, as well as several other areas.

Airborne geophysical surveys, in combination with detailed geologic mapping, provide a way to differentiate various rock units and delineate regional structures. 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. DGGS believes that geophysical and geological data, which lead to a better understanding of the geologic framework hosting identified and potential ore deposits in these districts, will stimulate increased mineral exploration investment within these belts of rocks and the surrounding areas, and will provide information useful for state resource management and land-use planning.

Contact: Laurel Burns, 907-451-5021, laurel.burns@alaska.gov

GEOLOGIC MAPPING IN THE STYX RIVER AREA, WESTERN ALASKA RANGE

The Alaska Division of Geological & Geophysical Surveys (DGGS) Mineral Resources section conducted four weeks of geologic mapping in the Styx River area of the Lime Hills C-1 Quadrangle (see figure) during summer 2013 as part of the State-funded Airborne Geophysical/Geological Mineral Inventory (AGGMI) program. DGGS geologists mapped with the benefit of airborne geophysical data from the 2008 Styx River survey, which aided geologic interpretations. Concurrent with this field program, two other airborne geophysical surveys were flown nearby: the Farewell survey (p. 44) and the East Styx area (p. 42). The DGGS map area is bounded by the high Tordrillo Mountains to the southeast, and is about 45 miles southwest of Denali National Park and Preserve.



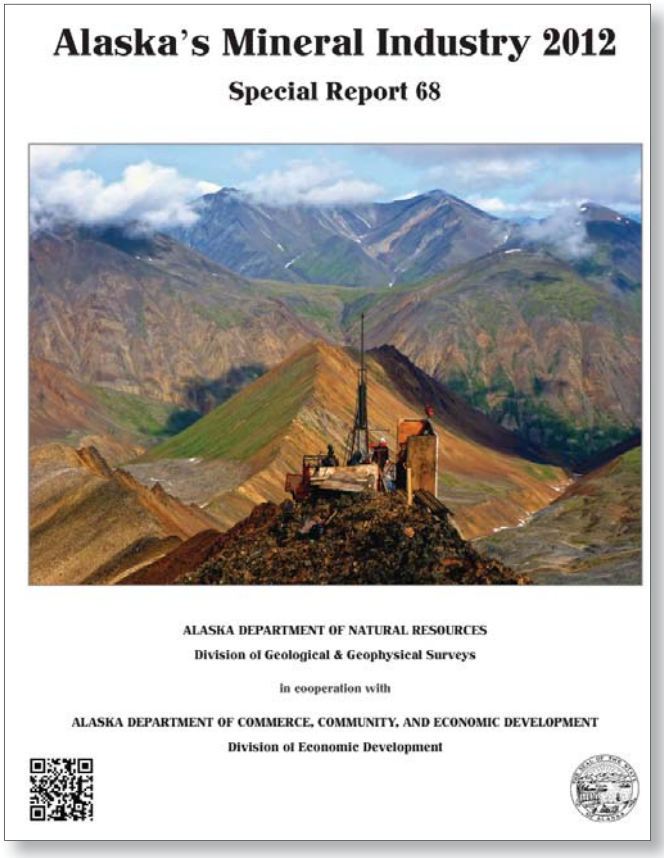
This is an area of interest for the State because of its mineral-resource potential, as evidenced by the many recent geophysical surveys and amount of active mineral exploration on State land. Millrock Resources, Inc., and Kiska Metals Corp. have large tracts of mining claims to the northeast of the study area. The claims are located in the mineralized Mount Estelle pluton and the Whistler and Island Mountain porphyry copper–gold–molybdenum systems. Northwest of the map area at the Terra prospect, Corvus Gold, Inc., and WestMountain Gold, Inc., are exploring and test-mining gold and polymetallic veins at the foot of the Revelation Mountains. There are also reduced intrusion-related gold, lead–zinc skarns, molybdenum-bearing quartz veins, sediment-hosted base metals, platinum-group-element, and rare-earth-element prospects in the region. The majority of these mineral occurrences are related to numerous Late Cretaceous- and Tertiary-age granite to gabbro intrusions and Tertiary volcanic rocks. Understanding the complex overlapping intrusive, volcanic, and tectonic history of the area is critical to determining the source and controls of mineralization. The detailed geologic mapping and research that DGGS conducts as part of the AGGMI program provides the basis for this understanding.

Prior to the geologic mapping by DGGS, the U.S. Geological Survey (USGS) published a 1:125,000-scale geologic map based on aerial photo interpretation and limited on-the-ground observations. The DGGS mapping team described and sampled bedrock, recorded the kinematics of structural features, and examined and sampled known and newly discovered mineral occurrences. Significant changes and refinements are being made to the existing map, including additional faults and dikes, revision of pluton boundaries, and subdivision of geologic units. These new observations and interpretations, supported by geochemical data, petrographic research, and new age determinations, will shed light on the intrusive, volcanic, and structural history of the area and will foster a better understanding of the ore deposits in the region. The DGGS team is also collaborating with the USGS Western Alaska Range Project (WARP) team, which is conducting two regional transects of the Alaska Range north and south of the Styx River project. Continued work on the Styx River project will result in a 1:63,360-scale geologic map, accompanying interpretive text, and supporting geochemical and geochronologic data releases. These products will be published on the DGGS website during 2014.

Contact: Karri Sicard, 907-451-5040, karri.sicard@alaska.gov

ANNUAL ALASKA MINERAL INDUSTRY REPORT

The Department of Natural Resources' Division of Geological & Geophysical Surveys (DGGS), and the Division of Economic Development (DED) in the Department of Commerce, Community & Economic Development gather, verify, collate, and distribute statistics and summary observations about Alaska's mineral industry and release this information to the public in a timely manner in the form of an annual report. The report satisfies Alaska Statute § 27.05.060 stating, "The department [DNR] shall make an annual report to the governor on all essential matters with regard to mining in the state…" The purpose of this cooperative effort is to supply information to the mineral industry, provide the State and the public with valuable data pertaining to the health of Alaska's mineral industry, and foster 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 in 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. Government personnel rely on the report as an essential tool for formulating public policy affecting resource and land management.

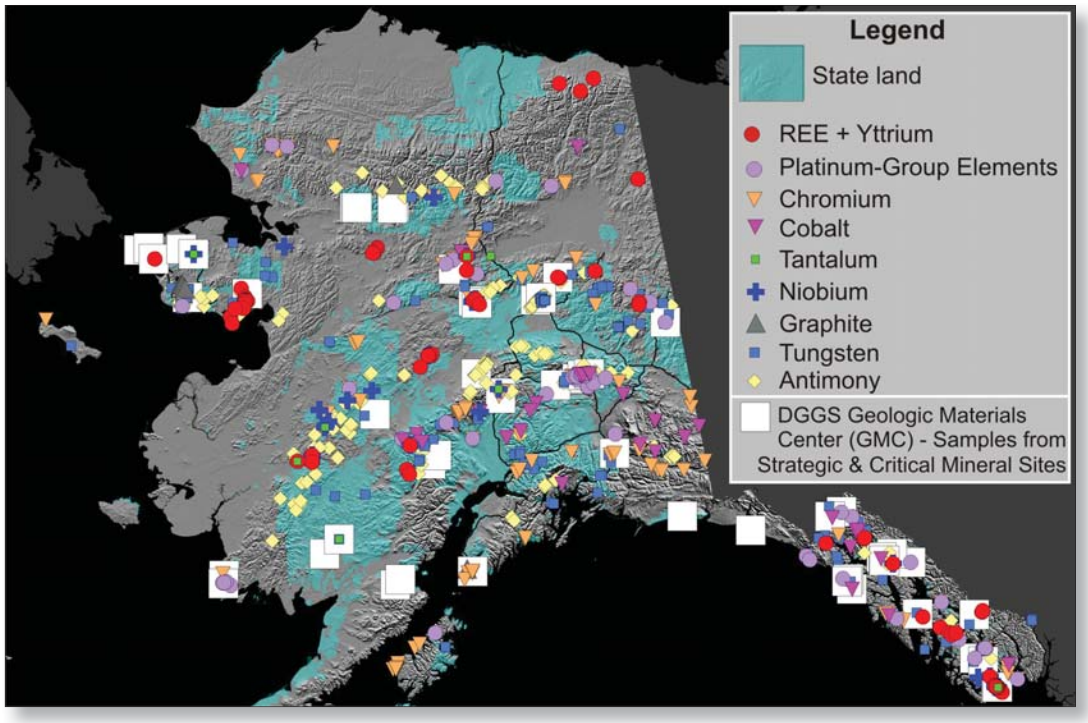
DGGS and DED are collaborating with the Department of Natural Resources' Division of Mining, Land & Water, Department of Labor & Workforce Development, and the Department of Revenue to streamline data collection and enhance reporting on Alaska's mineral industry. The agencies are working with industry representatives and the State Minerals Commission to develop a program that is comprehensive and statistically valid, minimizes redundant or archaic data collection methods, and keeps pace with evolving stakeholder needs. In the interim, DGGS and DED are committed to maintaining uninterrupted collection of mineral exploration, development, and production data. The 2012 Alaska mineral industry activity report, released in November 2013, summarizes information provided via questionnaires mailed by DGGS, phone interviews, press releases, and other information sources (see figure). The total reported value of Alaska's mineral industry remained strong in 2012, decreasing slightly to $4,113.6 million. Exploration expenditures for 2012 were at least $335.1 million, down about 8 percent from the 2011 value of $365.1 million. Development expenditures increased by almost 26 percent, to approximately $342.4 million, and mineral production value remained steady, decreasing a scant 2 percent to $3,436.1 million.

Contact: Larry Freeman, 907-451-5027, larry.freeman@alaska.gov

STRATEGIC AND CRITICAL MINERALS ASSESSMENT PROJECT

Strategic and critical minerals (SCMs) are essential for our modern, technology-based society. For example, platinum-group elements (PGEs) are extensively used in electronics and in catalytic converters for vehicles. Rare-earth elements (REEs) are necessary for military and high-technology applications, as well as clean/renewable-energy technologies such as wind turbines, solar panels, and batteries for electric vehicles. REEs are used to convert heavy crude oil into gasoline, and to make small, permanent magnets that enable miniaturization of electronic components for devices such as cell phones. Current technology and system designs of U.S. defense systems depend heavily on REEs. In many cases there are no effective non-REE substitutes. The current U.S. Geological Survey (USGS) list of SCMs includes REEs, the PGEs, antimony, barium, chromium, cobalt, fluorine, gallium, graphite, indium, niobium, rhenium, tantalum, titanium, tungsten, and yttrium. The U.S. is more than 70 percent dependent on imports for 13 of these 16 elements and elemental groups, and 100 percent dependent on imports for seven. This leaves the U.S. vulnerable to disruptions in the SCM supply chain.

The Alaska Division of Geological & Geophysical Surveys (DGGS) Strategic and Critical Minerals Assessment project provides information necessary for comprehensively evaluating Alaska's statewide SCM potential. Many areas of Alaska are geologically favorable for hosting SCMs, but the lack of basic data hinders evaluation of Alaska's SCM potential. Alaska has hundreds of known SCM occurrences (see figure) and millions of acres of selected or conveyed lands with the potential to contain SCMs, but the mineral-resource potential of these occurrences and lands is poorly understood. There has been no modern, systematic resource evaluation for SCMs in Alaska. The DGGS Strategic and Critical Minerals Assessment project is specifically designed to address this data and knowledge gap. By assessing Alaska's potential for SCMs, the State of Alaska will benefit from expanded mineral-industry investment in exploration, development, and associated employment, better understand the natural resources of its lands for management purposes, and help meet the nation's need for domestic supplies of these critically important elements.



In 2011 DGGS initiated the Rare-Earth Elements and Strategic Minerals Assessment project, which primarily focused on REEs. In 2012 DGGS expanded the scope of work with the Strategic and Critical Minerals Assessment project, including selected additional elements. The goals of these State-funded Capital Improvement projects are to: (1) compile historical and industry-donated data in digital format; (2) obtain new field and analytical data critical for assessing Alaska's SCM potential; (3) evaluate the historical and new data to identify areas of Alaska with the highest SCM potential, as well as those needing additional geologic evaluation; (4) communicate the results of our work to the public; and (5) publish the data and results of our studies on the DGGS website (free access).

In 2013 DGGS contracted for a 1,400-square-mile SCM-related airborne geophysical survey covering part of the Wrangellia Terrane in south-central Alaska (see p. 41 for project description). DGGS also conducted a 2,600-square-mile field project throughout the Wrangellia Terrane to evaluate its SCM potential (see p. 48 for project description). Additionally, DGGS compiled more than 5,390 historical geochemical analyses in digital format for areas with SCM mineral potential throughout the state and, to date, have obtained new, modern geochemical analyses for more than 1,200 archived samples stored at the DGGS Geologic Materials Center. Additionally, DGGS started the process of obtaining new geochemical analyses from statewide historical samples from State land that are stored at the USGS Denver Federal Center warehouse. Publication of geochemical data is planned for 2014. In summer 2014 DGGS will conduct additional geologic fieldwork and mapping in the Wrangellia Terrane.

Contact: Melanie Werdon, 907-451-5082, melanie.werdon@alaska.gov

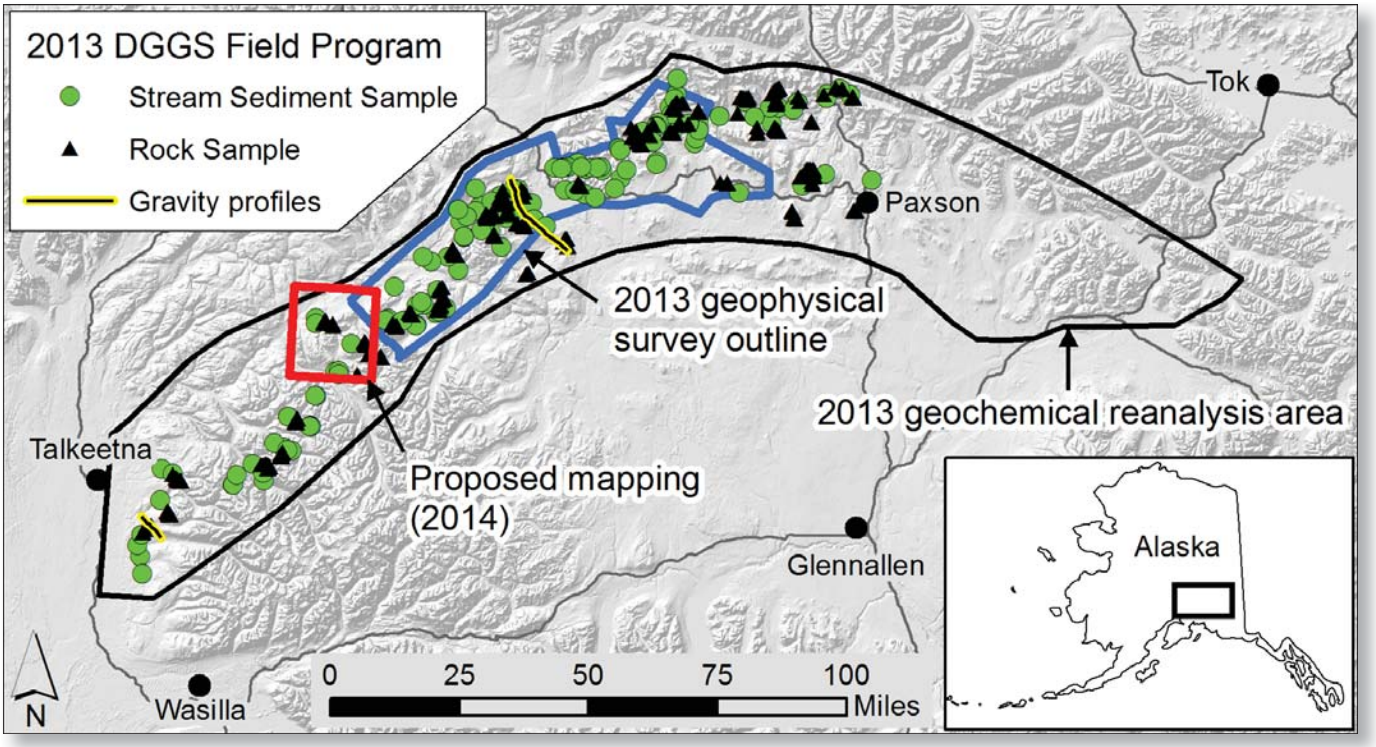
STRATEGIC AND CRITICAL MINERALS ASSESSMENT IN THE WESTERN WRANGELLIA TERRANE

During 2013 the Alaska Division of Geological & Geophysical Surveys (DGGS) began a multi-year project to understand and improve the geologic framework of the western portion of the Wrangellia geologic belt, with particular emphasis on evaluating the potential of the area to host magmatic-type nickel, copper, and platinum-group-element (Ni–Cu–PGE) deposits. The project aims to encourage exploration and increase the likelihood of discovering mineralization similar to that at the Wellgreen deposit in Yukon Territory, which is hosted in the eastern portion of the targeted Wrangellia geologic belt. The project is funded as part of the Strategic and Critical Minerals Assessment program.

The Wrangellia project includes components of exploration geochemistry, geophysics, and targeted geologic mapping. Our initial three-week field reconnaissance program traversed an area of approximately 2,600 square miles in the eastern Alaska Range foothills and the Talkeetna Mountains between Paxson and Talkeetna (see figure). The DGGS field crew conducted stream-sediment sampling and geological traverses in areas of known or suspected Late Triassic mafic to ultramafic intrusions, the geologic features most likely to host Ni–Cu–PGE mineralization. The crew also conducted two gravity profiles, totaling 24 line-miles, to help resolve concealed magnetic anomalies. In partnership with the U.S. Geological Survey (USGS), DGGS will also be reanalyzing archived stream-sediment samples using modern, high-sensitivity methods for a broad spectrum of elements, including platinum and palladium. Finally, DGGS contracted for a 1,400-square-mile airborne magnetic and electromagnetic survey over prospective Ni–Cu–PGE areas in the northern Talkeetna Mountains.

Geologic work started with the compilation and digitization of published and unpublished detailed geologic mapping and focused on areas where mafic and ultramafic bodies were previously reported or were inferred from geophysical and geochemical surveys. DGGS geologists targeted traverses to validate, map, and sample these intrusions for major- and trace-element geochemistry, petrographic study, and radiometric dating. Additional traverses focused on resolving stratigraphic uncertainties using the distinctive trace-element geochemistry of the Late Triassic basalts as a marker. Preliminary results from this project have improved our understanding of the geology and metallogenesis of western Wrangellia; they will be published as a series of DGGS raw-data files and a final interpretive report once analyses are complete.

This investigation and previous work by DGGS and the USGS have shown that there are significant shortcomings in existing basic geologic mapping that hamper evaluation of PGE potential of the project area, particularly the southwestern portion. The DGGS Mineral Resources Section has applied for matching funds through the USGS STATEMAP program to complete a detailed geologic map in the Talkeetna Mountains C-4 Quadrangle during the 2014 field season.



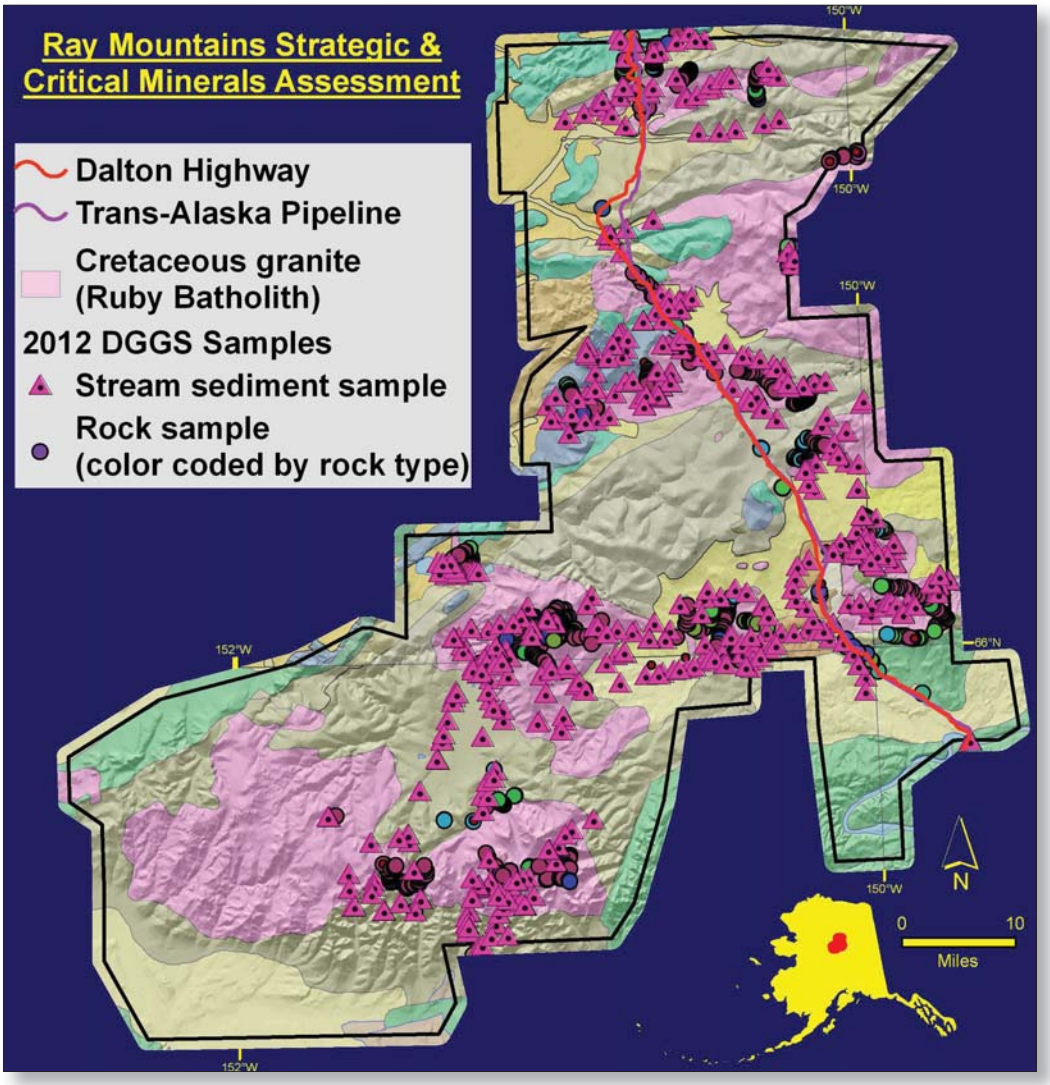
Contact: Evan Twelker, 907-451-5086, evan.twelker@alaska.gov

STRATEGIC AND CRITICAL MINERALS ASSESSMENT IN THE RAY MOUNTAINS AREA, NORTH-CENTRAL ALASKA

During summer 2012 the Alaska Division of Geological & Geophysical Surveys (DGGS) conducted fieldwork in the Ray Mountains area of north-central Alaska (see figure) as part of the DGGS Strategic and Critical Minerals Assessment project (p. 47). The Ray Mountains area has been recognized since the 1970s as having anomalously high values of uranium, thorium, tungsten, tin, and rare-earth elements (REEs). Recent private-sector work highlighted the potential for localized placer–REE concentrations associated with Cretaceous granite. Most of the land in this area is State selected or top filed under U.S. Public Land Order 5150, which closed a large area to mineral entry prior to finalizing the route of the Trans-Alaska Pipeline; the area is currently under U.S. Bureau of Land Management (BLM) jurisdiction. The DGGS field-based assessment in the Ray Mountains area builds on previous mineral-resource assessments conducted by the U.S. Geological Survey, U.S. Bureau of Mines, and BLM, and is enhanced by donations of proprietary data from private entities. Evaluation of all available geologic data will allow for science-based prioritization of the State-selected and top-filed lands based on their strategic and critical mineral-resource potential. Products will include interim data releases and a report of investigations that will be made available on the DGGS website in 2014.

The 3,500-square-mile Ray Mountains study area is 125 miles northwest of Fairbanks in the Ray Mountains and Hodzana Uplands. The area extends from east of the Trans-Alaska Pipeline and Dalton Highway southwest 73 miles to the Ray Mountains. DGGS geologists examined and geochemically sampled known and newly discovered lode and placer occurrences, mapped and sampled granitic rocks, and collected stream-sediment and pan-concentrate samples. The field work and ongoing geochemical, geochronologic, and petrographic studies will allow us to determine appropriate ore deposit models and assess the strategic and critical mineral-resource potential for lode and placer deposits.

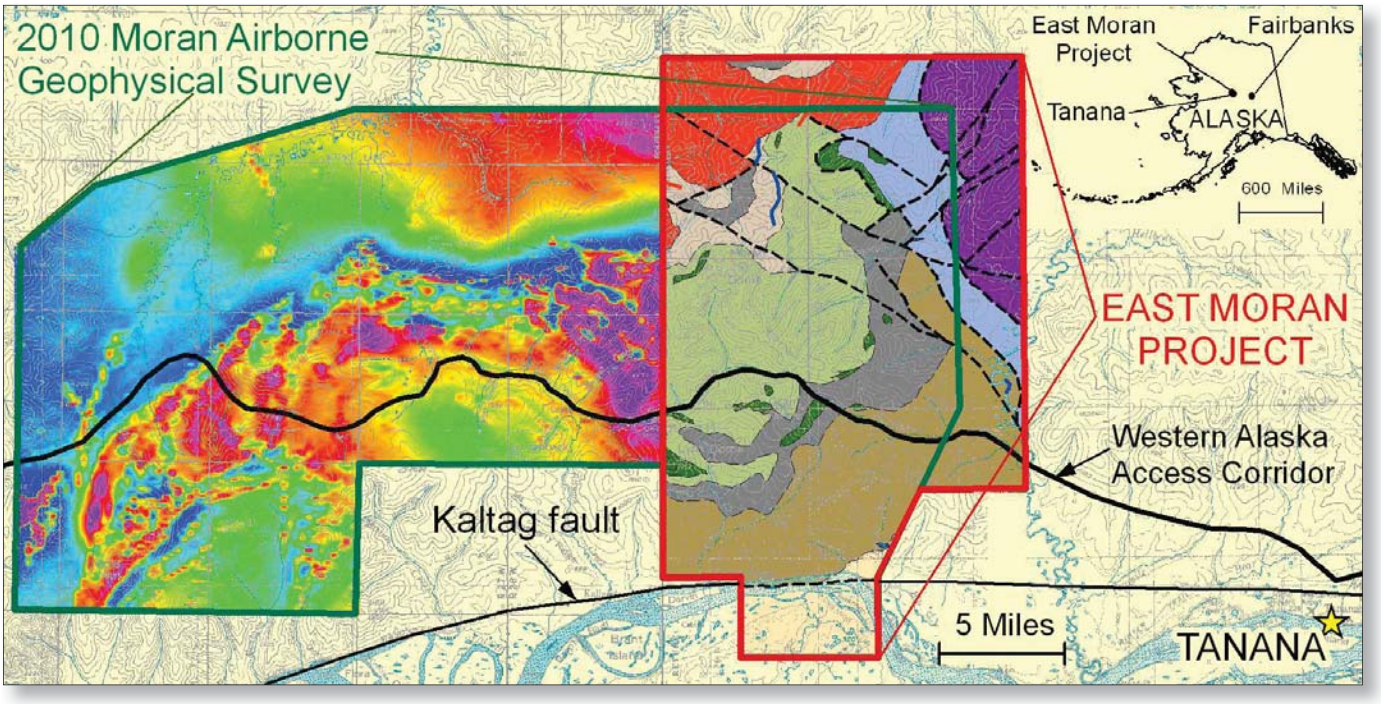
Initial results indicate the Cretaceous granites of the Ruby Batholith are variably enriched in REEs and that the REEs occur as widely disseminated accessory minerals. The accessory minerals are released as the granites are eroded, and are subsequently concentrated in ancient and modern river gravels. Further studies will include scientific interpretations of the granite source of the REE minerals, the concentration and type of REEs and other minerals contained in the ancient and modern gravels, and the extent of potentially economic concentrations of REEs and tin in the gravels. Land managers and policymakers will be able to use the results of this study to make informed and logical decisions on prioritization of State-selected lands for potential transfer to State ownership.



Contact: Larry Freeman, 907-451-5027, larry.freeman@alaska.gov

GEOLOGIC MAPPING IN THE EASTERN MORAN AREA, TANANA AND MELOZITNA QUADRANGLES, ALASKA

Historical and active placer mines in the Melozitna mining district, which encompasses the Moran Dome area, have produced more than 12,000 ounces of gold and an undetermined amount of tin, yet little is understood about sources for the placer metals or the area's gold and polymetallic lode occurrences. To encourage renewed industry exploration for mineral deposits in this region, in 2010 the Alaska Division of Geological & Geophysical Surveys (DGGS) released the 653-square-mile Moran airborne-geophysical survey (see figure) as part of the State-funded Airborne Geophysical/Geological Mineral Inventory (AGGMI) program. The Moran survey area is 150 miles west of Fairbanks, on the north side of the Yukon River between the villages of Ruby and Tanana. The State's preferred Western Alaska Access Corridor transects the survey area. During summer 2011 DGGS geologically mapped 301 square miles in the eastern part of the Moran geophysical survey area, and conducted reconnaissance mapping in the western part. Geochemical data from the project were released in 2011, several public presentations were given at trade and professional meetings, and additional products, including geochronologic data and the final 1:63,360-scale geologic map, will be published in 2014. The products will foster a better understanding of the area's geology and mineral potential. This mapping project was funded primarily by State general funds, with supplemental funding from the federal STATEMAP program through the U.S. Geological Survey.



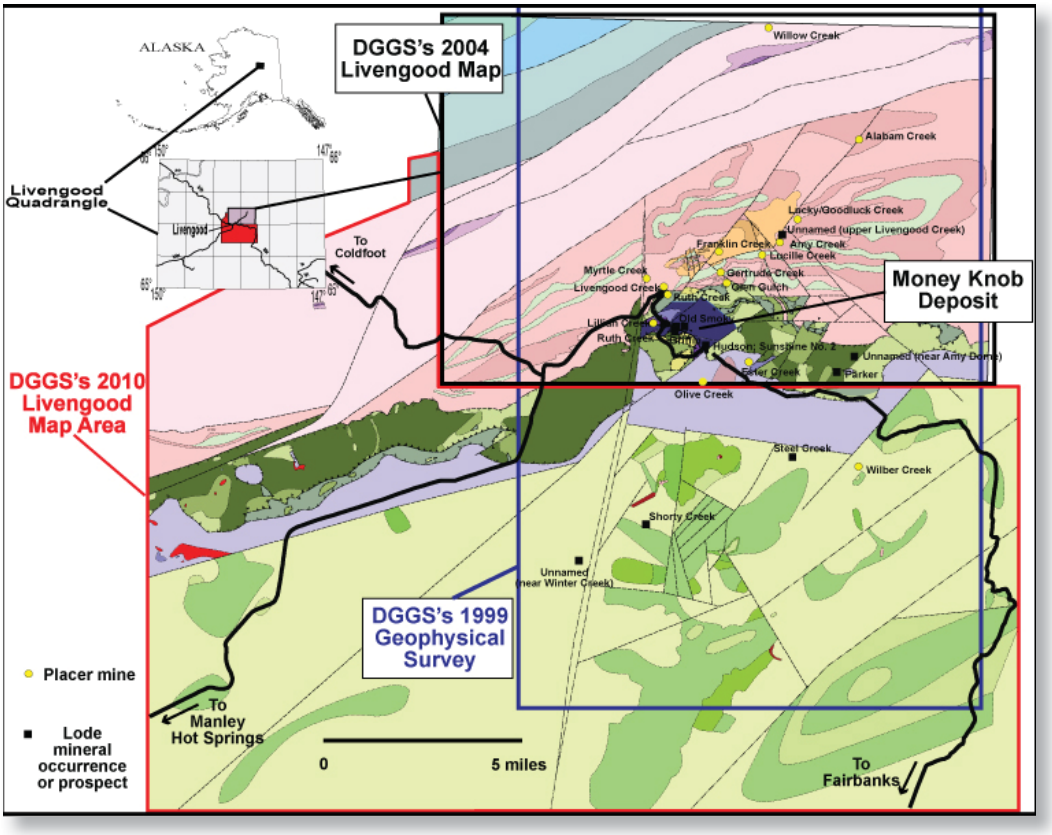
Prior to 2011, only reconnaissance-level, 1:250,000-scale geologic maps were available for the Moran area; DGGS's 2010 geophysical data indicate the geology is much more complex than shown on these maps. During 2011 fieldwork DGGS geologists field-checked airborne geophysical interpretations, identified the location, type, and character of bedrock and surficial-geologic units, examined and geochemically sampled known and newly discovered lode and placer occurrences, and determined the location and kinematics of structural features. This detailed geologic framework, supported with ongoing geochemical, geochronologic, and petrographic studies, will allow us to develop deposit models for the area's gold and polymetallic lode prospects and explain the distribution and metal content of local placer deposits. Regional geologic hazards are also of concern and potentially include the Kaltag fault, which crosses the southern edge of the map area. Part of the 2011 study includes evaluation of possible Holocene and Quaternary displacement history of the Kaltag fault and its associated seismic hazards between Tanana and Ruby.

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 strategic and critical minerals. 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 by State and local agencies that need to balance resource and infrastructure development with other land-management priorities.

Contact: Larry Freeman, 907-451-5027, larry.freeman@alaska.gov

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 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 General Funds. DGGS released a 230-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 (see figure). Subsequent mineral industry exploration in this map area resulted in the discovery of a large gold deposit at Money Knob, with an identified resource of 20.6 million ounces of gold. In 2010, DGGS conducted geologic mapping and sampling of the southern portion of the 1999 geophysical survey and surrounding area.



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. The only known significant lode mineralization in the 2010 map area is 5.5 miles south of Money Knob at Shorty Creek, a prospect with elevated Ag–Bi–Sn and, locally, Au values in rock and soil samples. Felsic igneous rocks spatially associated with the Shorty Creek prospect are compositionally different and temporally about 25 million years younger than the Money Knob gold-related plutonic rocks; hence they represent two different types of mineralizing systems. Rocks of the Cascaden Ridge pluton, 8 miles southwest of Money Knob, are compositionally equivalent to Money Knob dikes and similarly intrude Devonian sedimentary and volcanic rocks that act as the host rock in the Money Knob system. The Money Knob prospect is currently being further delineated for possible development and production by International Tower Hill Mines.

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, and the present stream morphology suggests the gold is derived from the 2010 map area. Magnetic anomalies in the 1999 geophysical survey indicate a potential igneous source for the Wilber Creek placer deposit. A group of felsic dikes of similar composition to the gold-related Money Knob rocks is found in the area and may be related to a potential lode source of the placer gold.

A geochemical report for the south Livengood area was published in 2010, and a 1:50,000-scale bedrock-geologic map and accompanying interpretive report for the entire Livengood study area will be published in 2014. This publication will summarize the collective findings of the DGGS 2004 and 2010 investigations, as well as incorporating industry data from the area around the Money Knob deposit. AngloGold Ashanti (2003–2006) and International Tower Hill Mines Ltd. (2006–present) have conducted detailed geologic mapping of Money Knob and surrounding area, and contributed to geologically subdividing the Paleozoic Amy Creek assemblage, the Cambrian ophiolite package, and the Devonian Cascaden Ridge unit. We also utilized the 2010–2011 DGGS LiDAR survey of the Trans-Alaska Pipeline corridor to identify faults in the map area.

Contact: Evan Twelker, 907-451-5086, evan.twelker@alaska.gov

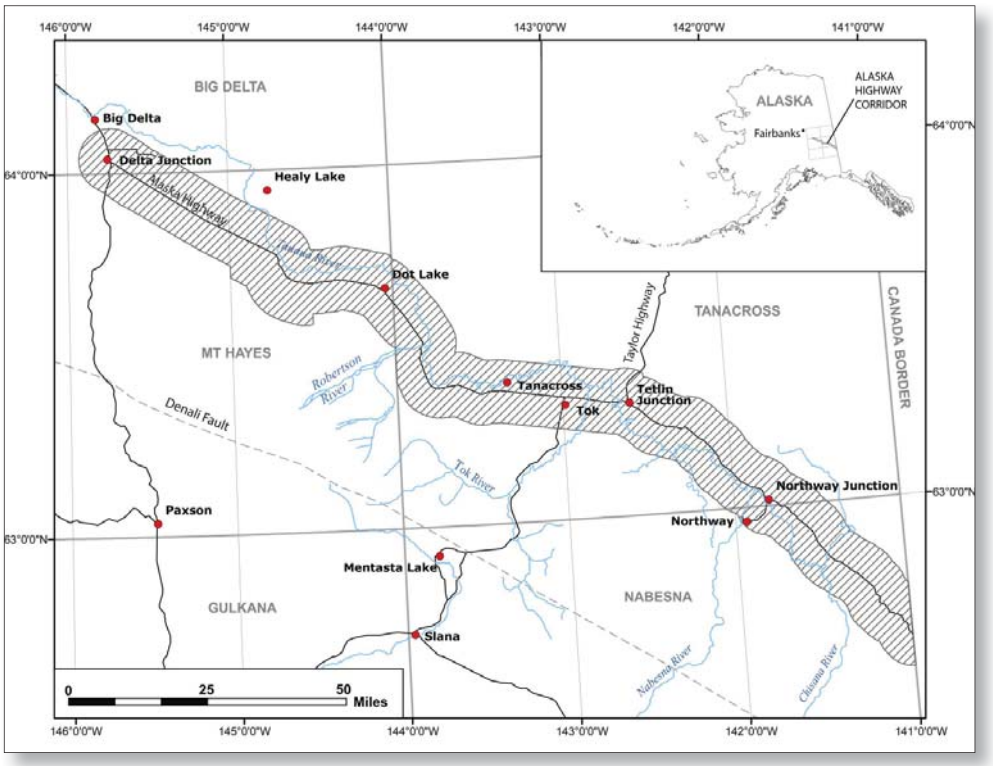
BEDROCK GEOLOGY AND MINERAL RESOURCE ASSESSMENT ALONG THE ALASKA HIGHWAY CORRIDOR FROM DELTA JUNCTION TO THE CANADA BORDER

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 a proposed natural gas pipeline or Alaska Railroad extension are constructed along this route. Despite its strategic location, relatively little geological and geotechnical work has been published relating to this corridor. The Alaska Division of Geological & Geophysical Surveys (DGGS) is engaged in a multi-year program, primarily supported by State Capital Improvement Project (CIP) funds, to develop a framework of geologic data between Delta Junction and the Canada border with which engineering, design, and resource decisions may be evaluated for future development in that area. 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. In the second phase DGGS was charged with mapping the bedrock and surficial geology of the area and evaluating the geologic hazards and resources. The surficial-geology and geologic-hazards segments of the project are described separately (p. 59).

DGGS staff have completed the field data collection phase needed to assess the mineral resources of the area and create a 1:63,360-scale bedrock-geologic map. 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 along the entire length of the corridor from Delta Junction to the Canada border.

The bedrock maps incorporate interpretations of DGGS's airborne magnetic and resistivity data, field data, and various scientific analytical data. The geophysical data is particularly valuable for interpreting the geology in areas covered by surficial deposits or vegetation. Numerous plutonic rock suites were defined; these plutons intruded complexly deformed, amphibolite-facies metasedimentary and metaigneous rocks similar to those found elsewhere in the Yukon–Tanana Upland, as well as a suite of greenschist-facies metasedimentary rocks and metamorphosed mafic intrusions that correlate with similar units directly across the border in Canada. DGGS also determined the location and kinematics of many smaller-scale faults in the corridor that are related to the Denali fault system; these data will provide a better understanding of the history and potential impacts of the faults.

DGGS evaluated the mineral-resource potential of bedrock units by sampling and analyzing altered rocks to provide baseline geochemical data for use by State land-use planners and mineral exploration companies. Geochemical analyses, U-Pb, and $^{40}Ar/^{39}Ar$ age dates for samples collected during 2008–2010 fieldwork will be published in early 2014. Bedrock-geologic maps for the three segments of the proposed gas pipeline corridor will be published by the end of 2014.



Contact: Melanie Werdon, 907-451-5082, melanie.werdon@alaska.gov

CLIMATE AND CRYOSPHERE HAZARDS

Most high-latitude northern regions have undergone rapid and substantial warming over the last few decades. Alaska is particularly sensitive to the effects of climate warming as much of its social and economic activity is connected to the existence of snow, ice, and permafrost. Changes to the cryosphere can increase the magnitude and frequency of certain types of geologic hazards (such as flooding, erosion, slope instability, and thawing permafrost) and 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 cryospheric hazards that are caused or amplified by climate variability and change.

Figure 1. Jennifer Davis (DGGS/UAF) preparing to use an acoustic doppler current profiler (ADCP) on Valdez Glacier Stream near Valdez, Alaska. Photo by J. Davis.

The Division of Geological & Geophysical Surveys' (DGGS) Climate and Cryosphere Hazards Program (CCHP) conducted studies of cryosphere-related hazards during 2013 in and around the communities of Seward, Valdez, Whittier, and Yakutat. DGGS expects to complete draft products for the Yakutat and Seward projects and final products for the Whittier and Valdez projects in 2014, which will include geologic hazards inventory and assessment (Whittier) and flood hazard (Valdez) maps and reports.

A highlighted project of the 2013 CCHP efforts involves Hubbard Glacier in southeastern Alaska. The tidewater terminus of Hubbard Glacier extends into Disenchantment Bay and currently blocks most of the mouth of Russell Fjord. Recent advances of Hubbard Glacier (1986 and 2002) caused the damming of Russell Fjord, creating one of the largest glacier-dammed lakes on the continent and presenting the community of Yakutat and the local commercial fishing and tourist industries with a host of potential hazards.

In May 2013 scientists from DGGS, the Cold Regions Research and Engineering Laboratory (CRREL), University of Alberta (UA), and University of Alaska Fairbanks (UAF) combined efforts to investigate the highly active terminus of Hubbard Glacier. Researchers co-located and synchronized data collection scans from ground-based interferometric radar (GBIR) and ground-based light detection and ranging (LiDAR) systems (fig. 2). These innovative techniques will help researchers quantify changes at the terminus of Hubbard Glacier and develop a better understanding of the mechanisms associated with future damming events.

Figure 2. Scanning the calving terminus of Hubbard Glacier with a GBIR to detect surface deformation and quantify short-term changes in the velocity field, May 2013. Photo by G. Wolken.

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

Contact: Gabriel Wolken, 907-451-5018, gabriel.wolken@alaska.gov

CLIMATE AND CRYOSPHERE MONITORING

Scientists rely on weather information to monitor glacier and permafrost variations and to develop predictive models of cryospheric hazards. Weather data are often acquired from nearby towns, most of which are at low elevations and do not represent high mountain conditions. In April 2013 a team of scientists from the Division of Geological & Geophysical Surveys (DGGS), the University of Alaska Fairbanks (UAF), and the U.S. Cold Regions and Research Laboratory (CRREL) installed automated weather stations at two high-elevation locations in the Prince William Sound region. The stations sit on exposed bedrock near Scott Glacier, northwest of Cordova, and Valdez Glacier, north of the town of Valdez. Both stations transmit measurements of air temperature, relative humidity, wind speed and direction, solar radiation, and air pressure in real time via telemetered satellite links.

Data from these stations are being used by a number of research and public service efforts throughout the Prince William Sound region. The stations are allowing us to more accurately monitor snow and ice melting events to assess potential downstream flooding hazards and to predict freshwater runoff into Prince William Sound, which has impacts on ocean ecosystems critical to Alaska's economy. These stations are also helping to improve weather forecasts and aviation safety by providing real-time information from data-sparse regions directly to forecasters at the National Oceanic and Atmospheric Administration (NOAA).

The station installations could not have occurred without the cooperation of multiple agencies. CRREL provided all of the station components, DGGS and UAF provided technical and logistical support, the U.S. Geological Survey (USGS) contributed to logistics, and the Prince William Sound Science Center in Cordova provided facilities for staging equipment.

A weather station (elevation 6,000 feet) recently installed on a ridge between the Valdez Glacier and Mineral Creek drainage basins near Valdez, Alaska. Photo by G. Wolken.

Contact: Gabriel Wolken, 907-451-5018, gabriel.wolken@alaska.gov

GLACIER AND RUNOFF CHANGES IN THE UPPER SUSITNA BASIN

The Alaska Energy Authority (AEA) has been authorized by the State of Alaska to perform studies required for the licensing process of the Susitna–Watana Hydroelectric Project, which is being designed to serve the region's energy needs. Critical to any hydroelectric development is a firm understanding of the basin-wide contributions to river runoff and how these might change over time to influence the quantity and seasonality of water flow into a hydroelectric reservoir. In the upper Susitna basin, changes in glacier volume and extent in response to climate warming and/or altered precipitation regimes have the potential to substantially alter the magnitude and timing of runoff. Although only about 4 percent of the upper Susitna watershed area (13,279 square kilometers) is glacierized, these glaciers provide a significant portion of the total runoff in the upper Susitna drainage and it is well documented that these glaciers are currently retreating.

The Alaska Division of Geological & Geophysical Surveys (DGGS) and the University of Alaska Fairbanks are in the second year of a multi-year collaborative hydrology study of the upper Susitna drainage basin. The focus is on modeling the effects of future climate variability and change, permafrost thaw, and glacier wastage and retreat on runoff. The study combines field measurements of glacier mass balance, snow accumulation, runoff, meteorology, and computational modeling to provide estimates of recent historical and future runoff into the proposed 68 × 3 kilometer reservoir.

Results from this project are anticipated to be published in early 2015.

Erin Whorton (DGGS) and Garth Murdock (Pathfinder Aviation) servicing a mass balance monitoring station on Maclaren Glacier in the upper Susitna basin during the Fall 2013 field campaign. Photo by G. Wolken.

Contact: Gabriel Wolken, 907-451-5018, gabriel.wolken@alaska.gov

INVESTIGATIONS OF COASTAL DYNAMICS

Alaska's coastal communities depend on sound investigations of coastal dynamics in order to make informed planning decisions that will minimize losses due to new or exacerbated hazards in the coastal environment. The state's tidal shoreline is more than 40,000 miles long and is well recognized as lacking in baseline coastal information such as geomorphic classification, shoreline positions, topographic/bathymetric elevations, and water levels. In addition, many of Alaska's populated coastal areas are under-instrumented for traditional approaches to vulnerability mapping. Due to the high expense and logistical challenges associated with equipment deployment and repeat field campaigns in remote and harsh conditions, it is imperative that coastal monitoring and evaluation strategies for Alaska leverage interagency collaboration and opportunistic approaches to data collection.

The DGGS coastal program is dedicated to working with multiple partners to expand the quality and quantity of baseline data available to coastal scientists, planners, and residents. These data and the preliminary investigations that incorporate these findings are being continually released as DGGS publications. Additional educational outreach, online data distribution, and innovative observation strategies for severe storms will remain a focus in FY14.

A partial list of new contributions includes:

- The collection of nearshore bathymetric measurements using a portable sonar system (funded, in part, by the Western Alaska Landscape Conservation Cooperative) that is capable of shallow-water measurements in rural settings (fig. 1).
- The development and launch of an online portal (http://www.dggs.alaska.gov/tidalportal) to facilitate access to published coastal elevation conversion factors and to educate the public about the different types of reported elevation values that must be understood to accurately assess information related to water level, for example, flood vulnerability.
- Installation of a short-term tide gauge in Port Heiden to assist in filling a tidal network data gap and to refine tidal datums in the Bristol Bay region for planning and management purposes. Completed in conjunction with the collection of coastal profile mapping (fig. 2) and funded, in part, by the Alaska Ocean Observing System.
- Coordination with local observer networks, such as the Alaska Corps of Coastal Observers (AkCCO), to teach residents how to make scientifically rigorous observations of coastal erosion and flooding for use in geohazard assessments.

Figure 1. DGGS portable sonar system deployed off the southern coast of Golovin, Alaska. These measurements are being used to refine storm wave runup models and to test the use of satellite sensors for shallow-water depth mapping in Alaska.

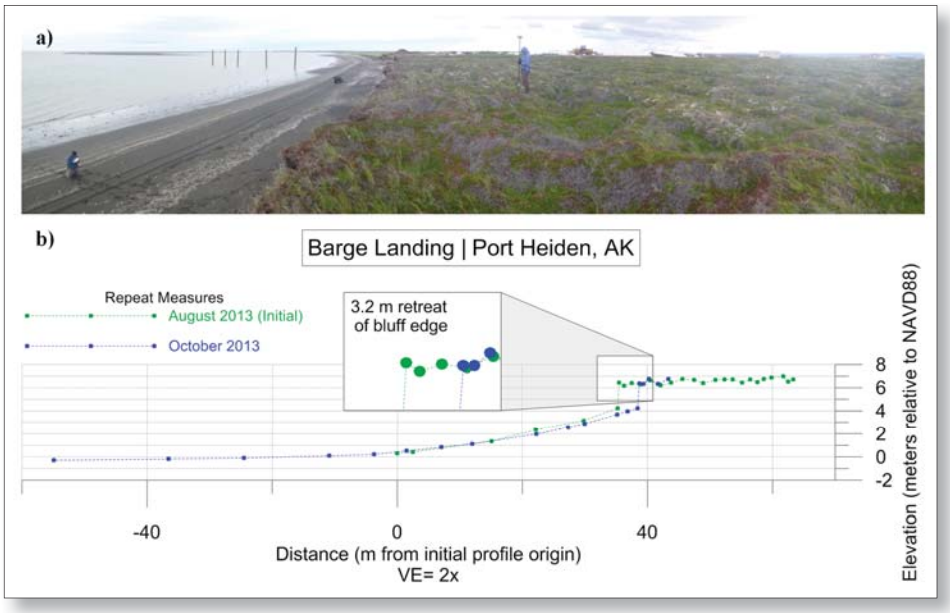


Figure 2. (a) DGGS geologists Alex Gould and Meagan DeRaps collect measurements of the upper shoreface in Port Heiden, Alaska, in August 2013. (b) Measurements were repeated in October 2013 following a high-energy wave event that caused the bluff to erode 3.2 meters inland.

Contact: Nicole Kinsman, 907-451-5026, nicole.kinsman@alaska.gov

GEOHAZARD EVALUATION AND GEOLOGIC MAPPING FOR COASTAL COMMUNITIES

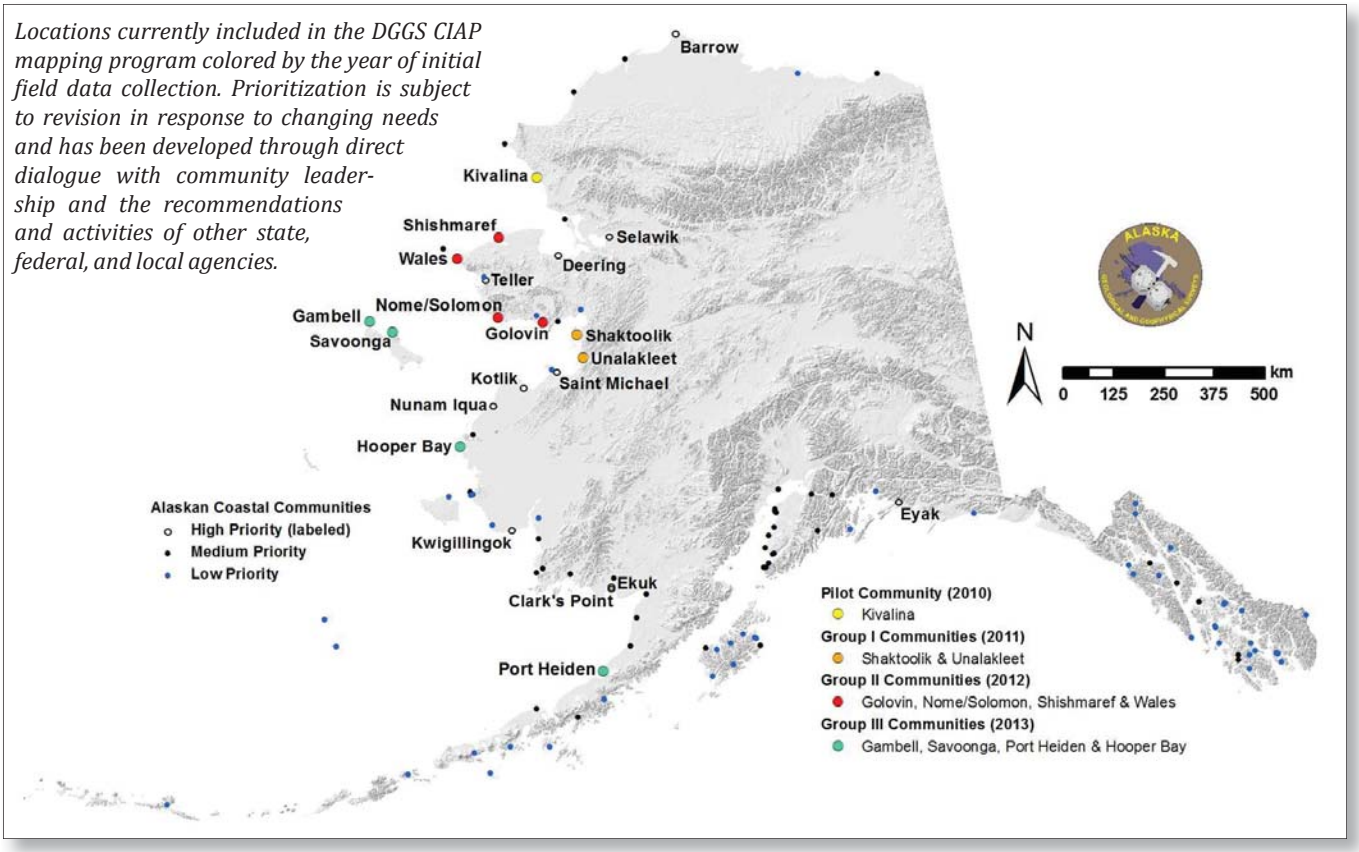
According to the 2010 United States census, more than 60 percent of Alaskans reside in coastal communities. These populations are inherently vulnerable to natural hazards such as erosion, storm surge flooding, and ivu (ice push). While these communities have been exposed to ongoing coastal processes in some capacity since their establishment, the timing, frequency and magnitude of new hazard events has not remained constant. As a result of these trends, some Alaskan villages experiencing extreme local rates of erosion have been labeled as imperiled or at-risk by agencies including the U.S. General Accounting Office and the U.S. Army Corps of Engineers. Communities throughout the state are becoming increasingly involved with costly mitigation or adaptation efforts to ensure the protection of human life, property, and the coastal environment amid accelerated erosion rates and the thawing of permafrost. Planning tools, such as vulnerability and geologic maps, can inform local decision making to ensure that planned and proposed development will not exacerbate existing hazards or trigger new events.

Since 2009, DGGS has used federal funds from the Coastal Impact Assistance Program (CIAP) to establish a coastal vulnerability mapping program in support of local and regional planning. This program ensures the collection of relevant coastal and oceanic process field measurements, mapping of local geology, and documentation of historic/contemporary natural hazard events. Baseline data have been collected in 11 areas as of FY13 and new collections are scheduled to take place through FY15(see figure).

A coastal vulnerability map series stemming from these field investigations is being tailored to meet the specialized needs of Alaskan communities. Established mapping strategies must be modified to account for isolated coastal development patterns, limited baseline data, and the presence of shorefast ice. These maps identify natural hazards that must be considered in the siting, design, construction, and operations of coastal development projects. The map series and associated reports will be published in GIS format with standard metadata as well as online in an interactive map interface currently under development for FY14.

DGGS continually seeks new ways of working with outside agencies and programs to enhance coastal hazards research in Alaska. Collaboration with the National Oceanic and Atmospheric Administration, U.S. Geological Survey, U.S. Army Corps of Engineers, other state agencies, the University of Alaska Fairbanks, affected coastal communities, and private-sector geotechnical consultants will continue to shape this program and avoid duplication of efforts.

Locations currently included in the DGGS CIAP mapping program colored by the year of initial field data collection. Prioritization is subject to revision in response to changing needs and has been developed through direct dialogue with community leadership and the recommendations and activities of other state, federal, and local agencies.

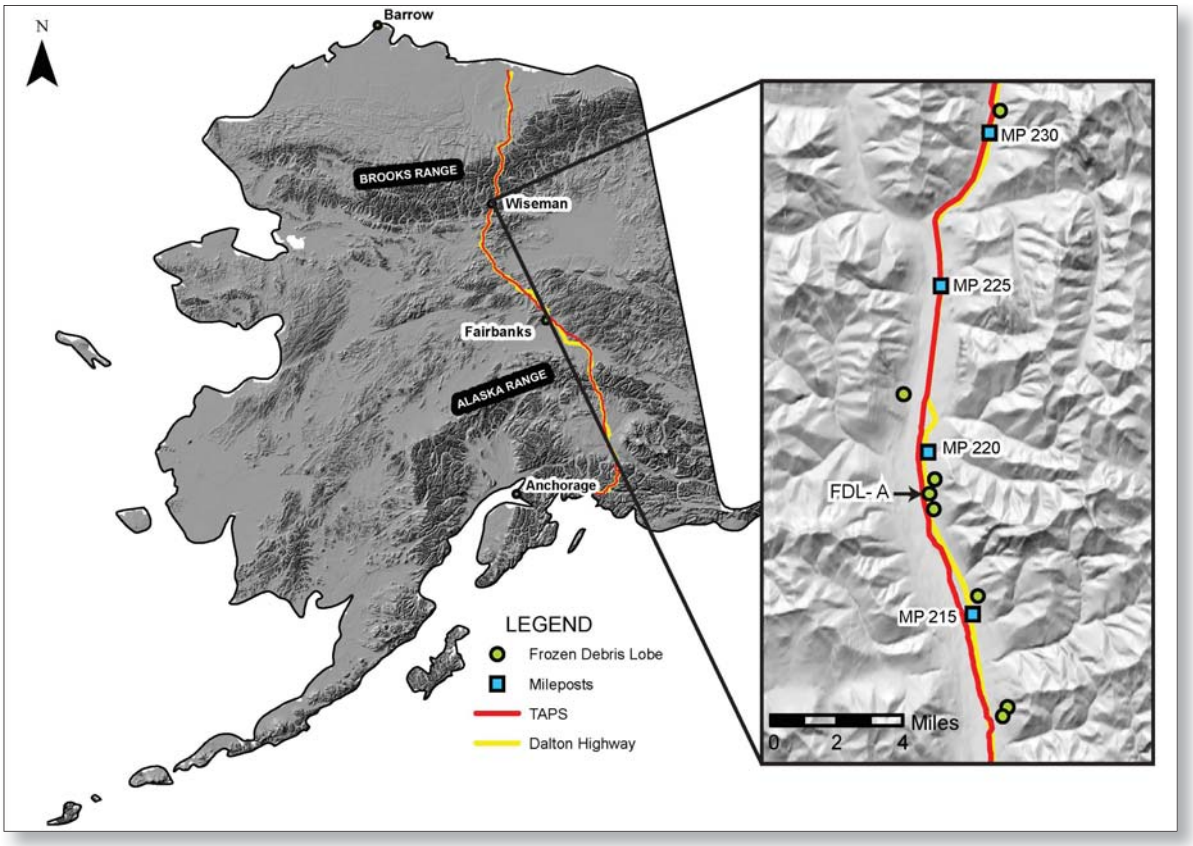


Contact: Nicole Kinsman, 907-451-5026, nicole.kinsman@alaska.gov

DALTON HIGHWAY FROZEN DEBRIS LOBES

The Dalton Highway is the main land link to the oil and gas resources of northern Alaska, making it vitally important to identify potential geologic hazards for maintenance decisions and development planning. The southern Brooks Range section of the highway is characterized by actively moving, steep slopes that are underlain by continuous permafrost and are likely to become increasingly unstable as climate warms. Recent studies of frozen debris lobes (FDLs: slow-moving landslides of frozen soil, rock, and debris) in this area indicate these features are moving rapidly enough to be a threat to the Dalton Highway and adjacent Trans Alaska Pipeline System (TAPS).

In 2013 DGGS, in cooperation with the University of Alaska Fairbanks, began a GIS, remote sensing, and field based study to examine FDLs in the southern Brooks Range (see figure). Research to date has shown that FDLs move at rates between 0.025 and 4.6 centimeters per day at the surface, and an in-place inclinometer has detected movement in a basal shear zone at a depth of 21meters below the surface. Temperatures in FDL-A, the FDL that currently poses the greatest threat to the Dalton Highway, are measured at just below freezing near the shear zone and pore ice was found during drilling conducted in 2012. Liquid water was also found in the shear zone and is under great pressure, which likely keeps the water from freezing. This water lubricates the movement of FDLs and they are therefore sensitive to ground temperature, atmospheric warming, and increased snowfall.



Location of FDLs being evaluated along the Dalton Highway and TAPS in the southern Brooks Range. FDL-A currently poses the greatest threat to the Dalton Highway.

LiDAR, multi-date remotely-sensed imagery and oblique photography, repeat differential GPS surveys, and multi-year geologic field observations are being used to investigate FDLs and their catchments to identify parameters useful for geologic hazards evaluation. Proximity of FDLs to the Dalton Highway and TAPS, surface disturbance, vegetation, slope, aspect, catchment size, soil properties, and rock type and strength are among the characteristics being evaluated.

Work on the FDL geohazards classification is ongoing and is expected to be published in 2014. Preliminary information describing bedrock geology and initial LiDAR evaluation of the FDLs and their catchments was presented at the 2013 Geological Society of America annual meeting, and preliminary models of FDL movement were presented at the 2013 annual meeting of the American Geophysical Union.

Contact: Trent Hubbard, 907-451-5009, trent.hubbard@alaska.gov,
or Ronnie Daanen, 907-451-5965, ronald.daanen@alaska.gov

GEOLOGY, GEOHAZARDS, AND RESOURCES ALONG PROPOSED NATURAL GAS PIPELINE CORRIDORS

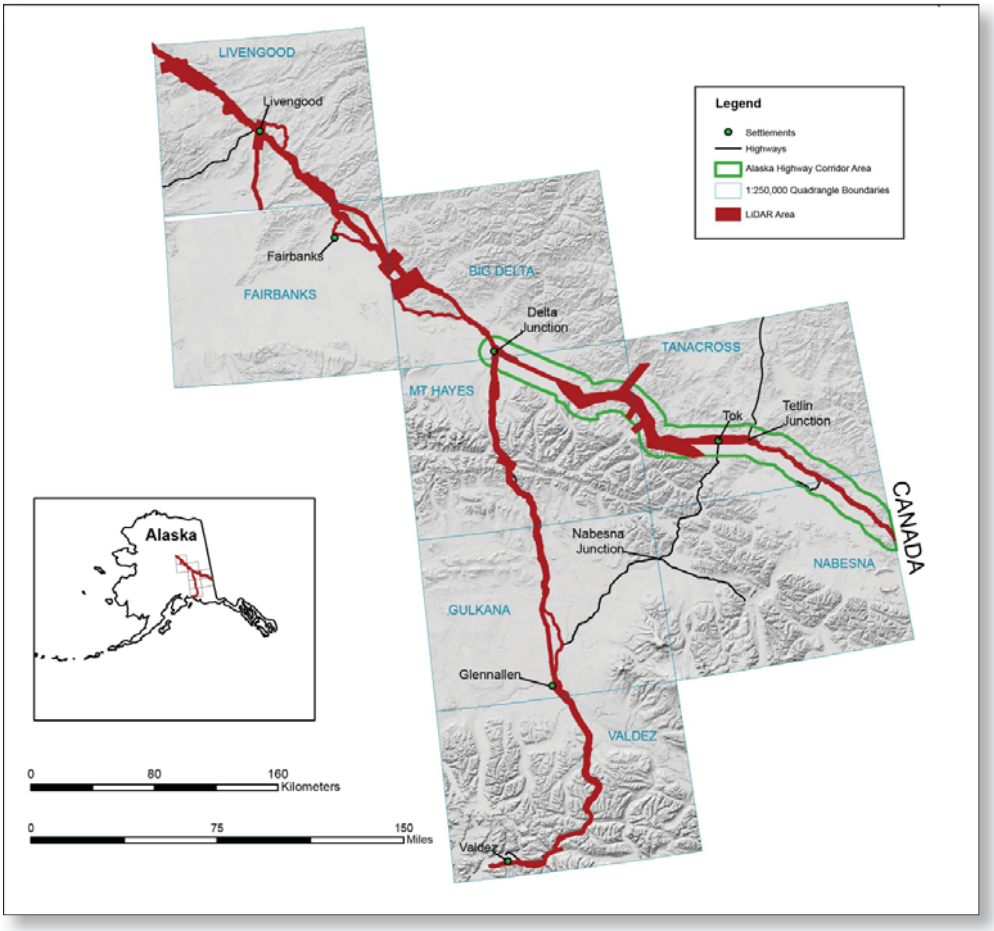
In preparation for construction of proposed natural gas pipelines, the Alaska Division of Geological & Geophysical Surveys (DGGS) has been evaluating the geology, geohazards, and material resources along a 12-mile-wide corridor centered on the Alaska Highway from Delta Junction to the Canada border, as well as selected areas where LiDAR has been collected along major transportation corridors between Livengood and Valdez (see figure).

For the area along the Alaska Highway, draft bedrock geologic maps for the corridor between Delta Junction and Tetlin Junction have been completed and submitted for cartographic review. We anticipate bedrock maps for the area between Tetlin Junction and the Canada border will be submitted for cartographic review in early 2014. Engineering-geologic maps were published in early 2013, completing the planned publication of preliminary maps and reports describing surficial geology, permafrost, engineering geology, and potentially active faults.

In 2013 DGGS continued work on a final comprehensive summary report describing permafrost, surficial geology, and geologic hazards, including active faulting, for the entire Alaska Highway corridor. This report and accompanying set of maps and seamless GIS layers will include geologic interpretations updated from preliminary versions based on evaluation of high-resolution LiDAR published by DGGS in 2011. A draft of this report will be submitted for cartographic review in early 2014. In conjunction with this report, DGGS is also finalizing a guidebook describing the roadside geology of the Alaska Highway and the Tok Cutoff to Nabesna Junction. We anticipate this will be ready for peer review in spring 2014.

DGGS is continuing evaluation of geology and geohazards in areas of LiDAR collection along the Livengood–Valdez corridor. Preliminary desktop interpretations were entered into the GIS database and summer field work was conducted to evaluate the initial work. Data and maps are currently being updated and we anticipate the resulting geologic atlas will be ready for review in fall 2014.

The Gas Pipeline Corridor project is funded by the State of Alaska as a Capital Improvement Project (CIP), with additional funding provided by the U.S. Geological Survey STATEMAP program.



Map showing areas of geology and geohazards investigations.

Contact: Trent Hubbard, 907-451-5009, trent.hubbard@alaska.gov

ALASKA STAND ALONE PIPELINE (ASAP) GEOHAZARDS STUDY

In 2013, the Alaska Division of Geological & Geophysical Surveys (DGGS) conducted field and office geohazards evaluations related to the proposed Alaska Stand Alone Pipeline (ASAP). The ASAP project is one of several pipelines being considered to transport natural gas from the North Slope to the Fairbanks and Cook Inlet areas, and possibly to a proposed export terminal in Valdez. DGGS's main objective in the geohazards investigation is to characterize a variety of geologic hazards, including earthquakes, mass movements, and cryogenic processes, that could potentially affect pipeline route feasibility, design, and construction. DGGS's investigative approach combines traditional field mapping with remote sensing technological advances, such as LiDAR and Geographic Information System (GIS) data processing technologies.

During the 2013 summer field season, DGGS geologists conducted field evaluations along the pipeline alignment from the Yukon River to Prudhoe Bay. In this area, the primary focus was to document the locations of debris slides, rock glaciers, deep-seated landslides, and slush flow chutes, as well as areas of seasonal stream icings and flooding. Additionally, previously mapped bedrock faults were inspected to determine the presence or absence of Quaternary activity. Our observations from this effort indicate that the region between the Yukon River and the Middle Fork Koyukuk River is characterized by relatively gentle slopes, shallow bedrock, and widespread solifluction. Between the upper Dietrich River and Galbraith Lake, including Atigun Pass, active slope processes present the most significant hazards to pipeline construction. Seasonal stream icings and flood erosion along the Sagavanirktok and Dietrich rivers will also require special route considerations.

The 2013 investigations contribute additional information to our 2011 and 2012 surveys; all three studies are being compiled into final maps and a report that will be delivered to the State Pipeline Coordinator's Office and the Alaska Gasline Development Corporation. The locations of geologic hazards along the entire alignment have been compiled on a hazard location map in the master GIS database, which provides a permanent archive of field data, Quaternary geology, and geologic hazards. Important details related to pipeline design and construction such as location, distribution, and relative importance of specific geologic hazards, as well as fault displacement parameters, will be addressed in the report.

The proposed ASAP pipeline alignment generally follows the Dalton Highway through the Brooks Range. This view from Table Mountain shows the route extending north from Chandalar Shelf toward Atigun Pass. Photo by Rich Koehler, June 3, 2013.

Contact: Richard Koehler, 907-451-5006, richard.koehler@alaska.gov

APPLIED ENGINEERING GEOLOGY AND NEOTECTONICS RESEARCH PROGRAM

During 2013 the applied engineering geology and neotectonics research program at the Alaska Division of Geological & Geophysical Surveys (DGGS) participated in numerous field and office technical briefings, pre-project planning meetings, and senior advisory and technical review committees related to state infrastructure projects. In addition to leading the investigations for proposed natural gas pipelines and coordinating the tsunami inundation mapping program (described separately), DGGS geologists participated in the following projects:

- Technical review of LiDAR along the Lake Clark fault zone for the Pebble Partnership.
- Field review of excavations along the Salcha seismic zone in the vicinity of the Trans Alaska Pipeline for Alyeska Pipeline Service Company.
- Review of geologic mapping associated with the Akutan geothermal project for the Alaska Energy Authority.
- Technical review of the Susitna–Watana hydroelectric project's seismic source characterization and fault lineament mapping.
- Technical review of the Design Basis for the Trans Foreland oil pipeline project, and follow up on our 2012 technical review of the Final Environmental Impact Statement for the Point Thompson oil pipeline project.
- Geotechnical characterization of the Yukon River bridge landslide for the Alaska Department of Transportation & Public Facilities.

DGGS geologists continued efforts to reduce exposure to seismic risk by participating in the Alaska Seismic Hazards Safety Commission and the Western States Seismic Policy Council. Additionally, DGGS geologists conducted paleoseismic studies aimed at better characterizing the sense of motion, recurrence, and slip rates of active seismic sources. A collaborative paleotsunami project conducted with the U.S. Geological Survey at Driftwood Bay on Umnak Island documented the presence of numerous sand sheets inferred to have been emplaced during large tsunamis associated with earthquakes along the Aleutian subduction zone. Topographic assessment of LiDAR along the Castle Mountain fault indicates that the dominant sense of motion in the Holocene has been north-side-up displacement, in contrast to the lateral motion reported by earlier workers (fig. 1). An ongoing project along the Denali fault east of the Parks Highway is using cosmogenic ^{10}Be dating methods to estimate the age of abandonment of a debris-flow fan and differential GPS surveying to quantify offset in an effort to better characterize slip rate on this section of the fault (fig. 2).

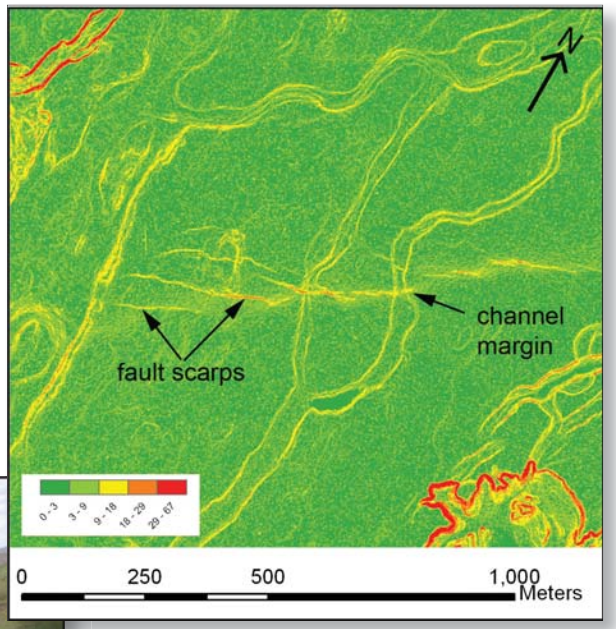


Figure 1. Slope map generated from LiDAR data showing abandoned stream channel margins that are continuous across the Castle Mountain fault and not laterally offset. The fault extends across the center of the image and is characterized by overlapping en echelon scarps.

Figure 2. Differential GPS base station set up along the Denali fault on a displaced debris-flow fan. The fault is expressed by an uphill facing scarp that extends between the red arrows.

Contact: Richard Koehler, 907-451-5006, richard.koehler@alaska.gov

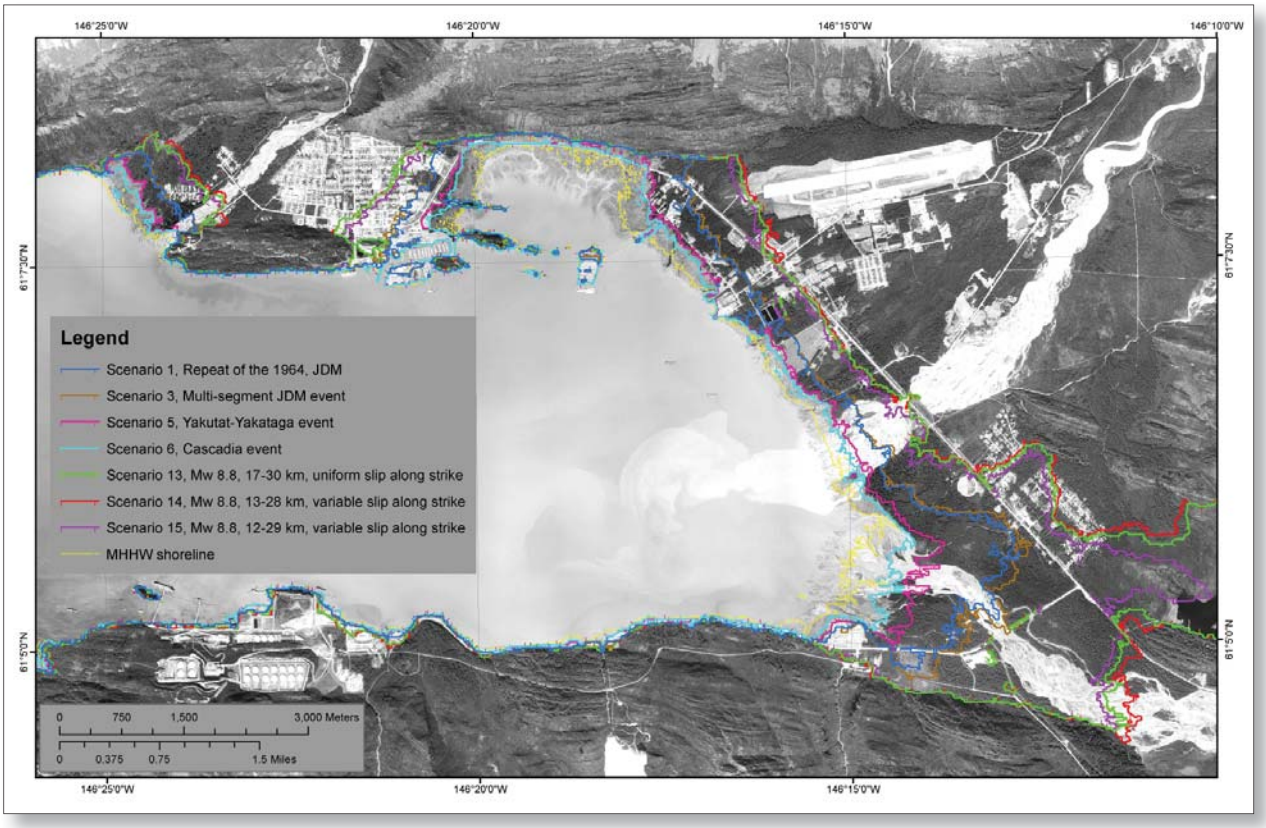
TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

The National Tsunami Hazard Mitigation Program (NTHMP) was formed by Congressional action in 1995 to reduce the impact of tsunamis through hazard assessment, warning guidance, and mitigation. Since that time, the importance of the program has been reinforced by damaging earthquakes and tsunamis in Sumatra (2005) and Japan (2011). The program now funds projects in Alaska, Hawaii, Washington, Oregon, and California, as well as the Atlantic and Gulf of Mexico states and territories.

The Division of Geological & Geophysical Surveys (DGGS) has continued to contribute to the NTHMP by participating in a cooperative project with the University of Alaska Geophysical Institute (UAGI) and the Alaska Division of Homeland Security & Emergency Management (DHSEM). Through this cooperative project, coastal communities are selected and prioritized based on their tsunami exposure risk, quality of bathymetric and topographic data, and willingness to incorporate results into evacuation route planning and other tsunami preparedness activities. Maps of potential inundation are created for each community based on hypothetical earthquake and landslide scenarios and modeled tsunami heights. Inundation maps are developed by modeling the interaction of the tsunami wave with seafloor bathymetry and projecting the resulting wave heights on the local topography. Modeling is conducted by UAGI at the Arctic Region Supercomputing Center. The resulting maps and explanatory reports are published by DGGS in hardcopy and digital formats. GIS files of the inundation limit are also made publicly available for use in local tsunami preparedness programs.

In 2013 DGGS published inundation maps and associated reports for the communities of Valdez and Sitka. For each of these communities, team members delivered on-site presentations to the local community and emergency responders to explain potential tsunami hazards, the model input data, and resulting inundation limits. Results of our recent tsunami inundation work were presented at the International Tsunami Symposium and the annual meeting of the American Geophysical Union. Final products for the communities of Chenega Bay, North Sawmill Bay, Tatitlek, and Cordova have been submitted for external peer review. Additionally, work has begun on defining earthquake sources to be used in inundation modeling for Dutch Harbor and Cold Bay.

Previously published tsunami inundation maps and reports for the communities of Kodiak, Homer, Seldovia, Seward, and Whittier are archived at DGGS, and available on the DGGS website (http://dggs.alaska.gov).



Tsunami inundation map of Valdez, Alaska, showing modeled inundation from waves generated from hypothetical scenario earthquakes.

Contact: Richard Koehler, 907-451-5006, richard.koehler@alaska.gov

HYDROGEOLOGIC STUDIES

In 2013 the Alaska Division of Geological & Geophysical Surveys (DGGS) initiated a major new program to rigorously assess the state's water resources. The DGGS Hydrogeology Program aims to lead research efforts that focus on understanding groundwater-related issues impacting resource development and communities. In collaboration with the University of Alaska Fairbanks and with input from DNR's Division of Mining, Land & Water, several projects are underway and baseline data are being gathered to guide future DGGS research.

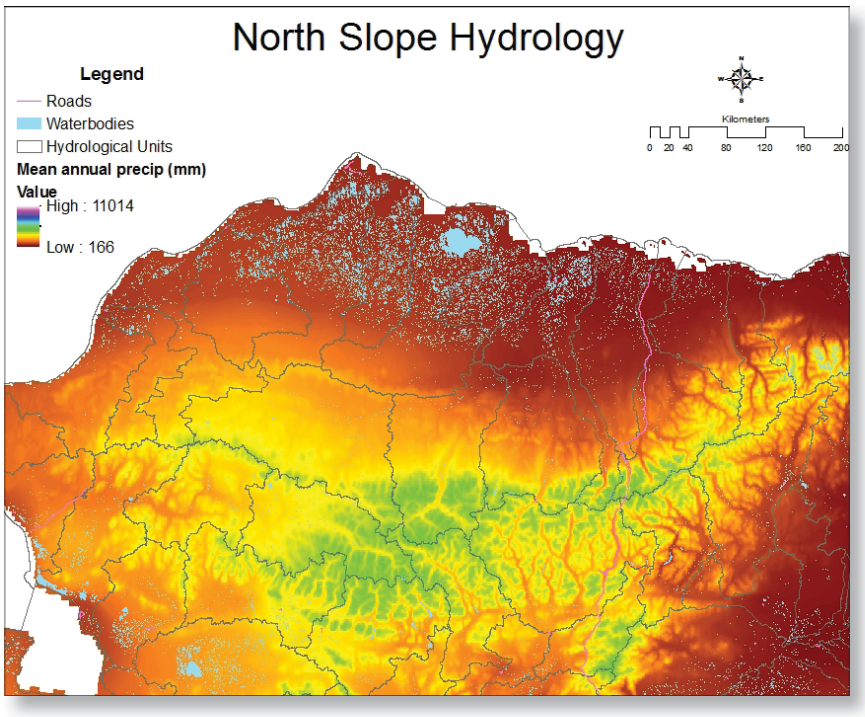


Figure 1. Map of mean annual precipitation on the North Slope and Brooks Range.

Major oil and gas exploration on the North Slope is focusing on unconventional resources, which are believed to be significant. These resources require the use of rock fracturing technologies, or "fracking," to free hydrocarbons from small pore spaces, a process that requires large amounts of liquid fresh water. In support of ongoing exploration and anticipated future development activities, the DGGS Hydrogeology Program is working to understand year-round regional water availability on the North Slope (fig. 1).

Another hydrogeology research effort is the assessment of the geothermal resource potential of Pilgrim Hot Springs, a possible source of power for the city of Nome. In 1979 DGGS and the Geophysical Institute at the University of Alaska Fairbanks initiated a study to describe the geothermal system and drilled several wells. The upflow zone, where geothermal liquid travels from a hot source to the surface, was never encountered. To develop the site it is important to drill the production well in the upflow zone to maximize the potential geothermal resource. In 2008 the Alaska Center for Energy and Power received a grant from the U.S. Department of Energy to explore Pilgrim Hot Springs using remote sensing tools and a drilling campaign (fig. 2). Drilling to date has still not intercepted the upflow zone, and DGGS is helping to analyze the available datasets to advise interested parties on a next-step approach to locating it.

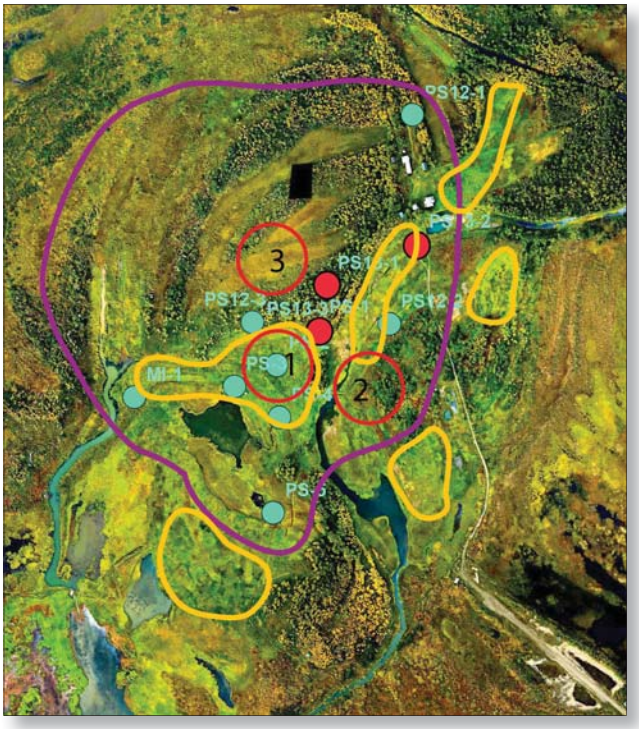


Figure 2. Map of Pilgrim Hot Springs geothermal anomaly, with deep well locations. Red dots indicate the 2013 wells, blue dots indicate older wells, and red circles numbered 1, 2, and 3 indicate current targets for upflow locations. Orange outlines are hot meadows that do not freeze in winter. Purple outline indicates the subsurface extent of an important shallow clay layer.

Contact: Ronnie Daanen, 907-451-5965, ronald.daanen@alaska.gov

GEOLOGIC CONTRIBUTIONS TO THE PROPOSED SUSITNA–WATANA HYDROELECTRIC PROJECT

The Alaska Energy Authority (AEA) has been authorized by the State of Alaska to develop the Susitna–Watana Hydroelectric Project on the Susitna River (fig. 1). The purpose of the project is to help meet the future electrical needs of Alaska's Railbelt Region by providing clean, renewable energy at the lowest possible long-term cost. Located approximately halfway between Anchorage and Fairbanks on the upper Susitna River, the 700-foot-high Susitna–Watana dam is expected to have a reservoir 68 kilometers long and up to 3 kilometers wide, with an average annual power generation of 2,600 GWhrs (AEA). The powerhouse, dam, and related facilities would be linked by a transmission line to the Railbelt Intertie, as well as to road or railroad access from the Parks or Denali highways.

An accurate assessment of the site geology and potential for seismic and other geologic hazards is essential for dam location, design, and construction. The Alaska Division of Geological & Geophysical Surveys (DGGS) is evaluating seismic-hazard issues and producing GIS-based geologic maps in support of the hydroelectric project. Ongoing work includes map and data compilation and assessment of existing geologic and seismic hazards data. Information developed in the course of this project will be disseminated through publicly available maps and reports published by DGGS.

DGGS geologists and contractors have gathered, reviewed, and compiled existing hardcopy geologic maps into a digital GIS database (fig. 2), which is currently undergoing final quality checking prior to technical review. The compilation maps and geodatabase are anticipated to be released in early 2014.

This project is funded by the Alaska Energy Authority.

*Figure 1. The Susitna–Watana Hydroelectric Project will provide power to meet the electrical needs of Alaska's Railbelt Region. Map by the Alaska Energy Authority, h*http://www.susitna-watanahydro.org.

Figure 2. The most current and detailed geologic mapping for twelve inch-to-mile quadrangles has been compiled into a single geodatabase, along with georeferenced scans and digitized vector files of the original source maps. This will be a valuable geologic data resource for developers, planners, and scientists working on the hydroelectric project, as well as for any other projects in the area.

Contact: De Anne Stevens, 907-451-5014, deanne.stevens@alaska.gov

LEGACY SURFICIAL- AND ENGINEERING-GEOLOGIC STATEMAP PROJECTS

The DGGS Engineering Geology Section is finalizing and publishing maps for five legacy projects that were supported in part by the U.S. Geological Survey (USGS) STATEMAP program (see figure). The surficial- and engineering-geologic maps for these projects describe properties and extents of surficial deposits, materials resources, and/or potential geologic hazards. Preliminary maps were submitted on time to the USGS in fulfillment of STATEMAP requirements, with the expectation that final maps would be published on a subsequent date.

Surficial-geologic and hazards maps for Kivalina and Whittier are currently undergoing co-author review and revision preparatory to external technical review in early 2014. These maps are products of the Engineering Geology Section's 2010 and 2012 STATEMAP projects, respectively, and cover areas of 168 square miles (435 square kilometers) and 100 square miles (260 square kilometers) at scales of 1:63,360 and 1:50,000. We anticipate publication and release of GIS data in late 2014.

Surficial-geologic mapping on the west side of Cook Inlet was undertaken in conjunction with the Energy Resources Section's 2009 and 2010 Tyonek STATEMAP projects. This 875 square mile (2,270 square kilometer) map area in the northwestern Cook Inlet trough is rich in petroleum, coal, geothermal, aggregate, and timber resources. The 1:63,360-scale surficial-geologic map is currently undergoing cartographic preparation in anticipation of technical review in early 2014.

A project to map surficial geology at a scale of 1:63,360 for a 1,212 square mile (3,139 square kilometer) area straddling the northern Brooks Range foothills between the Toolik and Ivishak rivers in the Sagavanirktok B-3, B-4, B-5, A-3, A-4, and A-5 quadrangles is in the final stages of revision prior to external technical review. We anticipate releasing the map by the end of 2014. The 2008 Sagavanirktok surficial mapping project was conducted in conjunction with the DGGS Energy Resources Section as part of their ongoing work along the northern foothills of the Brooks Range.

A 1:63,360-scale map of engineering geology in an 8-mile-wide (13 kilometer) corridor along the Dalton Highway near Galbraith Lake is on schedule to be released in January 2014. This map was derived from field observations and the completed surficial-geologic map, previously published by DGGS as part of the deliverables for the Energy Resources Section's 2001 STATEMAP project.

Location map of project areas for which surficial- and/or engineering-geologic maps are active in various stages of completion.

Contact: De Anne Stevens, 907-451-5014, deanne.stevens@alaska.gov

VOLCANIC ERUPTION RESPONSE: CLEVELAND, PAVLOF, AND VENIAMINOF VOLCANOES

Veniaminof volcano in eruption on August 21, 2013. Photo by Game McGimsey, USGS. Image URL: http://www.avo.alaska.edu/images/image.php?id=55161

Three volcanic eruptions occurred in Alaska during 2013: Cleveland volcano in the central Aleutians, and Pavlof and Veniaminof volcanoes on the Alaska Peninsula. During volcanic eruptions DGGS volcanology section staff spend a significant amount of time responding to the eruption. Responsibilities include responding to e-mails from the public, ensuring the public website contains the most up-to-date volcanic information releases and photographs, keeping the internal data flow manageable through the internal website and communications log, participating in daily seismic and remote sensing data monitoring checks, contributing to eruption scenario forecasts, and keeping a detailed record of ash fall, eruption chronology, and the eruption's impact on air traffic and infrastructure.

The current eruption of Cleveland volcano began on May 4, 2013, when multiple explosions were detected in infrasound arrays. Cleveland volcano is not seismically monitored and AVO relies on infrasound and satellite data to detect activity at the volcano. The volcano has remained at an elevated alert level since May; intermittent explosions are detected with infrasound and thermal anomalies are seen in satellite data. The volcano also erupted in 2011 and 2012, producing ash clouds as high as 12 kilometers (39,000 feet) above sea level, as well as lava flows and hot avalanches that reached the sea.

On May 13, 2013, seismic activity increased at Pavlof volcano and an intense summit thermal anomaly was detected in satellite imagery. On May 14, pilot reports confirmed the eruption was underway with a small lava flow near the summit. Elevated seismic activity, lava fountaining, and occasional steam, gas, and ash plumes to 22,000 feet (6,700 meters) continued until about May 24. The lava flow extended about 1.5 kilometers down the north flank of the volcano. During the eruption, regional air carriers canceled passenger and cargo flights to communities near Pavlof, including Sand Point. Flights were canceled on May 20 and June 4, 5, 6, and 25. Trace amounts of ash fell on the communities of Sand Point (May 19), Nelson Lagoon (May 20–22), Cold Bay (June 6–7), and King Cove (June 25).

Activity at Veniaminof volcano began on June 8, 2013, when AVO detected gradually increasing seismic tremor. On June 13, AVO increased the Aviation Color Code to Orange and the Volcano Alert Level to Advisory, noting that elevated surface temperatures observed in satellite data from that morning indicated an eruption with low-level effusive activity and small explosions was likely underway. From August 30 through September 2, increased seismicity, continuous tremor, lava fountaining, and ash emissions as high as 15,000–20,000 feet occurred, marking some of the strongest eruptive activity within the 2013 eruption. At the time of this writing, seismicity at Veniaminof remains elevated and the lava flows coming from the intracaldera cone, contained within the caldera walls, are approximately 300–1,000 meters in length and up to 50 meters in width.

For the complete record of these eruptions and others, visit the Alaska Volcano Observatory website at www.avo.alaska.edu.

Contact: Janet Schaefer, 907-451-5005, janet.schaefer@alaska.gov

ALASKA TEPHRA DATABASE

Figure 1. DGGS geologist Janet Schaefer inspects layers of volcanic ash (tephra) erupted from Chiginagak volcano on the Alaska Peninsula.

In 2014 the DGGS Volcanology Section will begin developing a comprehensive database of Alaska volcanic ash, or tephra. This database will house all pertinent Alaska tephra information necessary for sample processing, archiving, and scientific research. Developing correlations of tephra records across Alaska and the northern hemisphere requires an understanding of the age, chemistry, and character of tephra deposits. Tephra studies are a key component in understanding the magnitude and frequency of volcanic eruptions and help improve volcanic ashfall hazard assessments. In addition, tephrostratigraphy is an integral part of linking marine, lacustrine, and terrestrial records to aid research in paleoclimate studies and archaeology. Chemical, stratigraphic, and age data for Alaska tephras are currently dispersed in hundreds of publications and unpublished lab results, making efficient querying of information for specific research purposes impossible. Creating, populating, and developing web portals to a comprehensive tephra database will alleviate this difficulty and open up Alaska tephra data to geoscientists.

Although the tephra database is in its infancy, we have completed the following preliminary work: Carried out an initial needs assessment, prioritized the data tables that should be created and populated first, and created a draft schema to store the tephra sample metadata and electron microprobe analyses.

The entire DGGS Volcanology Section will be involved in this project by combining their expertise in a concerted effort to create and maintain a scientifically relevant and user-friendly database of Alaska tephras: Janet Schaefer, tephrochronology; Cheryl Cameron, database development; and Seth Snedigar, programming. This is a multi-year effort and the group is working closely with USGS geologist Kristi Wallace and the USGS Alaska Tephra Lab housed at the Alaska Volcano Observatory office in Anchorage.

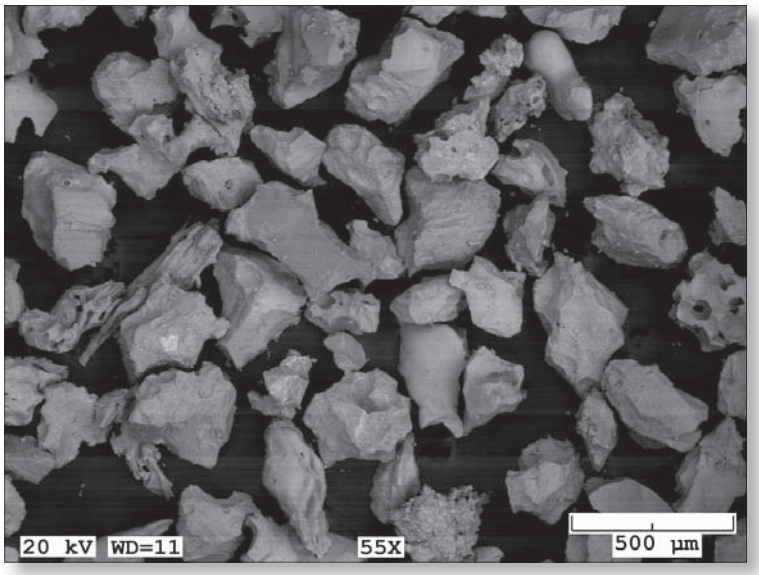


Figure 2. Backscattered electron image of ash erupted from Veniaminof volcano on August 18, 2013.

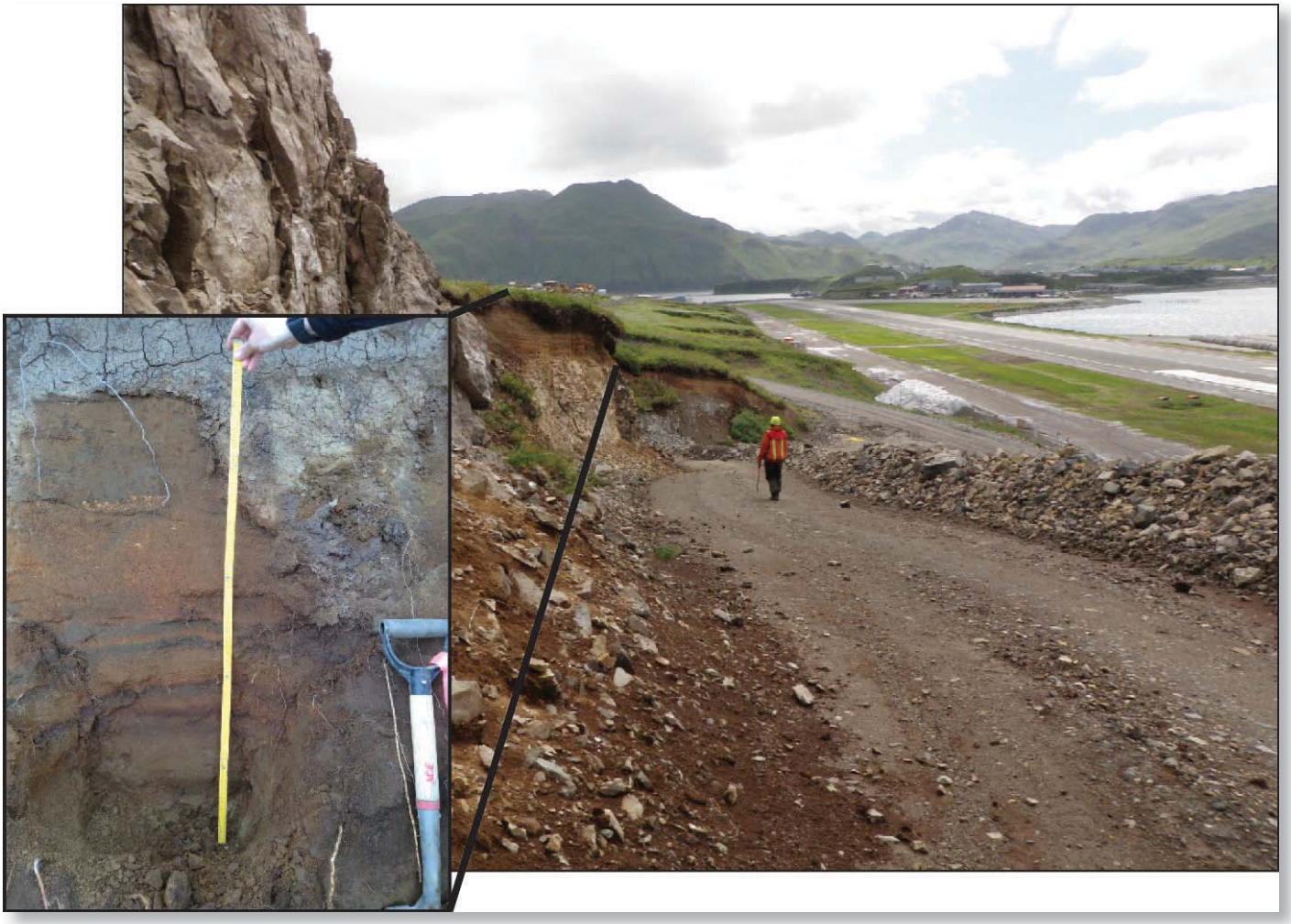
Contact: Janet Schaefer, 907-451-5005, janet.schaefer@alaska.gov

HOLOCENE ERUPTION HISTORY OF MAKUSHIN VOLCANO

Eruptions from Makushin volcano pose a hazard to facilities and residents of Dutch Harbor/Unalaska, the most productive fishing port in the nation. Given the potential impacts to Dutch Harbor, especially from volcanic ash fall, the Alaska Volcano Observatory has prioritized scientific investigations at Makushin to better understand the three voluminous early Holocene eruptions and numerous small ash fall events that have impacted the Dutch Harbor/Unalaska region.

DGGS geologist Janet Schaefer, along with colleagues Jessica Larsen and Jim Begét of the University of Alaska Fairbanks and Jim Vallance of the U.S. Geological Survey Cascades Volcano Observatory, are working to refine understanding of the recent volcanic history of Makushin volcano. Fieldwork over the last two years has focused on stratigraphic and geochemical studies of the caldera-forming eruptions and post-caldera ash fall. During the first of these explosive eruptions, ~8,700 years ago, voluminous basaltic andesite ignimbrites filled surrounding valleys to depths of 100 meters or more. Magma output was sufficient to cause collapse of the edifice to form a 2 x 3 kilometer-wide crater. During the next explosive eruption, ~8,000 years ago, pyroclastic density currents swept across the bay and deposited ash and pumice as much as 50 centimeters thick in the vicinity of Dutch Harbor (see figure). Yet another explosive eruption ~7,700 years ago produced a thick pumice and ash fall. Near the airport in Dutch Harbor this deposit contains pumice clasts as large as 1 centimeter diameter in a layer 1.7 centimeters thick. Dozens of smaller eruptions have occurred since then, depositing ash from a few millimeters to a few centimeters thick, with several deposits reaching Dutch Harbor/Unalaska.

Current work consists of detailed stratigraphic descriptions and tephra collection at multiple sites around the volcano to help refine the Holocene eruption history and to improve our understanding of the volumes, distribution, and recurrence interval of recent explosive eruptions.

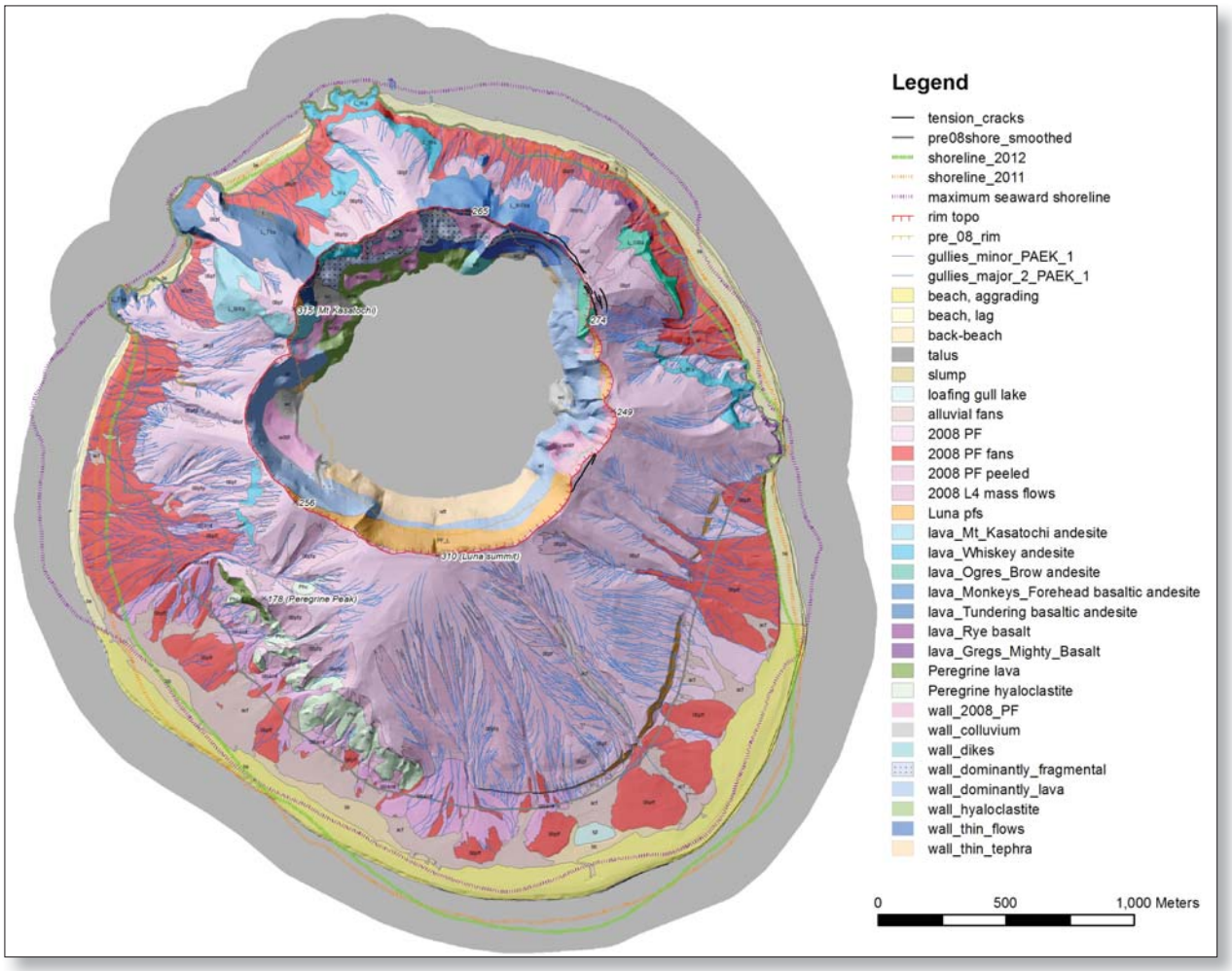


DGGS geologist Janet Schaefer walks along a road cut above the Dutch Harbor airport, where multiple explosive eruptions from Makushin volcano over the last ~9,000 years have deposited layers of ash from a few millimeters to several centimeters thick.

Contact: Janet Schaefer, 907-451-5005, janet.schaefer@alaska.gov

KASATOCHI VOLCANO: GEOLOGIC MAPPING AND VOLCANOLOGICAL STUDIES

Kasatochi is a 7 square kilometer (2.7 square mile) island volcano midway between Atka and Adak, in the Aleutian Islands. It provides nesting territory for several hundred thousand seabirds, is one of the largest sea lion rookeries in the Aleutians, and has been closely studied by the U.S. Fish and Wildlife Service (USFWS) and other biologists in recent decades. In August 2008 Kasatochi erupted for the first time in written history. The eruption was about a thousand times more energetic than any other Alaska eruption in nearly a century. During the day-long eruption the area of the island increased by 40 percent, the area enclosed by the crater rim increased by 30 percent, the crater-lake grew by 70 percent, and pyroclastic deposits completely covered seabird nesting crevices. A multiagency and multidisciplinary group quickly assembled, attracted to the rare opportunity to study the regrowth of an ecosystem that had been nearly obliterated. The study has been funded by the North Pacific Research Board, U.S. Geological Survey, USFWS, and the Alaska Volcano Observatory (AVO). Prior to the eruption the geology was virtually unknown. As an AVO partner organization, the Division of Geological & Geophysical Surveys (DGGS) is leading the effort to produce the first-ever geologic map of Kasatochi as part of the ecosystem recovery project, and as a lead-in to volcanologic and petrologic studies. Fieldwork has been based off the USFWS refuge ship Tiglax on 2–3-day trips twice each summer starting in 2009, although winds and waves that precluded landing a skiff on the island have resulted in dramatically reduced on-island time on some of the trips. To date roughly 100 rock samples have been collected and analyzed chemically and petrographically. These data and field mapping have served to distinguish several major pre-eruption rock units. Additionally 3,500 mineral analyses have been collected from a stratigraphically and compositionally representative subset of samples. The mineral analyses provide important information about complex petrogenetic (rock-forming) processes. The 2008 eruption, probably because it was so energetic, brought to the surface many nodules of cumulate zero-age gabbroic "crystal mush." Such nodules are unusual, though not unique and, as the solid residue of petrogenesis, provide important additional constraints on processes governing the genesis of magmas. The geologic map is complete (see figure), and writing of unit descriptions and other explanatory information is underway.

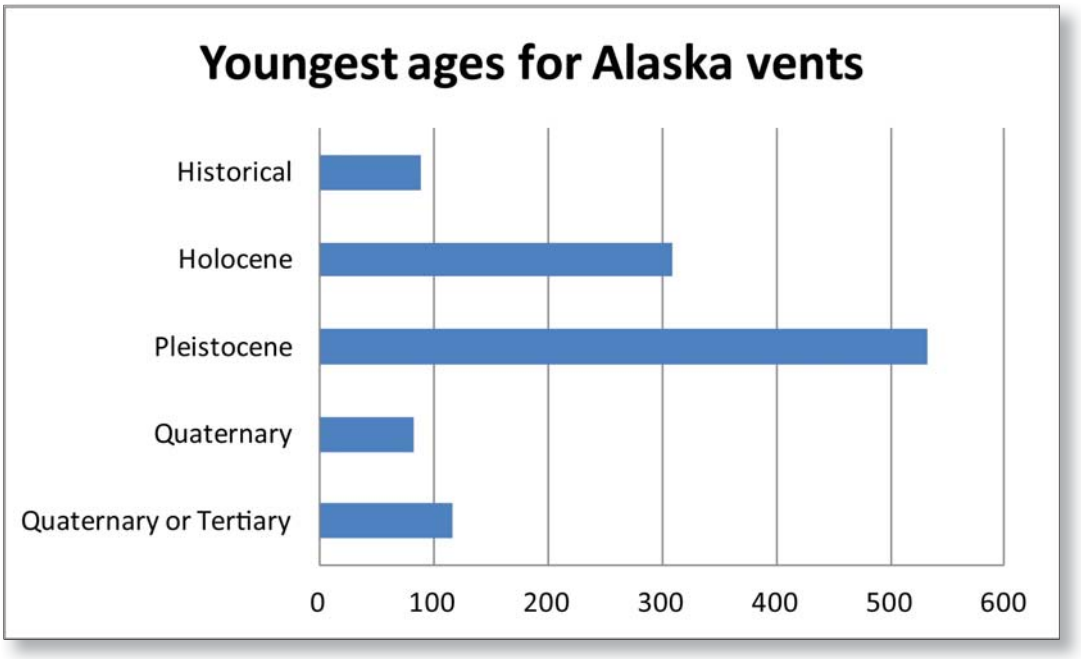


Draft geologic map of Kasatochi volcano.

Contact: Christopher Nye, 907-451-5005, chris.nye@gi.alaska.edu

DATABASE OF QUATERNARY VOLCANIC VENTS IN ALASKA

The Alaska Volcano Observatory currently uses an informal set of names for about 140 "volcanoes" (www.avo.alaska.edu/volcanoes). Some names refer to large, complex volcanic centers, while others indicate only a specific cone. The database of Quaternary volcanic vents expands the list of 140 volcanoes to include all volcanic vents (where magma has reached the surface) over the past 1.8 million years. This list currently contains 1,126 subaerial entries. This database of all known (published, or unpublished with permission) Quaternary vents was developed to better describe the nature and character of Quaternary volcanism in Alaska, and specifically to aid in the discussion of spatial and temporal patterns of Alaska volcanism.



Graph of Alaska Quaternary vents by known or suspected ages. Vents are classified as simply "Quaternary" when we don't know whether they are Holocene or Pleistocene, and "Quaternary or Tertiary" for those vents for which Quaternary age is less certain.

For each vent, we have compiled the following information:

- its place within geographic and volcanic hierarchies
- a broad morphology designator (for example, cone, dome, stratovolcano, etc.)
- a location (latitude and longitude)
- a confidence ranking for the location
- a confidence ranking for whether or not the feature is a vent
- an age of youngest eruption (magma reaching the surface of the earth)
- a short text field describing the basis for the age designation
- for those vents with published information, links to selected publications

For the more common morphologies, this compilation effort has classified 114 features as stratovolcanoes, 30 shield volcanoes, 287 cones, 294 monogenetic cones, and 174 domes. Although we currently have only two submarine entries, we expect to add more than 100 newly discovered seafloor cones. This list is a starting point for cataloguing and describing Alaska's young vents, and we hope it is continually updated and improved by the addition of newly discovered vents. We invite the community of volcanologists who study Alaska volcanism to help us increase the value of this database by adding new vents as they are discovered, and by improving the geologic descriptions of known vents as new information becomes available.

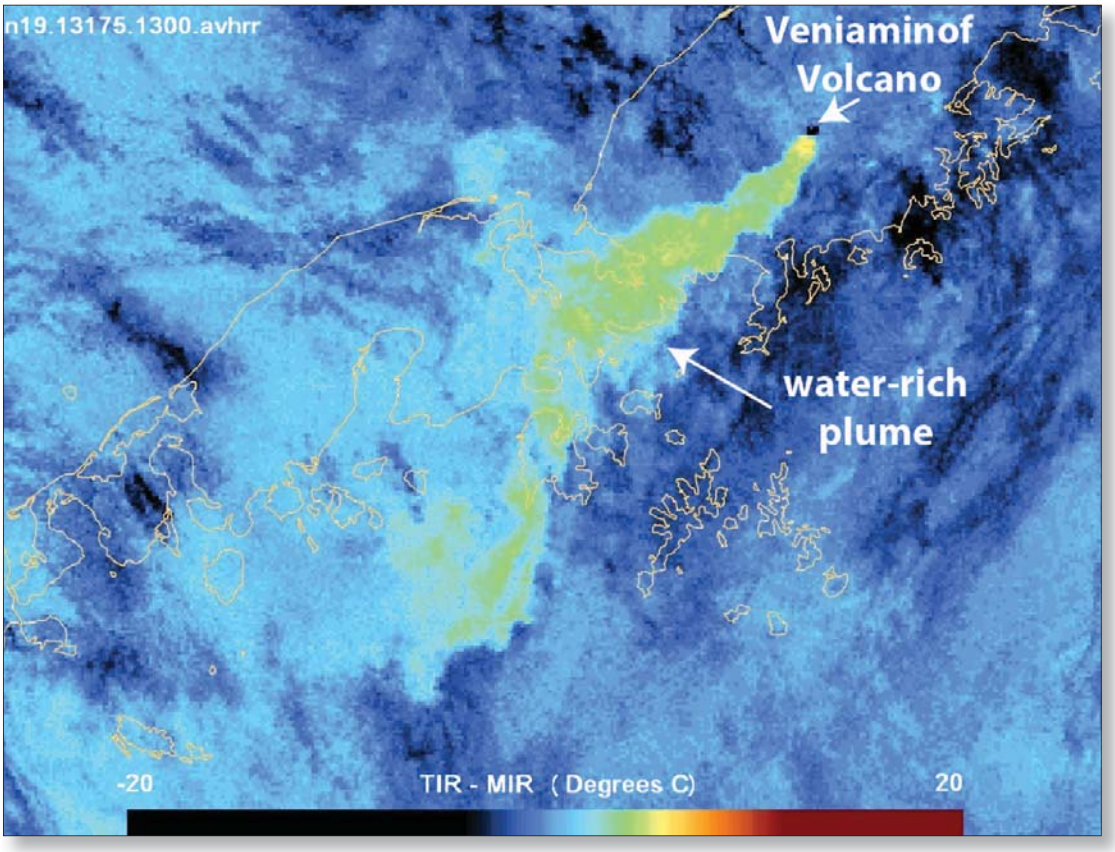
Contact: Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov

ALASKA VOLCANO OBSERVATORY (AVO) REMOTE SENSING OBSERVATION DATABASE

Although Alaska has more than 50 historically active volcanoes, only 29 are monitored seismically. The remaining volcanoes are monitored by satellite. At least once a day, AVO geologists examine satellite images for signs of volcanic unrest or eruption, such as ash plumes or elevated surface temperatures. To ensure that these observations and selected images are distributed, archived, and searchable, AVO/DGGS is creating a database and associated software to store the information internally. This application and database are designed to work with "VolcView", the U.S. Geological Survey satellite image viewing web application (http://volcview.wr.usgs.gov).

The software will allow users to upload image files to the observation database directly from their computer, or from a URL, and annotate the images with captions as appropriate. Users will have the capability to execute multiple cycles of adding text and images and previewing the results. Once the user is satisfied with the look of their report it is submitted to the database. At this stage the report is tagged with associated volcano names and keywords, and parsed into separate tables so it can be easily queried. Finally, the report is entered into the internal AVO communication log system and emailed to the AVO operations group.

This product is currently in the testing phase. We anticipate using it in daily operations in early 2014.



An extensive water-rich plume from Veniaminof volcano, June 24, 2013. This image was created by Dave Schneider, AVO/USGS, by enhancing the night-time thermal and mid-infrared satellite data. The new remote sensing observation database will allow this type of image and data analysis to be linked and available through an online query interface.

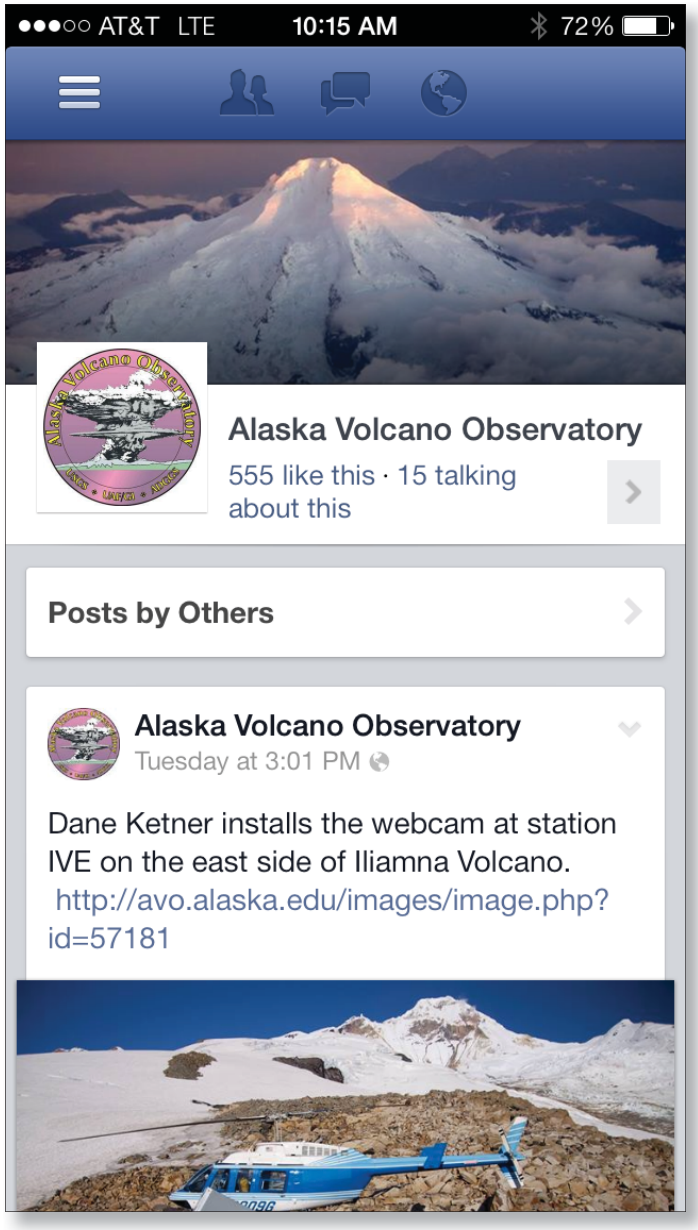
Contact: Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov,
or Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov

ALASKA VOLCANO OBSERVATORY (AVO) SOCIAL MEDIA

The Alaska Volcano Observatory has three primary objectives: (1) to conduct monitoring and other scientific investigations to assess the nature, timing, and likelihood of volcanic activity; (2) to assess volcanic hazards associated with anticipated activity, including kinds of events, their effects, and areas at risk; and (3) to provide timely and accurate information on volcanic hazards and warnings of impending dangerous activity to local, state, and federal officials and the public. As an AVO partner, and in support of the third primary objective, the Division of Geological & Geophysical Surveys' (DGGS) Volcanology Section is working to use social media such as Twitter and Facebook to reach a larger and more diverse audience than our current website, fax, and email protocols.

In 2013 DGGS created an AVO-specific Facebook account (http://facebook.com/alaska.avo) as part of the overall social media plan. This account is in addition to the Twitter presence AVO has maintained since 2009 (http://twitter.com/alaska_avo). To keep this account up to date with the latest official information, pictures, and news, several pieces of software used by other elements of AVO were updated to communicate with Facebook. The Hazard Notification System (HANS), which sends out Daily Status Reports, Weekly Updates, and other official notices, now also sends a short synopsis of each message to the Facebook account, as well as selected important updates to the Twitter account. We updated our internal image database so that AVO staff can upload images and captions directly to both Twitter and Facebook with the click of a button. DGGS–AVO staff also maintain a schedule to monitor the Facebook page, moderating comments and images as needed so the page contains appropriate information only.

We believe social media are excellent tools to provide rapid communication to our users, with some important qualifications: (1) information posted to social media must be the same information contained in our formal notices and our website; (2) social media posts must continue to provide links to full and complete information (rather than being an informational dead end); and (3) monitoring and maintaining social media accounts must not require unreasonable staff resources. Not only do social media help AVO reach an increasingly mobile-device-oriented public, it assists the public in communicating with AVO, especially for ashfall accounts, eruption photos, and information about eruption impacts.



AVO's newly created Facebook page, as viewed from a mobile device.

Contact: Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov,
or Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov

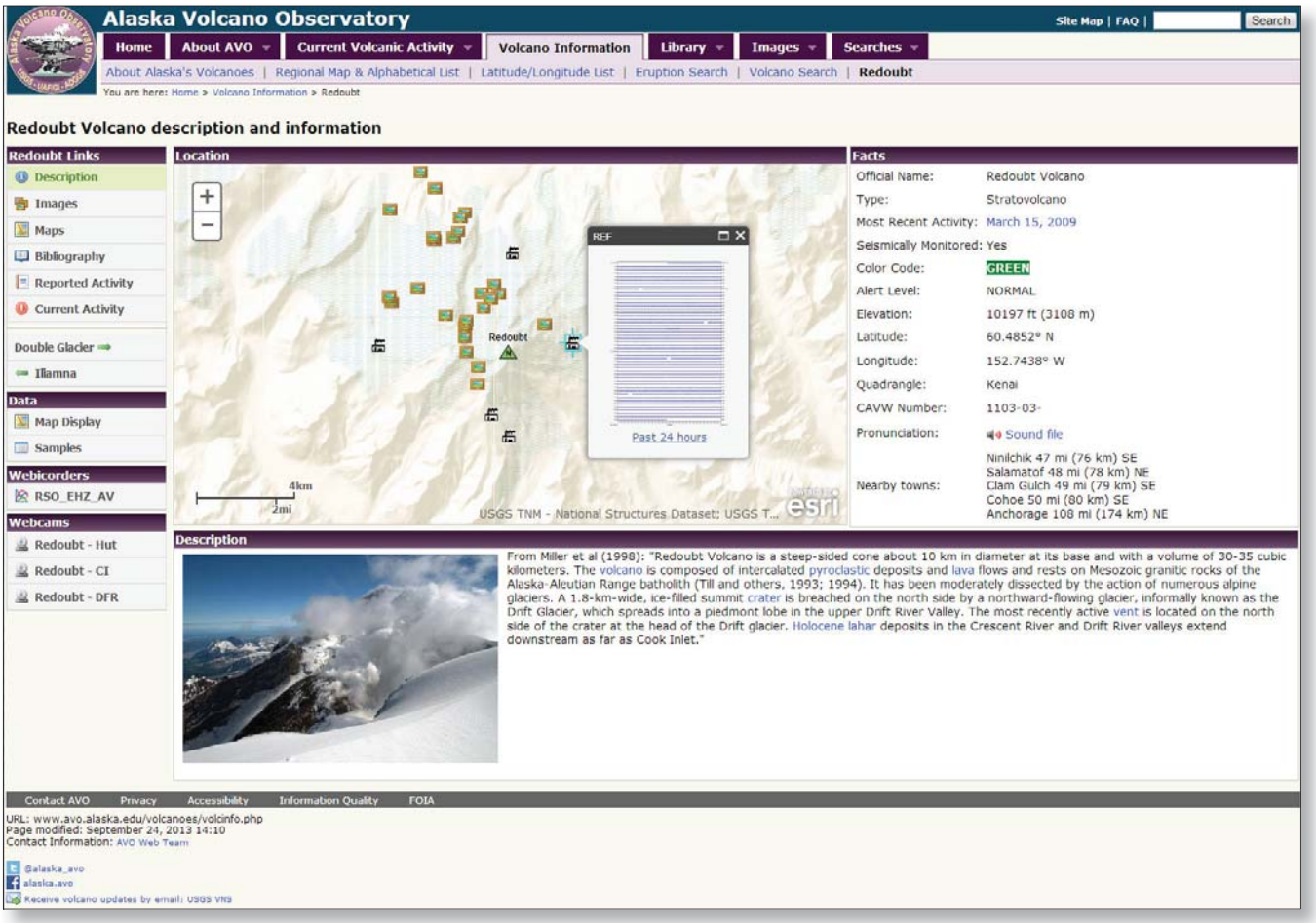
ALASKA VOLCANO OBSERVATORY (AVO) WEBSITE

The AVO public website (http://www.avo.alaska.edu) serves about 3,000,000 pages to well over 100,000 unique visitors per month, and is among the top ten most-visited 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. The website is dynamically driven by the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA).

The website and underlying content rely on several pieces of vendor-supplied software to operate efficiently. These external software products are continually updated, with new official versions being released on a regular basis. To keep the website performing at peak capability and running securely, the new software is tested locally and then installed on the production servers that run the website. This year DGGS upgraded the scripting language software (PHP) to the newest released versions.

Throughout the year DGGS adds many enhancements to the website software that improve the experience for both our public and internal users. A short list of 2013 improvements includes: Upgrades to the public e-mail system, allowing scientists to receive a text message when the website receives an e-mail regarding ash fall; a new interface for viewing webcam images, adding code that automatically generates videos from the previous 12- and 24-hour intervals; and continued updates to the web-mapping interface, with addition of dynamic, interactive location and information maps to more pages on the website (see figure).

DGGS/AVO is on the leading edge of web and database development for volcano observatories, and portions of DGGS-written database software have been installed at other U.S. volcano observatories. DGGS is following new and emerging technologies, such as sphinx text searches, that will allow us to further enhance AVO's web presence and data dissemination abilities. We continually refine and enhance the applications that AVO and other observatories use on a regular basis. We will maintain our focus on continual incremental improvements to the site, and serving new database modules as they become available.



Redoubt Volcano's information page, showing an updated webmap that includes geo-located photographs and seismic stations that link to actual data from the station.

Contact: Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov,
or Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov

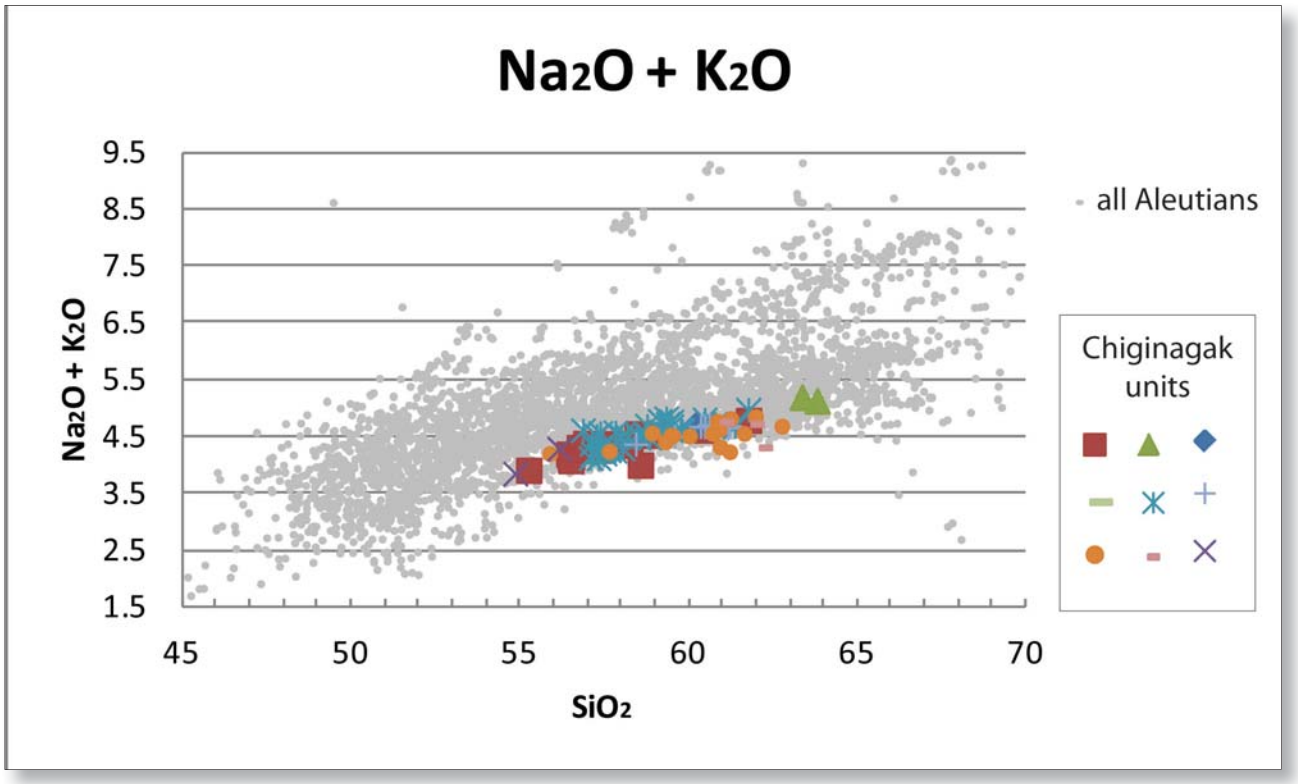
ALASKA VOLCANO OBSERVATORY (AVO) GEOCHEMICAL DATABASE

As part of DGGS's ongoing efforts with the Geological Database of Information on Volcanoes in Alaska (GeoDIVA), DGGS/AVO staff have created a database structure to hold geochemical data on Quaternary volcanic rocks in Alaska. Published data will be available to the public through AVO's website, and searchable by map, volcano, sample metadata information, or specific geochemical values or analysis types. Data are already available on the public website on a per-volcano basis. Unpublished data are available internally to AVO users if the data owner has granted explicit permission.

Currently, whole-rock major and trace element values, water cation and anion analyses, and analysis metadata are loaded in the database. The system is designed to accommodate other types of geochemical data as well, and is intended to be compatible with other major geochemical database efforts (e.g. EarthChem). We are making every effort to provide the best data possible for each sample and analysis, which often entails additional actions such as tracking down obscure references and untangling sample nomenclature through the decades. In addition, we have adjusted the results for hundreds of samples analyzed by inductively coupled plasma mass spectrometry (ICP-MS) at Washington State University prior to 2007 to correct calibration errors in the original report; we retain the best known value for each analysis.

This database is a valuable research tool for geoscientists with interests ranging from volcano-specific processes to whole-arc data synthesis. Because the database is an intrinsic part of GeoDIVA, it will also help consolidate all of Alaska's volcano information in one place. Our sample database currently holds more than 11,000 samples; the geochemical database holds 6,159 published and unpublished analyses. We estimate that fewer than 100 published analyses remain to be entered.

We are currently refining our web interface to query the data and return results of analysis values and metadata in useable formats for our end users. We are also wrapping up the data entry of previously published data, and looking forward to adding individual electron microprobe analyses of tephra grains in support of the upcoming tephra database (described elsewhere in this report).



A graph made using data from AVO's geochemical database. The gray dots represent values from thousands of published Aleutian samples, the colored symbols are values from Chiginagak volcano rock units.

Contact: Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov,
or Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov

ALASKA VOLCANO OBSERVATORY (AVO) GEODIVA DATABASE

AVO/DGGS staff design, populate, maintain, and distribute the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA). GeoDIVA maintains complete, flexible, timely, and accurate geologic and geographic information on Pleistocene and younger volcanoes in Alaska. This data supports scientific investigation, crisis response, and public information in a dynamic, digital format. GeoDIVA is the most comprehensive and up-to-date source of information for Alaska volcanoes available. This database is also the back-end of the public and internal websites of AVO.

The database has been developed in modules, and uses more than 360 tables in MySQL. We replaced our primary database server in 2013 when the previous server experienced a catastrophic failure. A backup server was in place at the time, so there was no loss in data delivery. GeoDIVA grows by continual feeding of new data into existing modules and by episodic surges of growth as new modules come on line. See the table below for completed, in progress, and planned modules.

Module	Status	Notes
Bibliography	Maintenance mode	Contains ~4,800 references
Basic volcano information	Maintenance mode	145 major volcanoes, 178 sub-features; update of descriptive text planned in 2014
Eruption history information	Maintenance mode	Information and references for 440 historical eruptions
Images	Maintenance mode	More than 21,000 images
Geologic sample information	Maintenance mode	11,273 samples and metadata
Geochemistry	Data loading nearly complete; user interfaces under construction	6,159 whole rock and water chemistry analyses
Petrology	Data created and loaded intermittently	Intent is to build an Aleutian-Arc-wide collection of thin section descriptions and images
GIS data	Flexible holding database built, not populated	Awaits personnel time to inventory existing GIS data
Hand-sample storage	Maintenance mode	More than 8,200 samples archived
Ash - Is it falling?	Maintenance mode	Website and database for citizen ashfall reporting
Internal logs and contacts	Updates planned to logs' "look and feel"; full text search planned	Supports internal AVO communications
Vent Inventory	Nearly published	See separate briefing paper
Satellite observations	Planning and test construction	See separate briefing paper
Tephra data	Planning and test construction	See separate briefing paper
Geochronology	Schema built	Lesser priority than geochemistry, vents, satellite observations, and tephra

Our internal calendar stores duty person assignments and personnel leave information in GeoDIVA MySQL tables and is available via our internal website. We have recently updated the internal calendar to interface with Google and Outlook. This greatly improves the calendar's functionality to AVO staff.

In calendar year 2014, in addition to the maintenance of the modules listed, we plan to overhaul the text of our volcano descriptions. This update will allow us to subdivide the descriptive text into categories (e.g. "hazards" or "historical seismicity"), as well as use wiki-style referencing and inline images. We anticipate this will not only improve and expand the content we deliver but also increase the readability of the basic volcano information on our website.

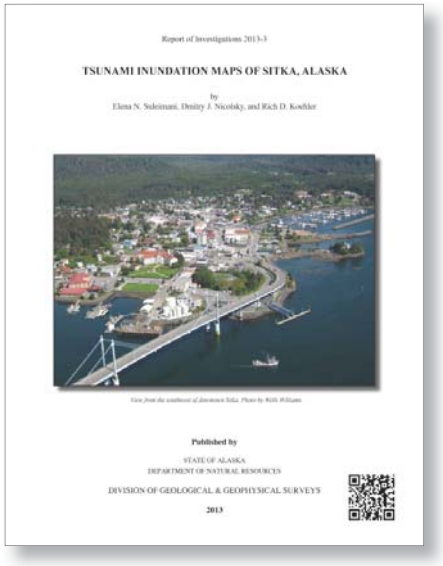
Contact: Cheryl Cameron, 907-451-5012, cheryl.cameron@alaska.gov,
or Seth Snedigar, 907-451-5033, seth.snedigar@alaska.gov

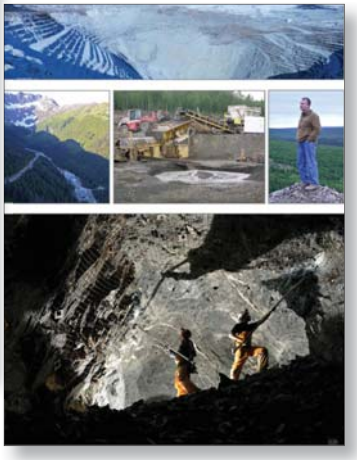
PUBLICATIONS AND OUTREACH PROJECT

This project publishes and distributes geologic data that has been collected, analyzed, and assembled by DGGS geologists. Some of the functions carried out through this project are:

- Design, digitally assemble, edit, and coordinate production of technical and educational geologic maps, reports, and informational publications in printed and digital formats.
- Prepare an annual report describing DGGS projects, activities, and accomplishments, and relating future challenges.
- Publish newsletters to summarize Division field projects and achievements and announce new publications.
- Prepare displays and represent the division at geologic conferences and meetings by providing staff and designing, assembling, and transporting the display booth.
- Staff full-time geologic information center, providing data about Alaska's geologic resources and hazards through Division publications, geoscience specialists, and other resources. Sell and distribute printed and online geologic reports, maps, and digital data.
- Manage DGGS's reference library so that reports, maps, and other data are available and publications that geologists need to prepare geologic products are readily accessible.
- Maintain as complete a collection as possible of Alaska-related geoscience publications produced by the U.S. Geological Survey, the former U.S. Bureau of Mines, the U.S. Bureau of Land Management, and the UAF Mineral Industry Research Laboratory; and other Alaska-related publications as needed.

Publications produced by this group record and preserve geologic data such as: statistics for Alaska's mineral industry; detailed (1:63,360-scale or greater) 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 explaining Alaska's geology or natural-science features. Some of DGGS's recent publications include: ◆ Quaternary faults and folds of Alaska online interactive map ◆ Report on Pacific northwest earthquakes and potential effects on Alaska ◆ Yukon River bridge landslide: Preliminary geologic and geotechnical evaluation ◆ Tsunami inundation maps of Port Valdez and Sitka ◆ Preliminary evaluation of coastal geomorphology and geohazards on 'Kigiqtam Iglua', an island northeast of Shishmaref ◆ Surficial-geologic and engineering-geologic maps of the Alaska Highway corridor, Tetlin Junction to Canada border ◆ Coastal hazard field investigations in response to the November 2011 Bering Sea storm ◆ Fossil fuel and geothermal energy sources for local use in Alaska: Summary of available information.





Publications are available in paper format (plotted as needed and sold for printing cost) and as digital PDF documents and scanned, compressed maps on the DGGS website (available for download at no charge). An increasing number of GIS digital datasets are available on the DGGS website, along with the maps and accompanying figures. Having the geospatial data available allows our users to download the data and use it as they need. 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.

Contacts: Joyce Outten, 907-451-5020, joyce.outten@alaska.gov,
Joni Robinson, 907-451-5017, joni.robinson@alaska.gov,
or Paula Davis, 907-451-5053, paula.davis@alaska.gov

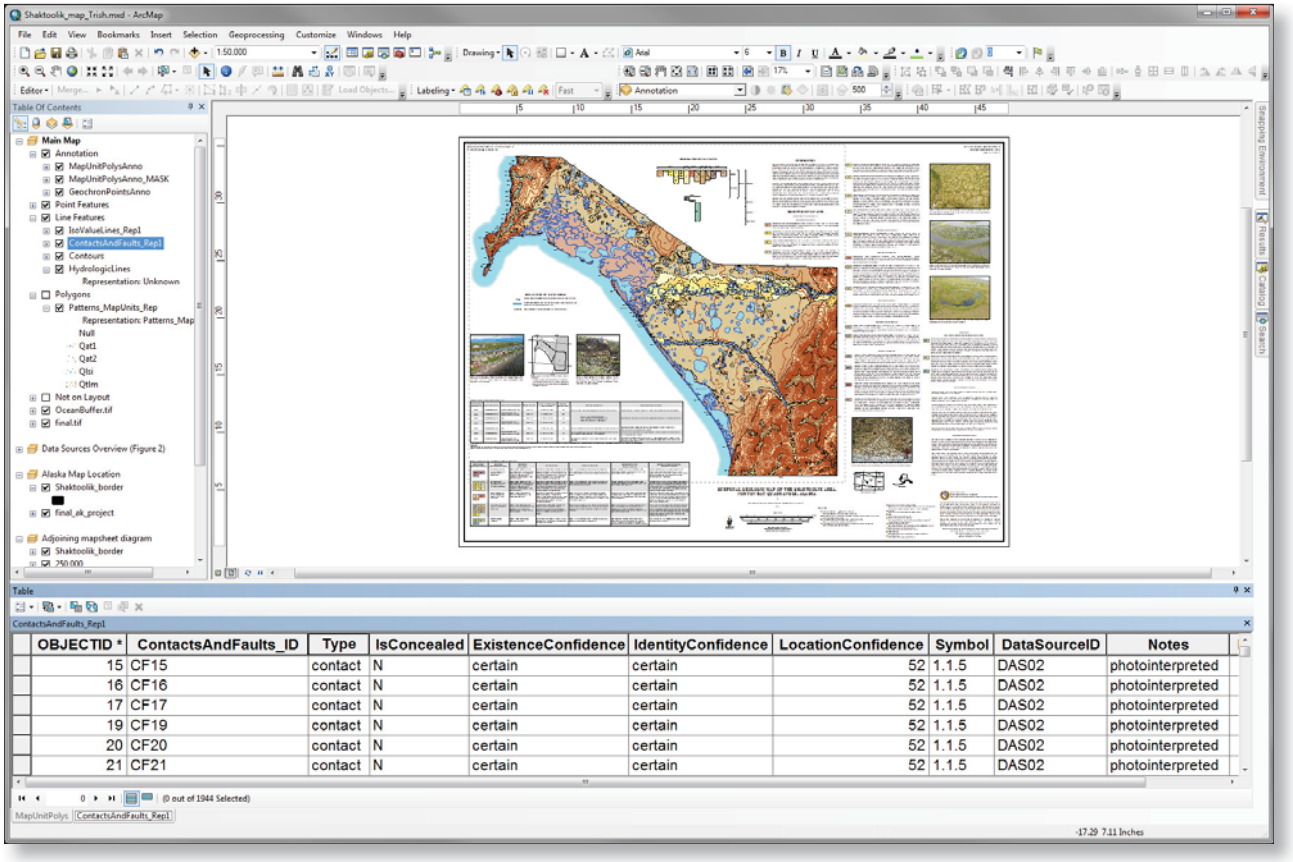
GEOGRAPHIC INFORMATION SYSTEM (GIS) PROJECTS

The GIS projects underway at the Division of Geological & Geophysical Surveys (DGGS) are designed to take advantage of recent advancements in geospatial tools, to present DGGS's geospatial data in multiple ways, and to provide the State with a comprehensive repository of all geoscientific data that we collect and distribute. While we continue to provide conventional maps and reports (available in both paper and PDF formats), we are rapidly expanding our GIS products to include more tabular files of analytical data, map data in shapefile format, geospatially-referenced image collections, web map services, and online map- and text-based search interfaces. This array of GIS products makes our information readily accessible to the widest possible audience, decreases the effort required to view, obtain, and use the data, and ensures systematic stewardship of legacy data.

In FY13 DGGS implemented a division-wide, standardized data design model and a higher degree of consistency in our metadata. Significant changes in workflow have shifted much of the cartographic, data management, and metadata compilation tasks from scientists to GIS and data management specialists. This assembly line approach allows DGGS scientists to focus on data collection and interpretation, and then hand off their interpreted data to GIS and database support staff for final cartography, formatting, and metadata compilation. In turn, support staff are able to use their topical expertise to provide users with GIS data that is optimized for a wide range of software applications, organized to allow for easy integration with other sources of information, and consistently described to extend the life cycle and broaden the usefulness of the information.

An important component of our revised data production process is implementation of a standardized geodatabase model based on the U.S. Geological Survey (USGS) NCGMP format (http://ncgmp.usgs.gov/). Instituting this model as our geodatabase format standardizes the data's content, attributes, naming conventions, and other pertinent information required for archiving and disseminating geologic map data, and ensures that all datasets are consistent.

Developing and implementing division-wide data standards for our GIS products has required significant modifications to the steps we use to prepare our data for distribution. Individualized processes, which worked well when our products were largely limited to print files, simply could not be sustainably adapted to provide end products that could be utilized by GIS users and integrated with other datasets. Our commitment to providing standardized data has already enabled us to develop an efficient and rigorous process for validating data and generating metadata. In time, these improvements will provide a solid organizational foundation from which we can cost-effectively build future web map applications, provide cartographic support, and generate high-quality metadata.



OBJECTID *	ContactsAndFaults_ID	Type	IsConcealed	ExistenceConfidence	IdentityConfidence	LocationConfidence	Symbol	DataSourceID	Notes
15	CF15	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted
16	CF16	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted
17	CF17	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted
19	CF19	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted
20	CF20	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted
21	CF21	contact	N	certain	certain	52	1.1.5	DAS02	photointerpreted

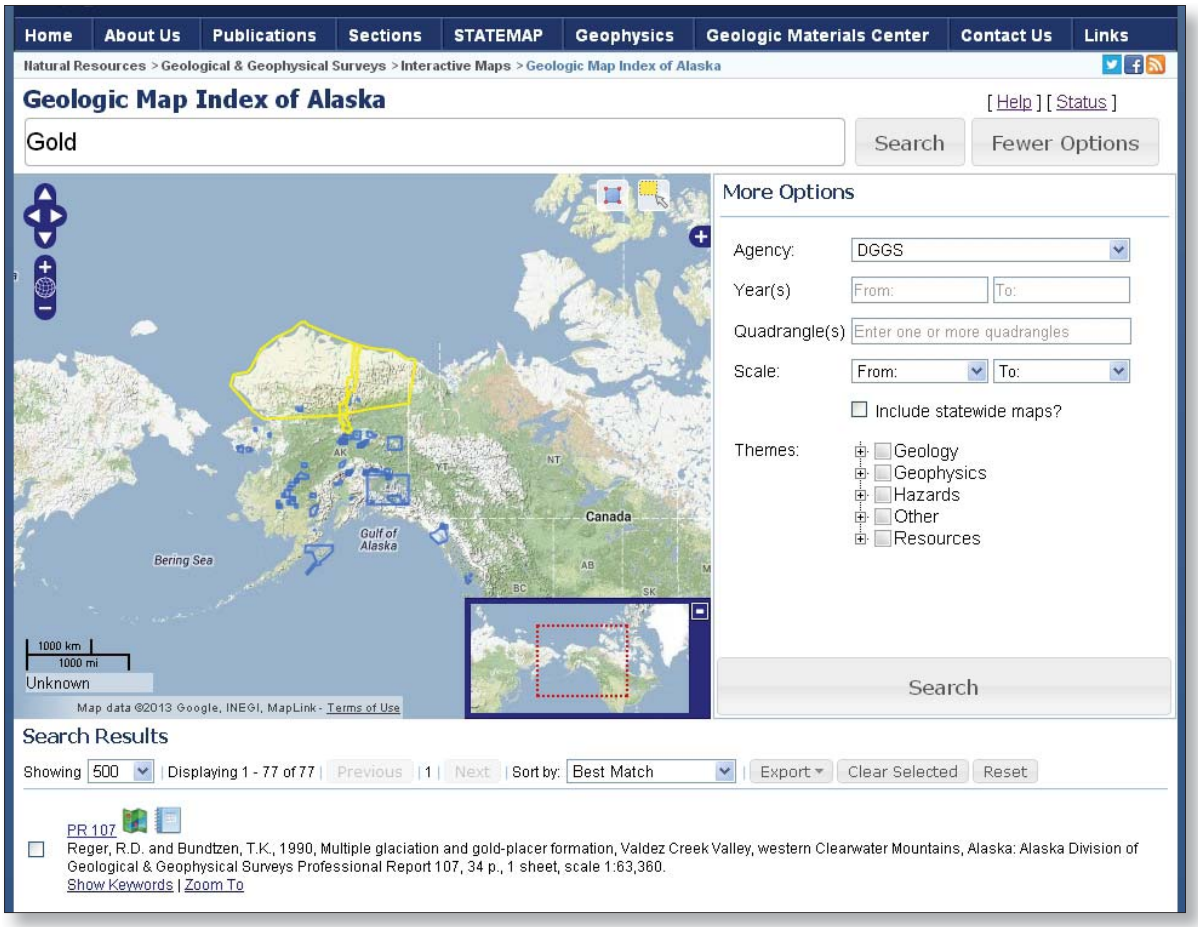
Contacts: Simone Montayne, 907-451-5036, simone.montayne@alaska.gov,
or Patricia Gallagher, 907-451-5039, patricia.gallagher@alaska.gov

GEOLOGIC MAP INDEX OF ALASKA

In FY2013 the Division of Geological & Geophysical Surveys (DGGS) continued efforts in support of the goal of providing data via interactive web interfaces to quickly deliver real-time, detailed information to the public. DGGS has released several web map search interfaces to allow access to a variety of data types, including the "Geologic Map Index of Alaska" (maps.dggs.alaska.gov/mapindex/) in October 2013. This application provides the locations and outlines of most DGGS and U.S. Geological Survey (USGS) geological and geophysical maps of Alaska in a single, interactive web map. It allows searches of the database by geographic area of interest, keywords, map themes (bedrock, engineering, and surficial geology, geophysics, hazards, resources, etc.), publishing agency, dates, and other criteria. Users can highlight search result records by individual publication or map selection and export them to an Adobe PDF document. The search results link to DGGS's comprehensive, multi-agency publications database, where users may view and download publications for free. No other geographic index of Alaska geologic map polygons exists at this time.

This valuable resource makes it easier for anyone with Internet access to find the geologic maps they need to perform research, make informed resource- and land-management decisions, and better understand the geology of the state. The Map Index provides access to approximately 4,300 traditional geologic maps, as well as geophysical, sample location, geologic hazards, and geologic resources maps. DGGS plans to add outlines and data to the application for remaining geologic maps published by DGGS, USGS, U.S. Bureau of Mines, and U.S. Bureau of Land Management. The USGS's National Geologic Map Database (ngmdb.usgs.gov/) is sharing its data with DGGS to streamline the process of updating the Map Index database and keep the USGS publication information current. Reports without maps can be accessed through DGGS's comprehensive publications database, www.dggs.alaska.gov/pubs/advanced-search.

The project was initiated with funding from the Federal Minerals Data and Information Rescue in Alaska (MDIRA) program, administered by USGS. Compilation and maintenance of the back-end database is now supported by State of Alaska General Funds.

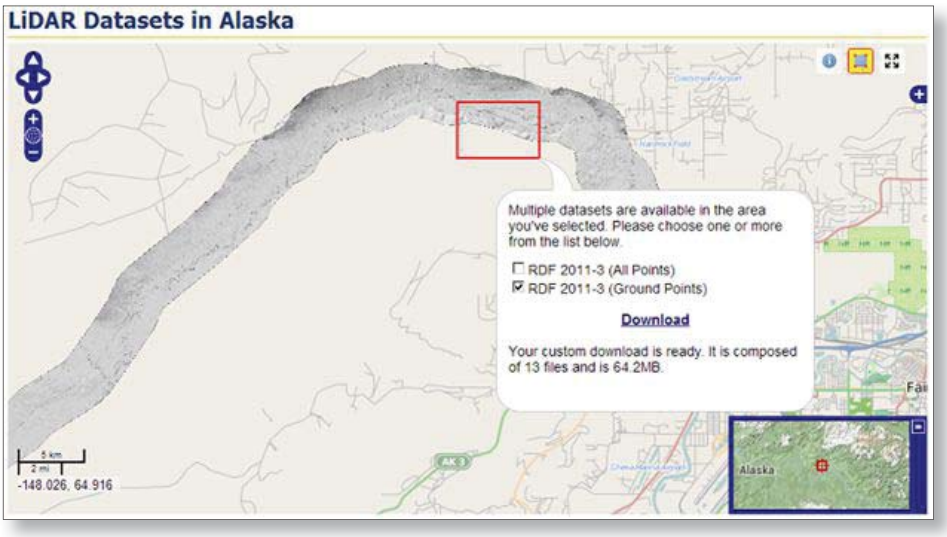


Contact: Jennifer Athey, 907-451-5028, jennifer.athey@alaska.gov,
or Susan Seitz, 907-451-5052, susan.seitz@alaska.gov

ONLINE MAP APPLICATIONS

LiDAR datasets in Alaska

In 2013 the Alaska Division of Geological & Geophysical Surveys (DGGS) identified a need to better disseminate to the public its collection of more than 4 terabytes of LiDAR data. As a result, DGGS created *LiDAR Datasets in Alaska*, (http://maps.alaska.gov/lidar) an interactive, web-based interface to DGGS's library of LiDAR data. *LiDAR Datasets in Alaska* offers instant access to one of the largest repositories of LiDAR data for Alaska, in total more than 3,050 square miles. The easy-to-use interface offers a preview of the available LiDAR data, broken down by survey, in the form of a digital elevation overlay. After viewing the available data, users can select an area as small as 750 square meters or as large as the entire state, putting the power in the hands of the user to precisely select their area of interest and download only what they need. Downloaded datasets are automatically packaged with metadata and publication references. Finally, all downloads are compressed—saving an additional 80 percent in bandwidth.

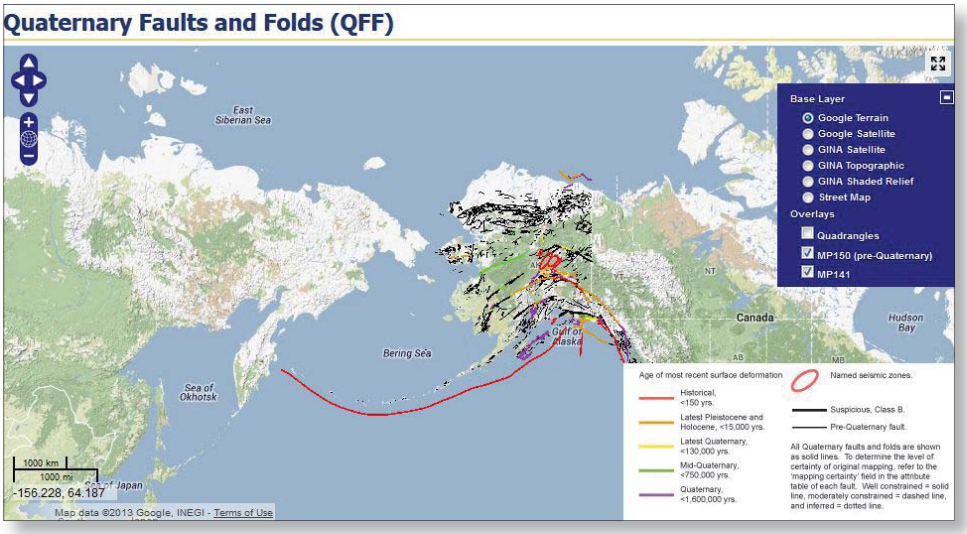


Screenshot from LiDAR Datasets in Alaska, showing a user selecting a small area in west Fairbanks for download.

Quaternary fault and fold database interactive web-based interface

In 2013 DGGS published Digital Data Series 3 (DDS 3; http://maps.dggs.alaska.gov/qff), an interactive, web-based interface that displays our Quaternary fault and fold database. The new web-based map displays the database information at the resolution of the original map and includes basic map options such as identification and search tools. Multiple base maps are displayed, including topography, satellite imagery, and digital elevation. Faults are color coded based on most recent age of activity including Historical (<150 yrs), post latest Wisconsin (<15,000 yrs), latest Quaternary (<130,000 yrs), mid-Quaternary (<750,000 yrs), and Quaternary (<1,800,000 yrs).

This web-based, interactive interface is designed to provide users easy access to both GIS shapefiles and fault parameters described in the database, including slip rate, age of most recent rupture, and dip direction, among others. Parameters are displayed on screen in pop-up windows accessed by clicking on individual faults. The GIS shapefiles are directly downloadable from the DDS 3 website (http://www.dggs.alaska.gov/pubs/id/24956).



Quaternary fault and fold database displayed on interactive map of the state of Alaska.

DGGS also digitized the legacy "Neotectonic map of Alaska." This layer is available on the interactive map so that users may view the complete compilation of Neogene faults in Alaska. Many of these faults are relatively unstudied and future research will likely determine Quaternary activity on some structures. Pre-Quaternary faults and faults with suspected but undocumented Quaternary displacement are shown in black on the interactive map.

Contacts: Rich Koehler, 907-451-5006, rich.koehler@alaska.gov
Ken Woods, 907-451-5022, ken.woods@alaska.gov

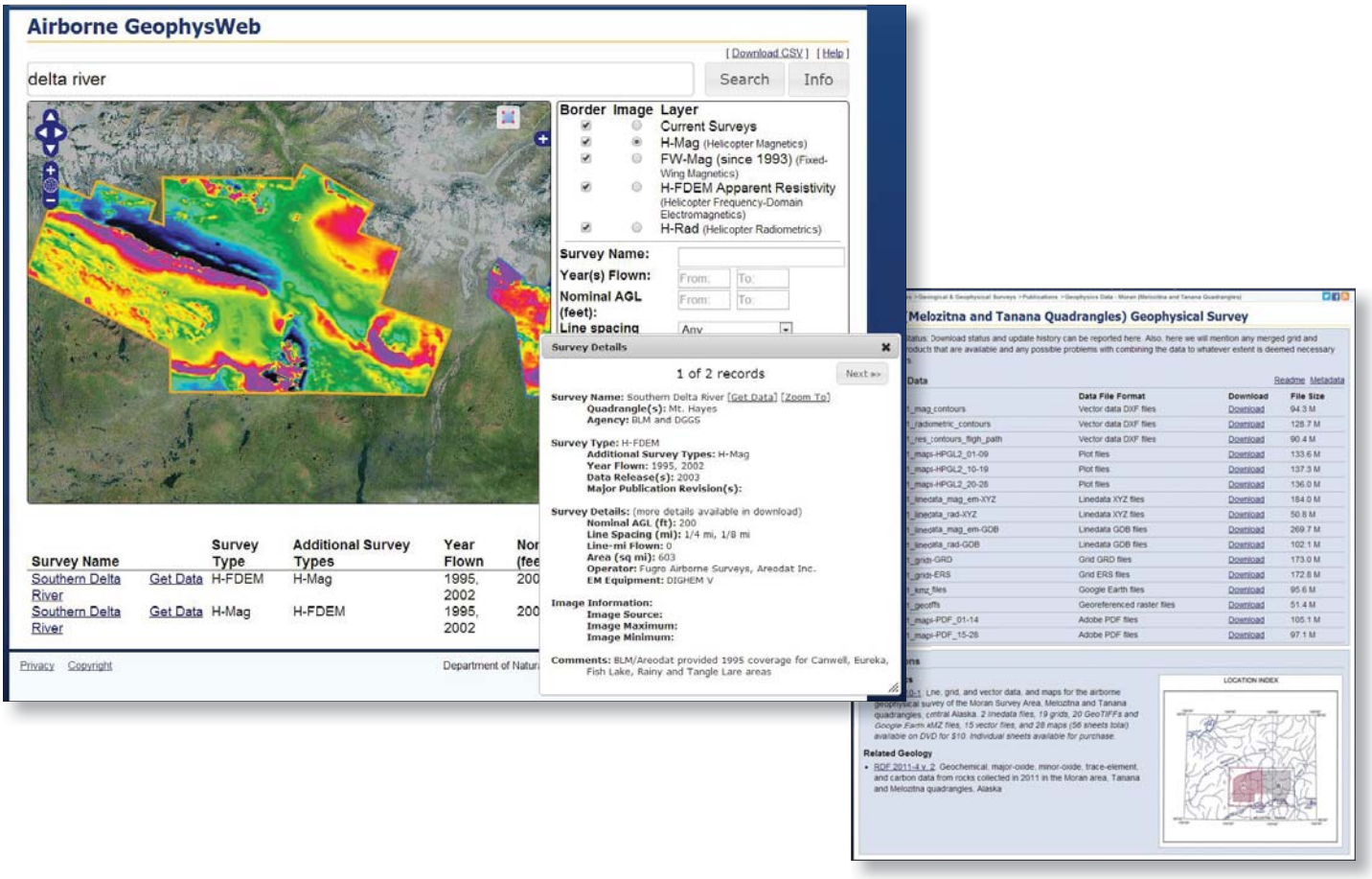
DISCOVERING ONLINE ALASKA GEOPHYSICAL DATA: AIRBORNE GEOPHYSWEB

To facilitate public discovery of published airborne geophysical data in Alaska, DGGS is developing the online Airborne GeophysWeb application. The application's user-friendly interactive map interface and text-search capability will facilitate searches for airborne geophysical datasets published by DGGS, U.S. Geological Survey, and Bureau of Land Management (BLM) since 1993. The application displays a representative image for each survey area and type of survey so users can get an idea of what the dataset might look like before they download. The Airborne Geophysical/Geological Mineral Inventory (AGGMI) program provides funding for the Airborne GeophysWeb application.

Details about the geophysical surveys, data collection parameters, and representative images displayed in the application will be available through GeophysWeb application and as a separate downloadable text file. The detailed information will help users understand the intricacies of the datasets and process the data appropriately for their purposes. A "Get data" page for each survey area provides links to download the geophysical data for free from DGGS's online publications database, and shows additional information of interest such as links to related geologic publications and adjacent geophysical surveys. The application will be kept current as older datasets are published or revised, and newly acquired data are published. The survey outlines and detailed information will be published as a downloadable GIS file in the future.

Airborne geophysical data are used to delineate regional geologic structures and identify rock types based on their geophysical signatures in conjunction with information collected from "boots on the ground" field work. Geophysical signatures are apparent even through surficial deposits and vegetation, which makes geophysical data an invaluable tool in the geologist's toolkit. Geophysical data are often used to help delineate mineral exploration targets and areas of interest and may also be used for energy exploration and locating permafrost.

DGGS anticipates the application will be released by summer 2014 through DGGS's interactive map splash page: http://maps.dggs.alaska.gov. Geophysical survey area outlines and supporting information will also be available as a Web Feature Service (WFS), a real-time, online data format supported by most Geographic Information Systems (GIS) software. DGGS believes this online tool will lead to better access and increased use of important airborne geophysical data critical to the understanding of the framework geology of Alaska and its resources



Contacts: Jennifer Athey, 907-451-5028, jennifer.athey@alaska.gov,
or Laurel Burns, 907-451-502-2, laurel.burns@alaska.gov

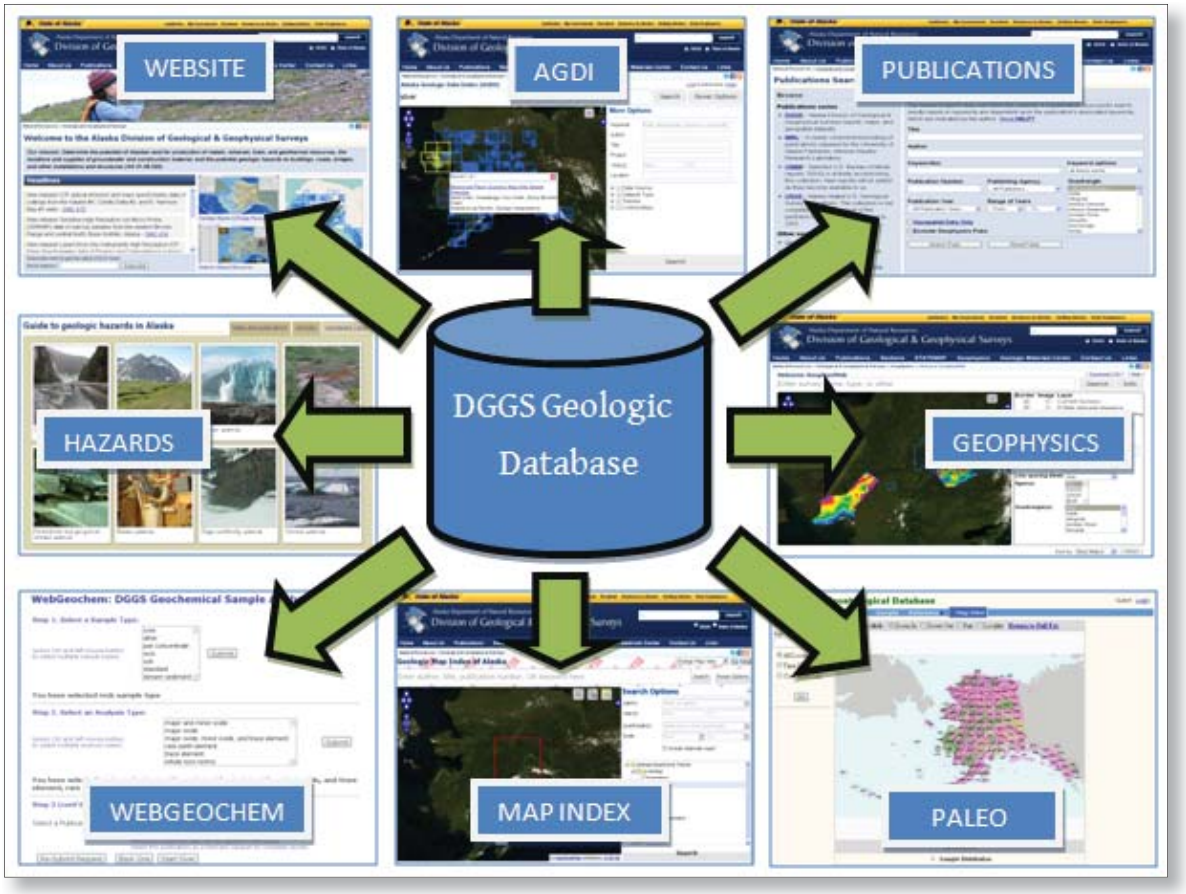
WEBSITE DEVELOPMENT AND DIGITAL GEOLOGIC DATABASE

Over the past decade, the Division of Geological & Geophysical Surveys (DGGS) website (dggs.alaska.gov) has grown from a few static HTML pages to the division's primary mechanism for distributing geologic information, publications, and interactive maps. DGGS has become the leading Alaska geology-related database agency and a trusted online repository of geologic publications and data. The website allows users to search our publications catalog, an extensive collection of scanned reports, maps, and GIS datasets produced by DGGS and other geoscience agencies, including the U.S. Geological Survey, UAF Mineral Industry Research Lab, and U.S. Bureau of Mines. The volume of files and information provided by the DGGS website has grown exponentially. It also provides web users easy access to geophysical data, geochemical data, information about its Geologic Materials Center, an online Guide to Geologic Hazards in Alaska, the Alaska Geologic Data Index, descriptions of the division's projects and special studies, Alaska's mineral industry reports, and other topics of interest.

Website content is nearly completely dynamically generated by the division's Oracle database system. Development of this geologic database was initiated as part of the federally funded Minerals Data and Information Rescue in Alaska (MDIRA) program in 2000; ongoing data input, use, and maintenance of the database system are now an integral part of DGGS's operations and are supported by State general funds.

Since 2000, the database and website team has established a secure and stable enterprise database structure, loaded data into the database, and created multiple web user interfaces. During 2013 the team continued progress on various projects requiring database and web application support: Geologic Map Index of Alaska (p. 78), Airborne GeophysWeb (p. 80), Alaska Geologic Data Index, Geologic Materials Center Inventory (p. 82), Alaska Paleontology Database, and other web mapping applications in our Digital Data Series (p. 79). Also, we have ongoing additions of geochemistry data to Webgeochem, and Alaska-related U.S. Bureau of Mines and U.S. Geological Survey publications to the publications search, as well as maintenance of existing applications. In 2013 DGGS also made incremental improvements to the website, including optimizing site performance, the addition of the Alaska Tidal Datum Portal, standardizing our digital data releases, and publishing web services for our GIS users.

In the coming year DGGS will continue to expand its repository of geologic data and strive to incorporate new technologies that meet public demand for advanced, easy-to-use, online data delivery systems.



Contacts: Susan Seitz, 907-451-5052, susan.seitz@alaska.gov,
or Ken Woods, 907-451-5022, ken.woods@alaska.gov

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 (77,000 linear feet of core) on Federal, State, and private lands in Alaska, including the Alaska outer continental shelf. Additionally, the collection holds: more than 260,000 linear feet of diamond-drilled hard-rock mineral core, representing more than 1,800 exploratory boreholes; rock samples from more than 1,650 oil and gas exploratory or production wells; samples for geotechnical boreholes; and numerous surface rock and sediment samples. The GMC also maintains extensive geochemical data and reports derived from third-party sampling, and has an archive of more than 190,000 processed slides, including 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 (DGGS), 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 (BOEM), and Alaska Oil and Gas Conservation Commission (AOGCC). The mission of the GMC is to permanently archive, index, protect, and make available for public inspection accessible geologic materials and related data to help advance exploration and knowledge of Alaska's natural resources. The chief user of the GMC is the oil and gas industry, although use by the minerals industry, government, engineering firms, and academic institutions is increasing.

> *"A geologist's ability to perform modern analyses on these unique samples is paramount for responsible development of Alaska's vast resources. It is critical that access to and protection of this valuable resource be improved and updated."*
>
> Robert Swenson, DNR Deputy Commissioner

Collaboration between DGGS management, the Department of Natural Resources Commissioner's Office, the Department of Administration, ECI/Hyer, and the Governor's Office helped secure a new building for the GMC. On July 2, 2013, the Alaska Department of Administration officially acquired the Debarr Road Sam's Club warehouse to house the new Geologic Materials Center. The new location will offer 100,000+ square feet of warehouse storage with 18-foot-tall, organized shelving and will utilize the building's existing loading docks for delivery of additional core samples. The larger space will accommodate many years of sample growth, research, and climate-controlled preservation.

Features and services available at the new facility will include: a 2,500 square foot core viewing room; three private core viewing rooms; full-spectrum lighting in the viewing areas; a conference room with A/V equipment; a sample processing room with slabbing saws and plugging drill; a core photography setup; petrographic microscope upgrades; and available shelf space for proprietary samples.

Architectural and engineering design work will be completed in early 2014, while renovations to the facility, including upgrading the concrete slab and installing heavy-duty shelving to accommodate the samples, and construction of private viewing rooms and spaces for staff and the public will continue through summer and fall 2014. Samples from the Eagle River location will be transported to the new facility (fig. 1) in fall 2014, with an opening date for the new facility slated for mid-September 2014.

Figure 1. Artist's rendering of the new GMC at the Penland Parkway location.

Contact: Kenneth Papp, 907-696-0079, kenneth.papp@alaska.gov

In anticipation of the upcoming move, GMC staff members have been proactive and hard at work improving the quality of the sample inventory and establishing a transfer plan. Now that the new facility is a reality, 2013 saw the beginning of a major, year-long project with DGGS programmers and IT staff to completely redesign the GMC inventory database and sample-tracking system. The new database system will provide: (1) the ability for clients to view and query the inventory in near-real-time via a web-map interface; (2) real-time inventory tracking, redundancy, and backup capabilities; and (3) a more efficient framework to manage the expected increase in client scheduling, visitor information, and service fees as a result of expanded public usage and services at the new GMC facility. The new database structure will support web-based searches for the public and give staff members the ability to retrieve inventory information on the fly from a tablet device directly from the warehouse floor. Just over 80 percent of the current inventory has been loaded into the new database as of January 2014.

Figure 2. Outcrop samples collected in 1968 from Anuk and Tingmerkpuk creeks are part of the Irv Tailleur U.S. Geological Survey Rock Collection at the GMC.

GMC interns completed 33 percent of a large-scale inventory project to drastically improve the quality of the DGGS and oil and gas outcrop collections. The GMC's outcrop inventory is not currently available online and this project, when completed, will add more than 80,000 newly searchable records to the web. The project involves confirming the samples inside every box and linking related location, fossil, and description information to each sample. Approximately 1,275 boxes have been inventoried, generating an impressive 19,585 sample records.

Contract curator and former Alaska State Geologist Don Hartman completed the first step of a major inventory project involving the GMC's Irv Tailleur U.S. Geological Survey Rock Collection. The contents of all 37 cabinets, totaling 333 drawers and thousands of samples collected between 1950 and 1991, have been documented and indexed (fig. 2). Former GMC Curator John Reeder, John Kelley (U.S. Geological Survey), and Brian Tailleur, son of Irv Tailleur, rescued the 12,000 pounds of samples from destruction in 2006.

PUBLICATIONS RELEASED IN 2013

DGGS REPORTS

AR 2012 DGGS Staff, 2013, Alaska Division of Geological & Geophysical Surveys Annual Report: Alaska Division of Geological & Geophysical Surveys Annual Report 2012, 82 p. http://www.dggs.alaska.gov/pubs/id/24764

DDS 3 Koehler, R.D., 2013, Quaternary Faults and Folds (QFF): Alaska Division of Geological & Geophysical Surveys Digital Data Series 3. http://www.dggs.alaska.gov/pubs/id/24956

DDS 4 DGGS Staff, 2013, LiDAR Datasets of Alaska: Alaska Division of Geological & Geophysical Surveys Digital Data Series 4. http://www.dggs.alaska.gov/pubs/id/25239

DDS 5 DGGS Staff, 2013, Geologic Map Index of Alaska: Alaska Division of Geological & Geophysical Surveys Digital Data Series 5. http://www.dggs.alaska.gov/pubs/id/25601

GMC 416 Baseline Resolution Inc. Analytical Laboratories, 2013, Total organic carbon and rock-eval pyrolysis of core and core chips from the OCS Y-0280 Anteres #1, Badami #1, Fiord #1, and W Kuparuk St. #3-11-11 wells: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 416, 1 p. http://www.dggs.alaska.gov/pubs/id/25135

GMC 417 ALS Minerals, 2013, Multi-element ICP analyses of core (boreholes 12 and 22) from the Sun Prospect, Ambler Mining District, Survey Pass Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 417, 1 p. http://www.dggs.alaska.gov/pubs/id/25136

GMC 418 Weatherford Laboratories, 2013, Porosity, permeability, grain density core analysis (CT scans), and core photos from the ConocoPhillips N. Cook Inlet Unit #A-12, Shell Oil Co. SRS St. #1 and SRS St. #2 wells: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 418, 1 p., 1 DVD. http://www.dggs.alaska.gov/pubs/id/25137

GMC 419 TIORCO Inc., 2013, X-Ray diffraction analysis of cuttings samples from the Trading Bay Unit #M-31B well: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 419, 3 p. http://www.dggs.alaska.gov/pubs/id/26881

GMC 420 Shimer, G., 2013, X-Ray fluorescence spectroscopy and 40Ar/39Ar analyses of core from the Gubik Test #1, Gubik Test #2, Square Lake Test Well #1, Umiat #2, Umiat #9, and Umiat Test Well #11 wells: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 420, 16 p. http://www.dggs.alaska.gov/pubs/id/26882

GMC 421 ConocoPhillips, 2013, Hydrocarbon-show evaluation report for the Kuparuk River Unit #2K-10, Kavearak Pt. #32-25, Long Island #1, NW Eileen St. #1, Sak River #1, W. Sak River St. #1, Socal #33-29E, and W. Kuparuk St. #3-11-11 wells: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 421, 1 p. http://www.dggs.alaska.gov/pubs/id/26883

GPR 2013-1 Burns, L.E., Fugro Airborne Surveys Corp., and Fugro GeoServices, Inc., 2013, Southern Dishna River, Fox Hills, and Beaver Creek survey areas: Airborne Magnetic and electromagnetic data in line (point), grid, vector, and map formats, Iditarod, Ophir, and Holy Cross quadrangles, western Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2013-1, 1 DVD, scale 1:63,360. http://www.dggs.alaska.gov/pubs/id/26701

GPR 2013-2 Burns, L.E., Fugro Airborne Surveys Corp., and Fugro GeoServices, Inc., 2013, Middle Styx survey area: Airborne magnetic, electromagnetic, and radiometric data in line (point), grid, vector, and map formats, Lime Hills and Tyonek quadrangles, southcentral Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2013-2, 1 DVD, scale 1:63,360. http://www.dggs.alaska.gov/pubs/id/25419

GPR 2013-3 Burns, L.E., Fugro Airborne Surveys Corp., and Fugro GeoServices, Inc., 2013, Dalzell Creek survey area: Airborne magnetic, electromagnetic, and radiometric data in line (point), grid, vector, and map formats, McGrath Quadrangle, southcentral Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2013-3, 1 DVD, scale 1:63,360. http://www.dggs.alaska.gov/pubs/id/25439

MP 149 Werdon, M.B. and Freeman, L.K., 2013, Alaska's mineral resources: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 149, 1 sheet, scale 1:4,000,000. http://www.dggs.alaska.gov/pubs/id/24784

MP 150 Koehler, R.D., Burns, P.A.C., and Weakland, J.R., 2013, Digitized faults of the Neotectonic map of Alaska (Plafker and others, 1994), in Koehler, R.D., Quaternary Faults and Folds (QFF): Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 150, 1 p. http://www.dggs.alaska.gov/pubs/id/24791

MP 151 Adleman, J.N. and Bluemink, Elizabeth, 2013, Second annual Alaska strategic and critical minerals summit: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 151, 17 p. http://www.dggs.alaska.gov/pubs/id/25095

PIR 2002-3 Stevens, D.S.P., 2013, Engineering-geologic map of the Dalton Highway from Galbraith Lake to Slope Mountain, southern Arctic Foothills, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2002-3, 1 sheet, scale 1:63,360. http://www.dggs.alaska.gov/pubs/id/25486

PIR 2012-1B Hubbard, T.D., Reger, R.D., and Gallagher, P.E., 2013, Engineering - geologic map of the Alaska Highway corridor, Tetlin Junction to Canada border, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2012-1B, 2 sheets, scale 1:63,360. http://www.dggs.alaska.gov/pubs/id/24624

PIR 2013-1 Gillis, R.J., 2013, Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1, 48 p. http://www.dggs.alaska.gov/pubs/id/24824

PIR 2013-1A Gillis, R.J., 2013, Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1A, p. 1-4. http://www.dggs.alaska.gov/pubs/id/24844

PIR 2013-1B Stanley, R.G., Herriott, T.M., LePain, D.L., Helmold, K.P., and Peterson, C.S., 2013, Reconnaissance studies of potential petroleum source rocks in the Middle Jurassic Tuxedni Group near Red Glacier, eastern slope of Iliamna Volcano, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1B, p. 5-9. http://www.dggs.alaska.gov/pubs/id/24845

PIR 2013-1C Helmold, K.P., 2013, Reservoir quality of sandstones in the Naknek and Kaguyak Formations: Field observations, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1C, p. 11-12. http://www.dggs.alaska.gov/pubs/id/24846

PIR 2013-1D Gillis, R.J., Maley, M.R., Frohman, R.A., and Peterson, C.S., 2013, Fracture studies in Upper Cretaceous and Upper Jurassic strata on the upper Alaska Peninsula and lower Cook Inlet, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1D, p. 13-17. http://www.dggs.alaska.gov/pubs/id/24847

PIR 2013-1E Stanley, R.G., Herriott, T.M., Helmold, K.P., Gillis, R.J., and Lillis, P.G., 2013, Hydrocarbon-bearing sandstone in the Upper Jurassic Naknek formation on the south shore of Kamishak Bay, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1E, p. 19-23. http://www.dggs.alaska.gov/pubs/id/24848

PIR 2013-1F Wartes, M.A., Decker, P.L., Stanley, R.G., Herriott, T.M., Helmold, K.P., and Gillis, R.J., 2013, Preliminary stratigraphy and facies analysis of the Upper Cretaceous Kaguyak Formation, including a brief summary of newly discovered oil stain, upper Alaska Peninsula, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1F, p. 25-32. http://www.dggs.alaska.gov/pubs/id/24849

PIR 2013-1G Gillis, R.J., Swenson, R.F., Wartes, M.A., and Frohman, R.A., 2013, Reconnaissance investigations of the Bruin Bay fault system along the western margin of lower Cook Inlet and upper Alaska Peninsula, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1G, p. 33-37. http://www.dggs.alaska.gov/pubs/id/24850

PIR 2013-1H Wartes, M.A., Herriott, T.M., Helmold, K.P., and Gillis, R.J., 2013, Preliminary stratigraphic interpretation of the Naknek Formation: Evidence for Late Jurassic activity on the Bruin Bay fault, Iniskin Peninsula, lower Cook Inlet, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1H, p. 39-46. http://www.dggs.alaska.gov/pubs/id/24851

PIR 2013-1I Gillis, R.J., 2013, Acknowledgments and references cited, in Gillis, R.J., Overview of 2012 field studies: Upper Alaska Peninsula and west side of lower Cook Inlet, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-1I, p. 47-48. http://www.dggs.alaska.gov/pubs/id/24852

PIR 2013-2 Wartes, M.A., Gillis, R.J., Herriott, T.M., Stanley, R.G., Helmold, K.P., Peterson, C.S., and Benowitz, J.A., 2013, Summary of 2012 reconnaissance field studies related to the petroleum geology of the Nenana Basin, interior Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-2, 13 p. http://www.dggs.alaska.gov/pubs/id/24880

PIR 2013-3 Kinsman, N.E.M., DeRaps, M.R., and Smith, J.R., 2013, Preliminary evaluation of coastal geomorphology and geohazards on 'Kigiqtam Iglua', an island northeast of Shishmaref, Alaska: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-3, 15 p. http://www.dggs.alaska.gov/pubs/id/24955

PIR 2013-4 Gillis, R.J., Stanley, R.G., LePain, D.L., Mauel, D.J., Herriott, T.M., Helmold, K.P., Peterson, C.S., Wartes, M.A., and Shellenbaum, D.P., 2013, Status of a reconnaissance field study of the Susitna basin, 2011: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-4, 8 p. http://www.dggs.alaska.gov/pubs/id/25015

PIR 2013-5 Helmold, K.P., LePain, D.L., Wilson, M.D., and Peterson, C.S., 2013, Petrology and reservoir potential of Tertiary and Mesozoic sandstones, Cook Inlet, Alaska: A preliminary analysis of outcrop samples collected during 2007-2010 field seasons: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-5, 34 p. http://www.dggs.alaska.gov/pubs/id/25035

PIR 2013-6 Koehler, R.D., Reger, R.D., Sicard, K.R., and Spangler, E.R., 2013, Yukon River bridge landslide: Preliminary geologic and geotechnical evaluation: Alaska Division of Geological & Geophysical Surveys Preliminary Interpretive Report 2013-6, 69 p. http://www.dggs.alaska.gov/pubs/id/25642

RDF 2013-1 Loveland, A.M. and PetroTech Associates, 2013, Mercury injection capillary pressure results from outcrop samples in the Indecision Creek Member of the Naknek Formation and the Kaguyak Formation type section: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-1, 4 p. http://www.dggs.alaska.gov/pubs/id/24916

RDF 2013-10 Gould, A.I. and Kinsman, N.E.M., 2013, Spatially referenced oblique aerial imagery of the Port Heiden shoreline, August 2013: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-10, 2 p. http://www.dggs.alaska.gov/pubs/id/26866

RDF 2013-2 Stevens, D.S.P., Werdon, M.B., and Wright, T.C., 2013, Geochemical trace-element and rare-earth element data from rock samples collected in 2012 on Annette Island, southeast Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-2, 2 p. http://www.dggs.alaska.gov/pubs/id/24975

RDF 2013-3 Hubbard, T.D., Wolken, G.J., Stevens, D.S.P., and Combellick, R.A., 2013, High-resolution lidar data for the Whittier area, Passage Canal, and Portage Lake, Alaska, in DGGS Staff, LiDAR Datasets of Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-3, 5 p. http://www.dggs.alaska.gov/pubs/id/24976

RDF 2013-4 Loveland, A.M. and PetroTech Associates, 2013, Mercury injection capillary pressure (MICP) results from outcrop samples in the Tyonek, Beluga, and West Foreland Formations, Tyonek and Talkeetna quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-4, 5 p. http://www.dggs.alaska.gov/pubs/id/25299

RDF 2013-5 Bachmann, E.N., Blessington, M.J., Freeman, L.K., Newberry, R.J., Tuzzolino, A.L., Wright, T.C., and Wylie, William, 2013, Geochemical major-oxide, minor-oxide, trace-element, and rare-earth-element data from rocks and stream sediments collected in 2012 in the Ray Mountains area, Beaver, Bettles, Livengood, and Tanana quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-5, 4 p. http://www.dggs.alaska.gov/pubs/id/25386

RDF 2013-6 Loveland, A.M. and PetroTech Associates, 2013, Mercury injection capillary pressure (MICP) results from outcrop samples in the Naknek Formation, Iniskin Peninsula, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-6, 10 p. http://www.dggs.alaska.gov/pubs/id/25494

RDF 2013-7 Blessington, M.J., Reioux, D.A., and Werdon, M.B., 2013, Analyses of historic U.S. Bureau of Mines rock and heavy mineral concentrate samples for geochemical trace-element and rare-earth element data--Ray Mountains and Kanuti-Hodzana uplands area, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-7, 2 p. http://www.dggs.alaska.gov/pubs/id/25581

RDF 2013-8 Solie, D.N., Layer, P.W., Werdon, M.B., Newberry, R.J., Freeman, L.K., and Lessard, R.R., 2013, 40Ar/39Ar data, Alaska Highway corridor from Delta Junction to Canada border, parts of Mount Hayes, Tanacross, and Nabesna quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-8, 35 p. http://www.dggs.alaska.gov/pubs/id/26841

RDF 2013-9 Solie, D.N., O'Sullivan, P.B., Werdon, M.B., and Lessard, R.R., 2013, Apatite fission track data, Alaska Highway corridor, Mount Hayes Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2013-9, 17 p. http://www.dggs.alaska.gov/pubs/id/26861

RI 2011-3B Wallace, W.K., Wartes, M.A., Decker, P.L., Delaney, P.R., Gillis, R.J., Loveland, A.M., and Reifenstuhl, R.R., 2013, Interpretations of seismic reflection data and structural cross sections for the Kavik River map area, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2011-3B, 20 p., 3 sheets. http://www.dggs.alaska.gov/pubs/id/25399

RI 2011-6 v. 2 Schaefer, J.R., Scott, W.E., Evans, W.C., Wang, Bronwen, and McGimsey, R.G., 2013, Summit crater lake observations, and the location, chemistry, and pH of water samples near Mount Chiginagak volcano, Alaska: 2004-2012: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2011-6 v. 2, 25 p. http://www.dggs.alaska.gov/pubs/id/25602

RI 2013-1 Nicolsky, D.J., Suleimani, E.N., Haeussler, P.J., Ryan, H.F., Koehler, R.D., Combellick, R.A., and Hansen, R.A., 2013, Tsunami inundation maps of Port Valdez, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2013-1, 77 p., 1 sheet, scale 1:12,500. http://www.dggs.alaska.gov/pubs/id/25055

RI 2013-2 Reger, R.D. and Burns, P.A.C., 2013, Surficial-geologic map of the Livengood area, central Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2013-2, 1 sheet, scale 1:50,000. http://www.dggs.alaska.gov/pubs/id/25179

RI 2013-3 Suleimani, E.N., Nicolsky, D.J., and Koehler, R.D., 2013, Tsunami inundation maps of Sitka, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2013-3, 76 p., 1 sheet, scale 1:250,000. http://www.dggs.alaska.gov/pubs/id/26671

RI 2013-4 Koehler, R.D. and Woods, R.-E.F., 2013, Paleoseismic and LiDAR investigations along the Cathedral Rapids and Dot "T" Johnson faults, interior Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2013-4, 21 p. http://www.dggs.alaska.gov/pubs/id/26761

SR 68 Athey, J.E., Harbo, L.A., Lasley, P.S., and Freeman, L.K., 2013, Alaska's mineral industry, 2012: Alaska Division of Geological & Geophysical Surveys Special Report 68, 61 p. http://www.dggs.alaska.gov/pubs/id/25621

OUTSIDE PUBLICATIONS

Peer-Reviewed Journal Articles

Arendt, A., Bolch, T., Cogley, J.G., Gardner, A., Hagen, J.-O., Hock, R., Kaser, G., Pfeffer, W.T., Moholdt, G., Paul, F., Radić, V., Andreassen, L., Bajracharya, S., Barrand, N., Beedle, M., Berthier, E., Bhambri, R., Bliss, A., Brown, I., Burgess, D., Burgess, E., Cawkwell, F., Chinn, T., Copland, L., Davies, B., De Angelis, H., Dolgova, E., Filbert, K., Forester, R.R., Fountain, A., Frey, H., Giffen, B., Glasser, N., Gurney, S., Hagg, W., Hall, D., Haritashya, U.K., Hartmann, G., Helm, C., Herreid, S., Howat, I., Kapustin, G., Khromova, T., Kienholz, C., König, M., Kohler, J., Kriegel, D., Kutuzov, S., Lavrentiev, I., Le Bris, R., Lund, J., Manley, W., Mayer, C., Miles, E., Li, X., Menounos, B., Mercer, A., Mölg, N., Mool, P., Nosenko, G., Negrete, A., Nuth, C., Pettersson, R., Racoviteanu, A., Ranzi, R., Rastner, P., Rau, F., Raup, B., Rich, J., Rott, H., Schneider, C., Seliverstov, Y., Sharp, M., Sigurðsson, O., Stokes, C., Wheate, R., Winsvold, S., **Wolken, G.,** Wyatt, F., Zheltyhina, N., 2013, Randolph Glacier inventory—A dataset of global glacier outlines, version 3.2: Boulder, CO, Global Land Ice Measurements from Space. http://www.glims.org/RGI/RGI_Tech_Report_V3.2.pdf

Coombs, M.L., Sisson, T.W., Bleick, H.A., Henton, S.M., **Nye, C.J.,** Payne, A.L., **Cameron, C.E.,** Larsen, J.F., Wallace, K.L., and **Bull, K.F.,** 2013, Andesites of the 2009 eruption of Redoubt Volcano, Alaska: Journal of Volcanology and Geothermal Research, v. 259, p. 349–372, doi:10.1016/j.jvolgeores.2012.01.002

Houseknecht, D.W., and **Wartes, M.A.,** 2013, Clinoform deposition across a boundary between orogenic front and foredeep—An example from the Lower Cretaceous in Arctic Alaska: Terra Nova, v. 25, no. 3, p. 206–211.

Jones, B.M., Stoker, J.M., Gibbs, A.E., Grosse, G., Romanovsky, V.E., Douglas, T.A., **Kinsman, N.E.M.,** and Richmond, B.M., 2013, Quantifying landscape change in an Arctic coastal lowland using repeat airborne LiDAR: Environmental Research Letters, v. 8, 045025, 10 p. doi:10.1088/1748-9326/8/4/045025

Mastin, L.G., Schwaiger, Hans, Schneider, D.J., Wallace, K.L., **Schaefer, Janet**, and Denlinger, R.P., 2013, Injection, transport, and deposition of tephra during event 5 at Redoubt Volcano, 23 March 2009: Journal of Volcanology and Geothermal Research, v. 259, p. 201–213, doi:10.1016/j.jvolgeores.2012.04.025

Sharp, M., **Wolken, G.,** Geai, M.L., Burgess, D., Cogley, J.G., Arendt, A., and Wouters, B., 2013, Mountain glaciers and ice caps (outside Greenland): Arctic Report Card 2013. http://www.arctic.noaa.gov/reportcard

Wallace, K.L., **Schaefer, J.R.,** and Coombs, M.L., 2013, Character, mass, distribution, and origin of tephra-fall deposits from the 2009 eruption of Redoubt Volcano, Alaska—Highlighting the significance of particle aggregation: Journal of Volcanology and Geothermal Research, v. 259, p. 145–169, doi:10.1016/j.jvolgeores.2012.09.015

Wolken, G., Sharp, M., Geai, M.-L., Burgess, D., Arendt, A., and Wouters, B., 2013, Arctic glaciers and ice caps (outside Greenland), *in* State of the Climate in 2012—Arctic: Bulletin of the American Meteorological Society, v. 94, no. 8, p. S119–S121.

Meeting Abstracts and Posters

Aubry-Wake, C., Hock, R., Braun, J.L., Zhang, J., **Wolken. G.J.,** and Liljedahl, A., 2013, Response of glacier mass balance and discharge to future climate change, upper Susitna basin, Alaska [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

Balazs, M.S., Meyer, F.J., Bollian, T., **Wolken, G.J.,** and Prakash, A., 2013, Landslide hazard mapping using ground-based interferometric radar in the fjords of south-central Alaska [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

Bliss, A.K., Braun, J.L., **Daanen, R.P.,** Hock, R., Liljedahl, A., **Wolken, G.J.,** and Zhang, J., 2013, Twenty-first century changes in the hydrology, glaciers, and permafrost of the Susitna Basin, Alaska [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

Burns, L.E., 2013, Overview of DGGS's new releases of airborne geophysical survey data and current surveys in progress—A total of over 4,445 square miles of new data for western, south-central, and northern south-central Alaska [abstract]: Alaska Miners Association Annual Convention, Anchorage, AK, November 4–10, 2013.

Clough, J.G., Harun, N.T., Hughes, C.A., **Weakland, J.R.,** and **Cameron, C.E., 2013**, Alaska geothermal sites map and database—Bringing together legacy and new geothermal data for research, exploration and development [abstract]: Eos Transactions, American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013, Suppl., Abstract #IN13A-1559.

Daanen, R.P., Darrow, M.M., and **Hubbard, T.D.,** 2013, Frozen debris lobe stability, a function of thermal and hydrological processes [poster]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 13, 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 1 sheet. http://www.dggs.alaska.gov/pubs/id/26886

Davis, J., Arendt, A., **Wolken, G.**, and Liljedahl, A., 2013, Assessment of flood hazard potential in Valdez Glacier watershed in future climate [abstract]: American Water Resources Association, Alaska Section Annual Conference, Anchorage, AK, March 2013.

Freeman, C.J., and **Werdon, M.B.,** 2013, 2012 Alaska mineral industry overview [abstract], *in* Resources for Life, Digging Deeper, AME BC's 30th Annual Mineral Exploration Roundup, Vancouver, BC, Canada, January 28–31, 2013: Proceedings, p. 9–11.

Freeman, L.K., 2013, Alaska Mineral Industry 2013: A preliminary summary [presentation]: Northwest Mining Association 119th Annual Meeting, Reno NV, December 2–6, 2013: Alaska Division of Geological & Geophysical Surveys, 38 p. http://www.dggs.alaska.gov/pubs/id/26884

Freeman, L.K., Newberry, R.J., Andrew, J.E., Szumigala, D.J., **Werdon, M.B., Athey, J.E.,** and **Burns, L.E.,** 2013, Geologic setting of syngenetic and epigenetic deposits in the eastern Bonnifield mining district, Alaska [presentation]: Alaska Miners Association, 22nd Annual Biennial Mining Conference, March 9–13, 2010: Alaska Division of Geological & Geophysical Surveys, 25 p. http://www.dggs.alaska.gov/pubs/id/25279

Gallagher, P.E., 2013, Creating FGDC-compliant cartographic representations [poster]: ESRI International Users Conference, San Diego, CA, July 7–12, 2013: Alaska Division of Geological & Geophysical Surveys, 15 p., 1 sheet. http://www.dggs.alaska.gov/pubs/id/25339

Gillis, R.J., Shellenbaum, D.P., Stanley, R.G., O'Sullivan, P., Metcalf, J.R., and **LePain, D.L.,** 2013, Upper crustal cooling of the southern foothills of the western and central Alaska Range and low-temperature detrital thermochronology from the adjacent Susitna Basin, south-central Alaska [abstract]: Geological Society of America Abstracts with Programs, v. 45, no. 7, p. 164.

Gusmeroli, A., **Wolken, G.J.,** and Arendt, A.A., 2013, Characteristics of snow accumulation on a large mountain glacier in the Gulf of Alaska [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

Gusmeroli, A., **Wolken, G.J.**, Arendt, A., and O'Neel, S., 2013, Performance of a helicopter-borne snow radar system over Alaska glaciers [abstract]: International Symposium on Radioglaciology, Lawrence, KS, University of Kansas, September 2013.

Herriott, T.M., Wartes, M.A., Stanley, R.G., Lillis, P.G., Helmold, K.P., Decker, P.L., and **Gillis, R.J.,** 2013, Oil-stained sandstones of the Upper Jurassic Naknek Formation and Upper Cretaceous Kaguyak Formation, Kamishak Bay area, lower Cook Inlet, Alaska [poster]: American Association of Petroleum Geologists, Pacific Section Meeting, Monterey, CA, April 19–25, 2013, Abstract #90162: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 1 sheet. http://www.dggs.alaska.gov/pubs/id/25139

Hubbard, T.D., Spangler, E., Daanen, R., Darrow, M., **Simpson, J., and Southerland, L.**, 2013, Frozen debris lobes—Characterizing a potential geologic hazard along the Dalton Highway, southern Brooks Range, Alaska [abstract]: Geological Society of America Annual Meeting, Denver, CO, Abstracts with Programs.

Kinsman, N.E.M., 2013, Alaska local tidal datums—An introduction for non-experts [presentation], Alaska Native Tribal Health Consortium Local Environmental Observer (LEO) Network Seminar Series, Online, March 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 19 p. http://www.dggs.alaska.gov/pubs/id/26885

Koehler, R.D., Reger, R.D., and **Spangler, E.**, 2013, A combined field and LiDAR mapping approach to characterizing geologic hazards—Natural gas pipeline corridor, Prudhoe Bay to Anchorage, Alaska [abstract]: Geological Society of America Annual Meeting, Denver, CO, Abstracts with Programs.

Koehler, R.D., Schwarz, D.P., Rood, D.H., Reger, R.D., and **Wolken, G.J.**, 2013, Preliminary paleoseismic observations along the central Denali fault, Alaska [poster], Eos Transactions, American Geophysical Union, Fall Meeting Supplement, San Francisco, CA, December 10, 2013, Abstract #T23C-2598: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 1 sheet. http://www.dggs.alaska.gov/pubs/id/26888

Liljedahl, A., Braun, J., **Daanen, R.**, Gusmeroli, A., Hock, R., Schulla, J., and **Wolken, G.**, 2013, Susitna–Watana Hydroelectric Project—Hydrologic modeling and field measurements of the upper Susitna basin [abstract]: American Water Resources Association, Alaska Section Annual Conference, Anchorage, AK, March 2013.

McGrath, D., Gusmeroli, A., Oneel, S., Sass, L.C., Arendt, A.A., **Wolken, G.J.,** Kienholz, C., and McNeil, C., 2013, Comparison of annual accumulation rates derived from in situ and ground penetrating radar methods across Alaskan glaciers [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

Nicolsky, D., Suleimani, E., and **Koehler, R.D**., 2013, Tsunami modeling and inundation mapping in south-central Alaska [abstract]: Eos Transactions, American Geophysical Union, Fall Meeting Supplement, Abstract #NH41B-1721.

Nicolsky, D., Suleimani, E., and **Koehler, R.D**., 2013, Tsunami modeling and inundation mapping in south-central Alaska [abstract]: International Tsunami Symposium, Göcek, Turkey, September 25–28, 2013.

Sicard, K.R., Twelker, Evan, Freeman, L.K., Bachmann, E.N., Reioux, D.A., Tuzzolino, A.L., Wright, T.C., Newberry, R.J., **Burns, L.E.,** and **Werdon, M.B.,** 2013, Geologic mapping in the Styx River area, Lime Hills C-1 Quadrangle, western Alaska Range [presentation], Alaska Miners Association Annual Convention, Anchorage, AK, November 4–10, 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 25 p. http://www.dggs.alaska.gov/pubs/id/26803

Smith, J.R., **Kinsman, N.E.M.,** and Misra, Debasmita, 2013, Using WorldView–2 multispectral bands for shallow water bathymetric survey near Wales, Alaska [poster]: American Society of Photogrammetry and Remote Sensing Annual Meeting, Baltimore, MD, March 24–28, 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 1 sheet. http://www.dggs.alaska.gov/pubs/id/25159

Spangler, E., Hubbard, T.D., Daanen, R., Darrow, M., **Simpson, J., and Southerland, L.**, 2013, Geologic and geomorphic characterization of frozen debris lobe catchments along the Dalton Highway, southern Brooks Range, Alaska [abstract]: Geological Society of America Annual Meeting, Denver, CO, Abstracts with Programs.

Suleimani, E., Nicolsky, D., and **Koehler, R.D**., 2013, Inundation mapping and hazard assessment of tectonic and landslide tsunami sources in southeast Alaska [abstract]: International Tsunami Symposium, Göcek, Turkey, September 25-28, 2013.

Suleimani, E., Nicolsky, D., Freymueller, J.T., and **Koehler, R.D.,** 2013, Specification of tectonic tsunami sources along the eastern Aleutian Island Arc and Alaska Peninsula for inundation mapping and hazard assessment [abstract]: Eos Transactions, American Geophysical Union, Fall Meeting Supplement, Abstract #NH54A-06.

Tuzzolino, A.L., Newberry, R.J., and **Freeman, L.K.,** 2013, Rare-earth-element (REE) potential in the Ray Mountains area, central Alaska [poster], Alaska Miners Association Annual Convention, November 4–10, 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 1 sheet. http://www.dggs.alaska.gov/pubs/id/26781

Twelker, Evan, Newberry, R.J., **Freeman, L.K., Sicard, K.R., Reioux, D.A.,** and **Bachmann, E.N.,** 2013, DGGS geologic and mineral-resource assessment of the western Wrangellia terrane, central Alaska—Initial progress report [presentation], Alaska Miners Association Annual Convention, Anchorage, AK, November 4–10, 2013: Alaska Division of Geological & Geophysical Surveys Posters and Presentations, 25 p. http://www.dggs.alaska.gov/pubs/id/26821

Wartes, M.A., Decker, P.L., **Gillis, R.J., Herriott, T.M.,** and **LePain, D.L.,** 2013, Predicting deep water reservoirs in the Brookian Sequence—Underexplored plays on the North Slope, Alaska [abstract]: American Association of Petroleum Geologists Polar Petroleum Potential (P3) Conference, Stavanger, Norway, October 15–18, 2013.

Witter, R.C., Carver, G.A., Bender, A., Briggs, R., Gelfenbaum, G., and **Koehler, R.D.,** 2013, Six large tsunamis in the past ~1,700 years at Stardust Bay, Sedanka Island, Alaska [abstract]: Eos Transactions, American Geophysical Union, Fall Meeting Supplement, Abstract #NH44A-08.

Wolken, G.J., Finnegan, D.C., Sharp, M.J., LeWinter, A., Fahnestock, M.A., and Stevens, R., 2013, Observations of ice motion changes at the terminus of Hubbard Glacier using co-located ground-based radar interferometer and LiDAR scanning systems [abstract]: American Geophysical Union, Fall Meeting, San Francisco, CA, December 2013.

DIGITAL DATA DISTRIBUTION (D3)

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
DDS 3	QFF application source datasets	92
MP 141	Quaternary faults and folds	58
DDS 1	Alaska Geologic Data Index (AGDI) documentation	54
MP 150	Digitized faults of the Neotectonic map of Alaska	44
MP 8	Geothermal Resources of Alaska	35
SR 37	Coal Resources of Alaska	26
RDF 2011-3	LAS index	22
RDF 2011-3	Raster index	21
RDF 2011-3E	Bare-earth digital elevation model (DEM), Fairbanks Quadrangle	20
MP 143	Redoubt Ash Fall Contours and Sample Locations	20
RDF 2011-3L	Bare-earth digital elevation model (DEM), Anchorage Quadrangle	19
MP 133 v. 1.1	Historically active volcanoes	19
RDF 2013-2	Annette Island trace-element and ree geochem	18
RDF 2013-1	Naknek, Indecision Creek, and Kaguyak: MICP	17
PDF 96-16	Fairbanks Mining Dist. preliminary geologic map	16
RI 2013-2	Surficial-geologic map of the Livengood area	15
MP 129	Transportation Corridor Geology	15
RDF 2011-3M	Bare-earth digital elevation model (DEM), Healy Quadrangle	14
RDF 2011-3S	Bare-earth digital elevation model (DEM), Philip Smith Mountains Quadrangle	13
RDF 2011-3P	Bare-earth digital elevation model (DEM), Valdez Quadrangle	13
RDF 2011-3L	Hillshade images, Anchorage Quadrangle	13
MP 144	Sitka DEM	13
PR 121	Philip Smith Mountains: Surficial Geology	11
PIR 1999-1	Central and East Anchorage Geologic map	11
GB 8	Quaternary history of Kenai Peninsula: Guide	11
RDF 2011-3I	Bare-earth digital elevation model (DEM), Talkeetna Quadrangle	10
RDF 2011-3D	Bare-earth digital elevation model (DEM), Big Delta Quadrangle	10

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
IC 38 ed. 1998	Volcanoes of Alaska	10
RDF 2012-3	Western Moran Geochemistry	9
RDF 2011-3TA116A87:A118	Bare-earth digital elevation model (DEM), Sagavanirktok Quadrangle	9
RDF 2011-3K	Bare-earth digital elevation model (DEM), Livengood Quadrangle	9
PIR 2012-1A	AK Highway corridor, Tetlin Junction: Surficial geology	9
PIR 2002-2	Philip Smith Mountains: Geologic map	9
RDF 2013-10	Port Heiden shoreline photo points	8
RDF 2012-1	Cook Inlet: Palynology	8
RDF 2011-6	Okmok DEM and shaded relief	8
RDF 2011-3Q	Hillshade images, Beechey Point Quadrangle	8
RDF 2011-3N	Bare-earth digital elevation model (DEM), Talkeetna Mountains Quadrangle	8
RDF 2011-3M	Hillshade images, Healy Quadrangle	8
RDF 2011-3D	Hillshade images, Big Delta Quadrangle	8
RDF 2011-3	Real time kinematic data (RTK)	8
RDF 2005-3	Volcanoes in Alaska: Latitudes and Longitudes	8
PIR 2009-6A	AK Highway corridor, Robertson River: Surficial geology	8
PIR 2009-5	Cobblestone Geology	8
PIR 2002-2	Philip Smith Mountains: Topo Data	8
RI 2010-2	Cook Inlet: Unconformity depth map	7
RI 2006-2 v. 1.0.1	Liberty Bell Fairbanks A-4 bedrock geology	7
RDF 2013-7	Ray Mountains - USBM samples	7
RDF 2013-10	Port Heiden shoreline images 1	7
RDF 2011-3Q	Bare-earth digital elevation model (DEM), Beechey Point Quadrangle	7
RDF 2011-3E	Hillshade images, Fairbanks Quadrangle	7
RDF 2011-3A	Bare-earth digital elevation model (DEM), Mount Hayes Quadrangle	7
RDF 2011-3	SBET data	7
PIR 2008-3A	AK Highway corridor, Delta Junction: Surficial geology	7
GPR 2011-2	Iditarod Geophysics Adobe PDF files	7
GPR 2011-2	Iditarod Geophysics Georeferenced raster files	7
RI 97-14A	Eastern McGrath Geology	6
RDF 2013-3	Whittier lidar Bare earth DEM	6
RDF 2011-4 v. 2	Moran Geochemistry	6
RDF 2011-3T	Hillshade images, Sagavanirktok Quadrangle	6
RDF 2011-3R	Bare-earth digital elevation model (DEM), Chandalar Quadrangle	6
RDF 2011-3N	Hillshade images, Talkeetna Mountains Quadrangle	6
PIR 2009-7	Kanayut Geology	6
RI 2011-3A	Kavik River Geology	5
RI 2000-1C	Sagavanirktok B-1 surficial geologic map	5
RI 2000-1B	Sagavanirktok B-1 bedrock geologic map	5
RDF 2013-5	Ray Mountains geochem - DGGS samples	5
RDF 2013-4	Tyonek, Beluga, and West Foreland Formations: MICP	5
RDF 2011-3R	Hillshade images, Chandalar Quadrangle	5
RDF 2011-3J	Bare-earth digital elevation model (DEM), Wiseman Quadrangle	5
PIR 2013-5	Cook Inlet petrology	5
PIR 2012-1B	AK Highway corridor, Tetlin Junction: Engineering geology	5
PIR 2008-1E	Aupuk Gas Seep Video	5

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
PIR 2007-1	Siksikpuk River, Chandler Lake Geologic map	5
PIR 2007-1	Siksikpuk River, Chandler Lake Topographic data	5
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Georeferenced raster files	5
RI 94-24	Anchorage C-7 NE Geology	4
RI 2009-3	Kavik River Surficial Geologic Map	4
RI 2000-1D	Sagavanirktok B-1 engineering geologic map	4
RI 2000-1A	Sagavanirktok B-1 Geologic map	4
RDF 2011-3S	Hillshade images, Philip Smith Mountains Quadrangle	4
RDF 2011-3N	Highest hit digital surface model (DSM), Talkeetna Mountains Quadrangle	4
RDF 2011-3N	Lake polygons, Talkeetna Mountains Quadrangle	4
RDF 2011-3N	Normalized digital surface model (nDSM), Talkeetna Mountains Quadrangle	4
RDF 2011-3I	Hillshade images, Talkeetna Quadrangle	4
RDF 2011-3H	Bare-earth digital elevation model (DEM), Tyonek Quadrangle	4
RDF 2011-3H	Canopy cover, Tyonek Quadrangle	4
RDF 2011-3E	Intensity images, Fairbanks B-4 Quadrangle	4
RDF 2011-3E	Lake polygons, Fairbanks Quadrangle	4
RDF 2011-3B	Hillshade images, Tanacross Quadrangle	4
RDF 2011-3A	Hillshade images, Mount Hayes Quadrangle	4
RDF 2011-2	Eastern Bonnifield Geochronology	4
RDF 2007-4	Seward Peninsula Geochemical Data	4
PIR 2009-5	Cobblestone Topography	4
PIR 2005-6	Oil and Gas Seeps: Northern AK Pen.	4
PDF 98-37B v. 1.1	Tanana A-1 and A-2 bedrock geology	4
PDF 98-37A v. 1.1	Tanana A-1 and A-2 geologic map	4
GPR 2013-3	Dalzell Creek Geophysics Google Earth files	4
GPR 2013-2	Middle Styx Geophysics Georeferenced raster files	4
GPR 2013-2	Middle Styx Geophysics Adobe PDF files	4
GPR 2013-2	Middle Styx Geophysics Vector data shape files	4
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Georeferenced raster files	4
GPR 2011-2	Iditarod Geophysics Grid ERS files	4
GPR 2011-2	Iditarod Geophysics Vector data files	4
GPR 2010-1	Moran Geophysics Linedata GDB files	4
GPR 2010-1	Moran Geophysics Linedata XYZ files	4
GPR 2009-1	Slate Creek-Slana River Geophysics Grids ERS	4
GPR 2008-3	Styx River Geophysics	4
RI 94-25	Anchorage C-7 NW Geology	3
RI 2013-3	Sitka tsunami inundation data	3
RI 2011-6 v. 2	Chiginagak water chemistry	3
RI 2011-4	Northern Fairbanks Mining District: Surficial Geology	3
RI 2009-1 v. 2	Nanushuk measured sections and sample data	3
RI 2001-1B	Chulitna region geology	3
RI 2001-1A	Chulitna region bedrock geologic map	3
RDF 2013-10	Port Heiden shoreline images 2	3
RDF 2013-10	Port Heiden shoreline images 3	3
RDF 2013-10	Port Heiden shoreline images 4	3
RDF 2013-10	Port Heiden shoreline images 5	3

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
RDF 2013-10	Port Heiden shoreline images 12	3
RDF 2012-4	Golovin shoreline photo locations 1	3
RDF 2012-2	William Henry Bay Geochemistry	3
RDF 2011-5	Norton Sound Photo Locations 7	3
RDF 2011-3T	Lake polygons, Sagavanirktok Quadrangle	3
RDF 2011-3S	Lake polygons, Philip Smith Mountains Quadrangle	3
RDF 2011-3Q	Lake polygons, Beechey Point Quadrangle	3
RDF 2011-3P	Highest hit digital surface model (DSM), Valdez Quadrangle	3
RDF 2011-3P	Normalized digital surface model (nDSM), Valdez Quadrangle	3
RDF 2011-3O	Bare-earth digital elevation model (DEM), Gulkana Quadrangle	3
RDF 2011-3N	Intensity images, Talkeetna Mountains Quadrangle	3
RDF 2011-3M	Highest hit digital surface model (DSM), Healy Quadrangle	3
RDF 2011-3M	Intensity images, Healy Quadrangle	3
RDF 2011-3L	Lake polygons, Anchorage Quadrangle	3
RDF 2011-3L	Normalized digital surface model (nDSM), Anchorage Quadrangle	3
RDF 2011-3K	Hillshade images, Livengood Quadrangle	3
RDF 2011-3I	Highest hit digital surface model (DSM), Talkeetna Quadrangle	3
RDF 2011-3I	Intensity images, Talkeetna Quadrangle	3
RDF 2011-3I	Lake polygons, Talkeetna Quadrangle	3
RDF 2011-3F	Bare-earth digital elevation model (DEM), Bettles Quadrangle	3
RDF 2011-3E	Canopy cover, Fairbanks Quadrangle	3
RDF 2008-3	Mother Goose Lake Bathymetry	3
PR 115	Upper Chena River geology	3
PIR 2013-6	Yukon River bridge landslide rock mass data	3
PIR 2010-1	AK Highway corridor, Dot Lake-Tok: trench data	3
PIR 2009-6B	AK Highway corridor, Robertson River: Engineering geology	3
PIR 2008-3B	AK Highway corridor, Delta Junction: Engineering geology	3
PIR 2002-1C	Fortymile Mining District, Eagle A-1 surficial geology	3
PIR 2002-1B	Fortymile Mining District, Eagle A-1 bedrock geology	3
PIR 2002-1A	Fortymile Mining District, Eagle A-1 geology	3
PIR 2001-3B	Fortymile Mining District, Eagle A-2 bedrock geology	3
PIR 2001-3A	Fortymile Mining District, Eagle A-2 geology	3
PDF 96-17	Fairbanks Mining Dist. prelim. geo. materials map	3
GPR 2013-3	Dalzell Creek Geophysics	3
GPR 2013-3	Dalzell Creek Geophysics Adobe PDF files	3
GPR 2013-2	Middle Styx Geophysics Linedata GDB files	3
GPR 2013-2	Middle Styx Geophysics Grid GRD files	3
GPR 2013-2	Middle Styx Geophysics Adobe PDF files	3
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Grid GRD files	3
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Adobe PDF files	3
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Vector data shape files	3
GPR 2011-2	Iditarod Geophysics Grid GRD files	3
GPR 2011-2	Iditarod Geophysics Linedata GDB files	3
GPR 2011-2	Iditarod Geophysics Linedata XYZ files	3
GPR 2011-1	Ladue Geophysics Adobe PDF files	3
GPR 2011-1	Ladue Geophysics Linedata GDB files	3

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
GPR 2011-1	Ladue Geophysics Linedata XYZ files	3
GPR 2011-1	Ladue Geophysics Vector data files	3
GPR 2010-1	Moran Geophysics Georeferenced raster files	3
GPR 2010-1	Moran Geophysics Linedata GDB files	3
GPR 2010-1	Moran Geophysics Linedata XYZ files	3
GPR 2010-1	Moran Geophysics Plot files	3
GPR 2009-1	Slate Creek-Slana River Geophysics Grids GRD	3
GPR 2008-3	Styx River Geophysics	3
GPR 2008-3	Styx River Geophysics	3
RI 95-2A	Circle geology	2
RI 94-25	Anchorage C-7 NW Derivative materials	2
RI 94-24	Anchorage C-7 NE Derivative materials	2
RI 2012-2 v. 1.1	Golovin Flood Extent	2
RI 2011-7	Tsunami Mapping: Whittier	2
RI 2009-3	Kavik River Topography	2
RI 2004-3	Okmok Volcano Hazard Assessment	2
RI 2004-3	Okmok Volcano Hazards Basemap	2
RI 2004-1C	Salcha River Pogo: Surficial geology	2
RI 2002-2	Big Delta A-4 Geologic map	2
RI 2001-1C	Chulitna region surficial geology	2
RI 2000-5	Healy A-6 fossil locality map	2
RDF 2013-6	Iniskin Peninsula MICP	2
RDF 2013-3	Whittier lidar intensity images	2
RDF 2013-3	Whittier lidar raster index	2
RDF 2013-10	Port Heiden shoreline images 6	2
RDF 2013-10	Port Heiden shoreline images 7	2
RDF 2013-10	Port Heiden shoreline images 8	2
RDF 2013-10	Port Heiden shoreline images 9	2
RDF 2011-3S	Canopy cover, Philip Smith Mountains Quadrangle	2
RDF 2011-3S	Mean Vegetation Elevation, Philip Smith Mountains Quadrangle	2
RDF 2011-3S	Vegetation digital surface model (DSM), Philip Smith Mountains Quadrangle	2
RDF 2011-3R	Lake polygons, Chandalar Quadrangle	2
RDF 2011-3Q	Normalized digital surface model (nDSM), Beechey Point Quadrangle	2
RDF 2011-3P	Hillshade images, Valdez Quadrangle	2
RDF 2011-3P	Intensity images, Valdez Quadrangle	2
RDF 2011-3O	Hillshade images, Gulkana Quadrangle	2
RDF 2011-3N	Canopy cover, Talkeetna Mountains Quadrangle	2
RDF 2011-3N	Mean Vegetation Elevation, Talkeetna Mountains Quadrangle	2
RDF 2011-3N	Vegetation digital surface model (DSM), Talkeetna Mountains Quadrangle	2
RDF 2011-3M	Lake polygons, Healy Quadrangle	2
RDF 2011-3L	Canopy cover, Anchorage Quadrangle	2
RDF 2011-3L	Highest hit digital surface model (DSM), Anchorage Quadrangle	2
RDF 2011-3L	Vegetation digital surface model (DSM), Anchorage Quadrangle	2
RDF 2011-3K	Canopy cover, Livengood Quadrangle	2
RDF 2011-3K	Lake polygons, Livengood Quadrangle	2
RDF 2011-3J	Hillshade images, Wiseman Quadrangle	2

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
RDF 2011-3J	Lake polygons, Wiseman Quadrangle	2
RDF 2011-3I	Normalized digital surface model (nDSM), Talkeetna Quadrangle	2
RDF 2011-3H	Hillshade images, Tyonek Quadrangle	2
RDF 2011-3H	Lake polygons, Tyonek Quadrangle	2
RDF 2011-3F	Hillshade images, Bettles Quadrangle	2
RDF 2011-3F	Lake polygons, Bettles Quadrangle	2
RDF 2011-3E	Intensity images, Fairbanks C-5 Quadrangle	2
RDF 2011-3E	Intensity images, Fairbanks D-1 Quadrangle	2
RDF 2011-3E	Intensity images, Fairbanks D-2 Quadrangle	2
RDF 2011-3E	Normalized digital surface model (nDSM), Fairbanks Quadrangle	2
RDF 2011-3B	Intensity images, Tanacross A-2 Quadrangle	2
RDF 2011-3A	Intensity images, Mount Hayes C-1 Quadrangle	2
RDF 2010-2	Slate Creek Geochemistry	2
RDF 2008-4	Tyonek D-6 Quadrangle Geochronology	2
PIR 2009-8A	Cook Inlet: Measured sections	2
PIR 2004-3B	Livengood 2004 Bedrock Geologic Map	2
PIR 2002-1D	Engineering-geologic map of the Eagle A-1 Quad	2
PIR 2001-3D	Fortymile Mining District, Eagle A-2 engineering geology	2
PIR 2001-3C	Fortymile Mining District, Eagle A-2 surficial geology	2
PDF 98-37D	Tanana A-1 and A-2 engineering geology	2
PDF 98-37C	Tanana A-1 and A-2 surficial geologic map	2
GPR 2013-3	Dalzell Creek Geophysics Linedata GDB files	2
GPR 2013-3	Dalzell Creek Geophysics Linedata GDB files	2
GPR 2013-3	Dalzell Creek Geophysics Grid ERS files	2
GPR 2013-3	Dalzell Creek Geophysics Grid GRD files	2
GPR 2013-3	Dalzell Creek Geophysics Adobe PDF files	2
GPR 2013-3	Dalzell Creek Geophysics Vector data shape files	2
GPR 2013-2	Middle Styx Geophysics Linedata GDB files	2
GPR 2013-2	Middle Styx Geophysics Grid ERS files	2
GPR 2013-2	Middle Styx Geophysics Google Earth files	2
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Linedata GDB files	2
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Linedata GDB files	2
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Linedata GDB files	2
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Grid ERS files	2
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Adobe PDF files	2
GPR 2011-2	Iditarod Geophysics Plot files	2
GPR 2011-2	Iditarod Geophysics Plot files	2
GPR 2011-2	Iditarod Geophysics Plot files	2
GPR 2011-1	Ladue Geophysics Georeferenced raster files	2
GPR 2011-1	Ladue Geophysics Google Earth files	2
GPR 2011-1	Ladue Geophysics Grid ERS files	2
GPR 2011-1	Ladue Geophysics Grid GRD files	2
GPR 2011-1	Ladue Geophysics Plot files	2
GPR 2010-1	Moran Geophysics Adobe PDF files	2
GPR 2010-1	Moran Geophysics Adobe PDF files	2
GPR 2010-1	Moran Geophysics Grid ERS files	2

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
GPR 2010-1	Moran Geophysics Grid GRD files	2
GPR 2010-1	Moran Geophysics Plot files	2
GPR 2010-1	Moran Geophysics Plot files	2
GPR 2010-1	Moran Geophysics Vector data DXF files	2
GPR 2010-1	Moran Geophysics Vector data DXF files	2
GPR 2010-1	Moran Geophysics Vector data DXF files	2
GPR 2009-1	Slate Creek-Slana River Geophysics Plot files	2
GPR 2008-3	Styx River Geophysics	2
GPR 2008-3	Styx River Geophysics	2
RI 97-15E	Tanana B-1 Potential geologic hazards	1
RI 97-15B	Tanana B-1 Interpretive geologic bedrock map	1
RI 97-15A	Tanana B-1 Geologic map	1
RI 94-27	Anchorage C-8 NW Derivative materials	1
RI 94-27	Anchorage C-8 NW Geology	1
RI 94-26	Anchorage C-8 NE Derivative materials	1
RI 94-26	Anchorage C-8 NE Geology	1
RI 2013-1	Tsunami inundation maps of Port Valdez	1
RI 2009-2	Tanana B-1 Geochemistry	1
RI 2001-1D	Chulitna region engineering geology	1
RDF 2013-3	Whittier lidar hillshade images	1
RDF 2013-3	Whittier lidar lake polygons	1
RDF 2013-3	Whittier lidar LAS index	1
RDF 2013-10	Port Heiden shoreline images 10	1
RDF 2013-10	Port Heiden shoreline images 11	1
RDF 2013-10	Port Heiden shoreline images 13	1
RDF 2013-10	Port Heiden shoreline images 14	1
RDF 2013-10	Port Heiden shoreline images 15	1
RDF 2013-10	Port Heiden shoreline images 16	1
RDF 2012-4	Golovin shoreline photo locations	1
RDF 2012-4	Golovin shoreline photo locations 6	1
RDF 2012-4	Golovin shoreline photo locations 2	1
RDF 2011-5	Norton Sound Photo Points	1
RDF 2011-5	Norton Sound Photo Locations 8	1
RDF 2011-5	Norton Sound Photo Locations 17	1
RDF 2011-5	Norton Sound Photo Locations 19	1
RDF 2011-3S	Highest hit digital surface model (DSM), Philip Smith Mountains Quadrangle	1
RDF 2011-3S	Normalized digital surface model (nDSM), Philip Smith Mountains Quadrangle	1
RDF 2011-3R	Canopy cover, Chandalar Quadrangle	1
RDF 2011-3R	Highest hit digital surface model (DSM), Chandalar Quadrangle	1
RDF 2011-3Q	Highest hit digital surface model (DSM), Beechey Point Quadrangle	1
RDF 2011-3Q	Intensity images, Beechey Point Quadrangle	1
RDF 2011-3Q	Vegetation digital surface model (DSM), Beechey Point Quadrangle	1
RDF 2011-3P	Canopy cover, Valdez Quadrangle	1
RDF 2011-3P	Coefficient variation, Valdez Quadrangle	1
RDF 2011-3P	Lake polygons, Valdez Quadrangle	1
RDF 2011-3P	Mean Vegetation Elevation, Valdez Quadrangle	1

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
RDF 2011-3P	Vegetation digital surface model (DSM), Valdez Quadrangle	1
RDF 2011-3N	Coefficient variation, Talkeetna Mountains Quadrangle	1
RDF 2011-3M	Canopy cover, Healy Quadrangle	1
RDF 2011-3M	Coefficient variation, Healy Quadrangle	1
RDF 2011-3M	Normalized digital surface model (nDSM), Healy Quadrangle	1
RDF 2011-3M	Vegetation digital surface model (DSM), Healy Quadrangle	1
RDF 2011-3L	Mean Vegetation Elevation, Anchorage Quadrangle	1
RDF 2011-3K	Intensity images, Livengood A-4 Quadrangle	1
RDF 2011-3K	Intensity images, Livengood C-4 Quadrangle	1
RDF 2011-3K	Intensity images, Livengood D-6 Quadrangle	1
RDF 2011-3K	Mean Vegetation Elevation, Livengood Quadrangle	1
RDF 2011-3J	Canopy cover, Wiseman Quadrangle	1
RDF 2011-3J	Highest hit digital surface model (DSM), Wiseman Quadrangle	1
RDF 2011-3G	Bare-earth digital elevation model (DEM), Tanana Quadrangle	1
RDF 2011-3G	Lake polygons, Tanana Quadrangle	1
RDF 2011-3F	Canopy cover, Bettles Quadrangle	1
RDF 2011-3F	Highest hit digital surface model (DSM), Bettles Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks A-5 Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks B-5 Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks C-1 Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks C-4 Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks D-3 Quadrangle	1
RDF 2011-3E	Intensity images, Fairbanks D-4 Quadrangle	1
RDF 2011-3E	Vegetation digital surface model (DSM), Fairbanks Quadrangle	1
RDF 2011-3D	Canopy cover, Big Delta Quadrangle	1
RDF 2011-3D	Highest hit digital surface model (DSM), Big Delta Quadrangle	1
RDF 2011-3D	Intensity images, Big Delta A-4 Quadrangle	1
RDF 2011-3D	Intensity images, Big Delta A-5 Quadrangle	1
RDF 2011-3D	Intensity images, Big Delta B-5 Quadrangle	1
RDF 2011-3D	Intensity images, Big Delta B-6 Quadrangle	1
RDF 2011-3D	Intensity images, Big Delta C-6 Quadrangle	1
RDF 2011-3D	Mean Vegetation Elevation, Big Delta Quadrangle	1
RDF 2011-3C	Bare-earth digital elevation model (DEM), Nabesna Quadrangle	1
RDF 2011-3C	Hillshade images, Nabesna Quadrangle	1
RDF 2011-3C	Lake polygons, Nabesna Quadrangle	1
RDF 2011-3B	Bare-earth digital elevation model (DEM), Tanacross Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross A-3 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross B-3 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross B-4 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross B-5 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross B-6 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross C-6 Quadrangle	1
RDF 2011-3B	Intensity images, Tanacross D-6 Quadrangle	1
RDF 2011-3B	Lake polygons, Tanacross Quadrangle	1
RDF 2011-3A	Highest hit digital surface model (DSM), Mount Hayes Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes A-3 Quadrangle	1

PUBLICATION NUMBER	PUBLICATION SHORT TITLE	2013 DOWNLOADS
RDF 2011-3A	Intensity images, Mount Hayes A-4 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes B-1 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes B-4 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes C-2 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes C-4 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes D-1 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes D-2 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes D-3 Quadrangle	1
RDF 2011-3A	Intensity images, Mount Hayes D-4 Quadrangle	1
RDF 2011-3A	Lake polygons, Mount Hayes Quadrangle	1
RDF 2011-1	Seward Peninsula Outcrop Structural Data	1
RDF 2010-3	Livengood South Geochemistry	1
RDF 2009-1	Eastern Bonnifield Geochemistry	1
RDF 2007-1	Fairbanks Mining District Geochemical Data	1
PIR 2009-8D	Cook Inlet: Mercury injection capillary pressure results	1
PIR 2009-6C	AK Highway corridor, Robertson River: Permafrost Map	1
PIR 2008-3D	AK Highway corridor, Delta Junction: Faults	1
PIR 2008-3C	AK Highway corridor, Delta Junction: Permafrost Map	1
PIR 2005-1	Bristol Bay AK Pen. 2004 Sample Analyses	1
MP 137	Active Volcanoes Kamchatka and Kurile Islands	1
GPR 2013-3	Dalzell Creek Geophysics Vector data DXF files	1
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Linedata XYZ files	1
GPR 2013-1	Southern Dishna River, Fox Hills, Beaver Creek GP Linedata XYZ files	1
GPR 2011-1	Ladue Geophysics Plot files	1
GPR 2011-1	Ladue Geophysics Plot files	1
GPR 2010-1	Moran Geophysics Google Earth files	1
GPR 2009-1	Slate Creek-Slana River Geophysics Adobe PDF files	1
GPR 2009-1	Slate Creek-Slana River Geophysics Linedata GDB	1
GPR 2009-1	Slate Creek-Slana River Geophysics Linedata XYZ	1
GPR 2009-1	Slate Creek-Slana River Geophysics Vectors	1
GPR 2008-3	Styx River Geophysics	1
	TOTAL PUBLICATIONS DOWNLOADED	**1589**