ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

Annual Report 2014

State of Alaska
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
January 2015

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Front cover: DGGS geologist Erin Whorton services a high-elevation (>6,000 ft) weather station on a ridge between the Mineral Creek and Valdez Glacier watersheds near Valdez, Alaska. DGGS's Climate and Cryosphere Hazards Program (see briefing paper in Engineering Geology Section) is a partner in a multi-agency effort to increase the number of high-elevation weather stations in Alaska. Data from these stations are tremendously valuable and are being used to inform a number of research and public service efforts, from monitoring and predicting hazards associated with changes in snow, ice, and permafrost to improving the accuracy of aviation weather forecasts. Photo by David Reioux.

State of Alaska
Department of Natural Resources
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
January 2015

STATE OF ALASKA
Bill Walker, *Governor*

DEPARTMENT OF NATURAL RESOURCES
Marty Rutherford, *Acting Commissioner*

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

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DIRECTOR'S FOREWORD

Recently falling commodity prices have brought the state's reliance on revenue from natural resources to the forefront. Alaska is not immune to national and world events and market changes. Many global commodity prices have fallen from peak values in the recent past to multi-year lows. Recent success around the nation in unconventional oil and gas development, a product of high commodity prices, led to domestic gluts of these commodities and factored into subsequent depressed prices. We can expect this situation to persist until the demand–supply relationship is reset at this new supply level. Low commodity prices can challenge the resolve to keep moving forward and exploring today for the resources of tomorrow. New explorers coming to Alaska depend on publicly available data to come up to speed quickly and make informed decisions. Increasing the data available to all explorers reduces exploration costs, making Alaska more competitive. Alaska cannot afford to stop exploring for tomorrow's resources; to do so means that we will not be appropriately positioned once global commodity prices rebound.

While many metal prices are also on the downswing, the long-term price outlook is bullish for several metals Alaska produces. Supply constraints in the near future from mine closures, coupled with increasing global demand, are especially promising for silver and some of the base metals. DGGS will be responsive to evolving markets and continue to provide the baseline science to support management and development decision making. Alaska has a bright future in these commodities.

2014 was a challenging field season for DGGS. Two separate sets of circumstances beyond our control resulted in serious field safety incidents. These situations highlight the risks our staff face conducting field work, and the need for constant vigilance to ensure our crews return safely from the field. They also highlight the excellent training, field safety, communication, and emergency response procedures DGGS has in place. During the winter we will re-evaluate our field procedures to further educate staff, reduce risks to field crews, and strengthen our culture of safe collection of geologic data.

This year has seen increased collaboration and coordination with other agencies and industry. We value these relationships and will be working to strengthen and broaden them over the coming year. Maintaining strong and mutually beneficial ties with our sister agencies, industry partners, and academic colleagues enhances our ability to accomplish our mission and stay on the cutting edge of geoscience in Alaska.

One exciting development this year was completion of the upgrades to the new Geologic Materials Center in Anchorage. After years of hard work, the new GMC was officially opened in November, and will be fully operational following the collection relocation in the spring. We are seeing an increased rate of donations, and of requests to use the facility. With room for the collection to grow, and providing greatly improved services, this facility will safeguard and make Alaska's geologic materials collection available to industry, agencies, and educators long into the future. I encourage you to visit and make use of this collection of Alaskan core, drill cuttings, and rock samples.

Despite the many challenges we face, I am constantly amazed by the hard work and commitment of our staff. Their efforts are evidenced by the increased number of geologic maps and reports published this year. The breadth of topics spans the range of DGGS activities, from natural resources to geologic hazards, coastal erosion, and climate-change issues. We have a very talented team that also provides geoscience data in new and innovative ways via our website. I encourage you to visit the DGGS website (www.dggs.alaska.gov) and check out these resources, data, and publications; and don't miss out on reading about our ongoing projects in this annual report.

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

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

ANNUAL REPORT 2014

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, 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

ORGANIZATION

DGGS is one of seven divisions and ten 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, 10 nonpermanent staff, and 10 student interns.

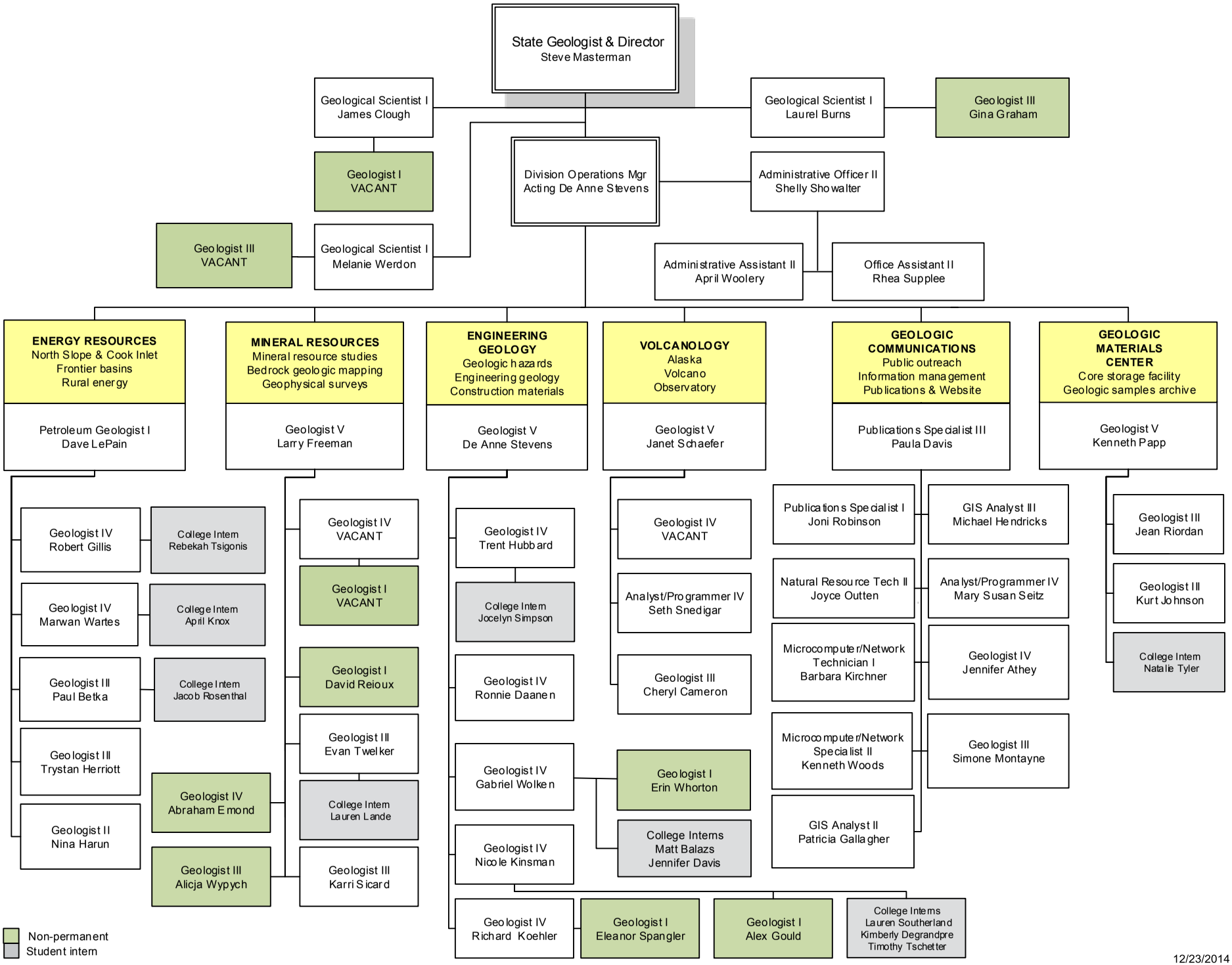
Geologic Materials Center, Anchorage

L TO R: *Back: Steve Masterman, April Woolery, Rhea Supplee, Front: De Anne Stevens, Shelly Showalter*

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.

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 potential to host energy resources. The Energy Resources Section seeks to improve the success of State-revenue-generating commercial oil and gas exploration and development to identify potential local sources of energy for rural Alaska villages and enterprises, and to provide objective science to assist State officials in making informed land-use decisions relating to energy potential.

L TO R: *Paul Betka, Trystan Herriott , Nina Harun, Dave LePain, Jim Clough, Marwan Wartes, Bob Gillis*


State Geologist & Director
Steve Masterman
Geological Scientist I
James Clough
Geologist I
VACANT
Geologist III
VACANT
Geological Scientist I
Melanie Werdon
Division Operations Mgr
Acting De Anne Stevens
Geological Scientist I
Laurel Burns
Geologist III
Gina Graham
Administrative Officer II
Shelly Showalter
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
Geologist IV
Robert Gillis
College Intern
Rebekah Tsigonis
Geologist IV
Marwan Wartes
College Intern
April Knox
Geologist III
Paul Betka
College Intern
Jacob Rosenthal
Geologist III
Trystan Herriott
Geologist II
Nina Harun
MINERAL RESOURCES
Mineral resource studies
Bedrock geologic mapping
Geophysical surveys
Geologist V
Larry Freeman
Geologist IV
VACANT
Geologist I
VACANT
Geologist I
David Reioux
Geologist III
Evan Twelker
College Intern
Lauren Lande
Geologist III
Karri Sicard
Geologist IV
Abraham Emond
Geologist III
Alicja Wypych
ENGINEERING GEOLOGY
Geologic hazards
Engineering geology
Construction materials
Geologist V
De Anne Stevens
Geologist IV
Trent Hubbard
College Intern
Jocelyn Simpson
Geologist IV
Ronnie Daanen
Geologist IV
Gabriel Wolken
Geologist IV
Nicole Kinsman
Geologist IV
Richard Koehler
Geologist I
Eleanor Spangler
Geologist I
Alex Gould
College Interns
Lauren Southerland
Kimberly Degrandpre
Timothy Tschetter
VOLCANOLOGY
Alaska
Volcano
Observatory
Geologist V
Janet Schaefer
Geologist IV
VACANT
Analyst/Programmer IV
Seth Snedigar
Geologist III
Cheryl Cameron
Geologist I
Erin Whorton
College Interns
Matt Balazs
Jennifer Davis
GEOLOGIC COMMUNICATIONS
Public outreach
Information management
Publications & Website
Publications Specialist III
Paula Davis
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 II
Patricia Gallagher
GIS Analyst III
Michael Hendricks
Analyst/Programmer IV
Mary Susan Seitz
Geologist IV
Jennifer Athey
Geologist III
Simone Montayne
GEOLOGIC MATERIALS CENTER
Core storage facility
Geologic samples archive
Geologist V
Kenneth Papp
Geologist III
Jean Riordan
Geologist III
Kurt Johnson
College Intern
Natalie Tyler
Non-permanent
Student intern

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.

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

L TO R: *Jennifer Davis,Trent Hubbard, Alex Gould, Gabe Wolken, Rich Koehler, Erin Whorton, Nic Kinsman, Ronnie Daanan, Ellie Spangler, Matthew Balazs, De Anne Stevens*

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 urban and resource development areas. The section advises other DNR divisions and State agencies regarding water resources and potential hazard risks to proposed developments and land disposals.

The **Volcanology Section,** established in 2007, focuses on processes and hazards associated with the more than 50 active volcanoes in Alaska. The section is home for the DGGS participants in the Alaska Volcano Observatory (AVO), an interagency collaboration between the U.S. Geological Survey, the 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, recordkeeping, and data sharing within AVO. During volcanic eruptions (three in 2014) Volcanology Section staff spend a significant amount of time responding to the eruption.

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

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

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.

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 continually acquired; access to the materials at the GMC in Eagle River continues to be 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.

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

The Alaska Seismic Hazards Safety Commission is charged by statute (AS 44.37.067) to recommend seismic risk mitigation goals and priorities 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, administered by DGGS, 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 Section 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 the Division'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, Sitka, Cordova, Tatitlek, and Chenega Bay, 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 Haines, Skagway, Dutch Harbor, Unalaska, Akutan, Sand Point, Elfin Cove, Gustavus, Hoonah, and Yakutat 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, slope instability, and other surface processes that threaten their safety and 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 residents, 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). 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 (GIS). Some graduate students are able to apply their DGGS intern work to their thesis projects through research intern programs established by 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 long-standing 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. The DGGS coastal program has also recently developed close working relationships and funding opportunities with the National Oceanic and Atmospheric Association (NOAA) and its National Weather Service (NWS).

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 board 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.

2014 ACCOMPLISHMENTS

ENERGY RESOURCES

- Presented preliminary results from recent studies on the geologic evolution of Cook Inlet basin at the national meeting of the Geological Society of America in Vancouver, British Columbia, Canada.
- Presented new interpretations of potential Brookian reservoirs on the North Slope at the Alaska Geological Society Annual Technical Conference in Anchorage.
- Presented keynote address on the framework geology of Cook Inlet basin at the Alaska Geological Society Annual Technical Conference in Anchorage.
- Presented a summary of the Alaska geothermal database and geothermal sites of Alaska map at the Alaska Miners Association spring meeting in Fairbanks.
- Published data pertaining to the petroleum seal capacity of Jurassic, Cretaceous, and Cenozoic strata of the Iniskin Peninsula region in lower Cook Inlet basin.
- Published a six-chapter compilation report summarizing field studies and bedrock geologic mapping during 2013 in the Iniskin Peninsula area, lower Cook Inlet basin, aimed at better understanding the conventional and unconventional hydrocarbon potential of Mesozoic strata. This volume includes descriptions of two locations where oil-stained Mesozoic rocks are present in outcrop.
- Published a report on the geologic context, age, and sedimentology of a Pleistocene volcaniclastic succession near Mount Spurr volcano in south-central Alaska.
- Published interpretations of seismic reflection data and structural cross-sections for the Kavik River area, east-central North Slope foothills.
- Published a chapter on the geologic framework and petroleum geology of Cook Inlet basin to a major scientific memoir volume published by the American Association of Petroleum Geologists (AAPG), titled Oil and Gas Fields of the Cook Inlet Basin, Alaska. Memoir 104 will potentially reach a very large international audience and bring attention to exploration opportunities in Cook Inlet.
- Published a report summarizing geologic-mapping-based observations of the Middle Jurassic Chinitna Formation and Upper Jurassic Naknek Formation in outcrop on the Iniskin Peninsula.
- Published a preliminary report summarizing brittle deformation on the Iniskin Peninsula and implications for the history of the Bruin Bay fault zone. Motion along this fault zone significantly influenced sedimentation and subsidence patterns in lower Cook Inlet basin, which have important implications for its petroleum potential.

- Completed three weeks of helicopter-supported field work in lower Cook Inlet, focusing on the conventional and unconventional petroleum potential of Mesozoic strata and reconnaissance bedrock mapping of a 300–square-mile area between Chinitna and Tuxedni bays.
- Completed two weeks of field work on the North Slope directed at collecting new data and samples from Triassic and Cretaceous formations targeted in unconventional shale oil exploration.
- Completed four weeks of field work in lower Cook Inlet that focused on mapping the bedrock geology of the Iniskin Peninsula, including key exposures of potential Jurassic oil source rocks and the discovery of an oil-stained sandstone bed.
- Completed two weeks of helicopter-supported field work in the Susitna basin, aimed at better understanding its geologic history and petroleum source rock and reservoir potential.
- Completed two weeks of helicopter-supported field work in the Brooks Range foothills east of the Trans-Alaska Pipeline corridor, focusing on the source rock and reservoir potential of Brookian strata, including the shale oil potential of selected Mesozoic formations.
- Published a geologic map of the south-central Sagavanirktok Quadrangle, straddling the Trans-Alaska Pipeline corridor, illustrating key geologic relations for understanding the petroleum potential of Brookian strata.
- Measured a continuous stratigraphic section through the Middle Jurassic Red Glacier Formation, the primary source rock for oil in Cook Inlet basin, and collected an extensive suite of samples for geochemical characterization.
- Led a one-day field trip highlighting the reservoir geometry of Hemlock and Tyonek Formations in outcrop along the west side of Cook Inlet basin for oil companies exploring in Cook Inlet basin.
- Published and released a comprehensive Alaska geothermal dataset for inclusion in the National Geothermal Data System (http://www.geothermaldata.org), the culmination of a three-year U.S. Department of Energy-funded project for DGGS to compile at-risk legacy and new exploration data that was not readily accessible.
- Presented the new Geothermal Sites of Alaska Map (in preparation) and Alaska's new geothermal dataset at the annual meeting of the Geological Society of America in Vancouver, British Columbia, Canada.

MINERAL RESOURCES

- Published geophysical survey data covering 3,339 square miles in the Farewell area, western Alaska Range, East Styx area, west-central Alaska Range, and the Wrangellia area, northern Talkeetna Mountains.
- Published Alaska's Mineral Industry 2013, an authoritative annual report of the statewide mineral industry, including exploration, development, and production activities. The report is produced jointly with the Division of Economic Development (DCCED) along with statistics provided by staff from several other State and Federal agencies. The report is partially based on voluntary responses contributed by companies, agencies, and individuals in the minerals industry.
- Published an updated statewide map of Alaska's mineral resources.
- Presented summary reviews of the 2013 and 2014 Alaska mineral industry and resources at four different mineral industry conventions in Alaska, the western U.S., and Canada.
- Continued a multi-year strategic and critical mineral copper–nickel–cobalt platinum-group-element assessment of 2,600 square miles in the Wrangellia geologic province of south-central Alaska by conducting ore deposit research on the Triassic-age mafic rocks that are potential hosts to mineralization.
- Conducted 450 square miles of 1:50,000-scale geologic mapping of a portion of the Talkeetna Mountains in the Wrangellia geologic province in south-central Alaska to outline previously unrecognized Triassic mafic rocks that are potential hosts to copper–nickel–cobalt platinum-group-element deposits; the mapped area has a very diverse geology and could also host porphyry copper–molybdenum–gold, gold-vein, and epithermal gold–silver deposits.
- Participated in U.S. Geologic Survey field work to geologically map and assess rare-earth-element (REE) potential of the Roy Creek REE occurrence in east-central Alaska.
- Conducted reconnaissance geologic mapping and physical properties sampling in the Tonsina airborne geophysical survey area.
- Contracted an airborne geophysical survey and acquired data for 989 square miles in the Tok area, east-central Alaska, adjacent to previous Alaska Highway corridor and Slate Creek–Slana River airborne geophysical surveys.
- Contracted and acquired data for a 266-square-mile Strategic and Critical Minerals-related airborne geophysical survey near Tonsina, on the north side of the Chugach Mountains along the Richardson Highway in south-central Alaska.
- Published ten data files of new, high-quality, multi-element geochemical analyses of 2,954 archived U.S. Geological Survey and U.S. Bureau of Mines samples selected from areas with potential for strategic and critical minerals.
- Published four data files of high-quality, multi-element, and whole-rock geochemistry of 1,883 recently collected samples from areas with SCM, porphyry copper–molybdenum–gold, and intrusion-related gold potential.
- Published three data files of geochronology data for the Styx River area and the Strategic and Critical Minerals-related areas in the Ray Mountains and Wrangellia provinces. Significantly, the report from the Styx area identifies a previously

unrecognized age of porphyry copper–molybdenum–gold mineralization that potentially opens new target areas for exploration.
- 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 two posters and nine talks at professional meetings.
- Responded to more than 400 public, industry, and agency requests for mineral resources information.

ENGINEERING GEOLOGY

- Conducted geologic hazards evaluations for about 5,941 square miles of land, 160 linear miles of infrastructure corridor, and 24 communities.
- Completed the third and final year of fieldwork on a glacier change and hydrology study of the upper Susitna drainage basin in support of the Susitna–Watana Hydroelectric Project. The study uses measurements of glacier mass balance, snow accumulation, runoff, and meteorology to model the effects of climate variability and change, permafrost thaw, and glacier wastage on runoff into the proposed reservoir.
- Began two collaborative studies with Alaska DOT&PF to evaluate geologic hazards within transportation corridors. The studies focus on snow avalanche susceptibility along segments of the Richardson and Dalton Highway corridors, and on debris flows along the Haines Highway.
- At the request of Alaska DOT&PF, conducted a landslide-hazard evaluation for the Yukon River bridge crossing. The published results are being used by Alyeska Pipeline Service Company and Alaska DOT&PF in their efforts to understand the vulnerability of the bridge, road, and Trans-Alaska Pipeline crossing to potential future slope instabilities.
- Continued to manage the federally-funded Tsunami Hazards Mitigation Program. Inundation maps showing areas that could be affected by future potential tsunamis were published for Cordova, Tatitlek, and Chenega Bay. Results of these investigations have been disseminated to local emergency planners.
- Performed studies to assess seismic hazards related to active fault crossings of major natural gas pipelines including (1) trenching studies across the Castle Mountain and Northern Foothills faults along the Alaska Stand Alone Pipeline (ASAP) for the Alaska Gasline Development Corporation, and (2) fault location studies of the western Denali fault along the Donlin Gold natural gas pipeline route for DNR's Office of Project Management and Permitting.
- Collaborated with the University of Alaska Fairbanks to evaluate the potential geologic hazard of frozen debris lobes in proximity to the Dalton Highway corridor in the southern Brooks Range. Field work was conducted to investigate these features and to measure rates of surface movement.
- Completing development of interactive maps to deliver relevant coastal hazard data (for example, nearshore elevations and shoreline change rates) that can be used to plan for and minimize damages due to coastal flooding and erosion in communities throughout Alaska.
- Substantially increased involvement with federal partners to improve baseline data collection and data quality along Alaska's coastlines as an extension of the ongoing Geohazard Mapping for Coastal Communities project, which is funded through FY2016 by the Coastal Impact Assistance Program (CIAP).
- In coordination with the Alaska Region of the National Weather Service and the Alaska Ocean Observing System, published a series of color-indexed elevation maps and installed two real-time water-level sensors in western Alaska. These projects significantly improved community preparedness for the 2014 storm season.
- Conducted 1:50,000-scale surficial-geologic mapping of the Talkeetna Mountains C-4 Quadrangle and parts of the Talkeetna Mountains C-3, B-4, and B-3 quadrangles based primarily on remotely-sensed imagery and only limited fieldwork. This mapping is in support of the Mineral Resources Section's STATEMAP project, and will provide more detailed surficial geology data than is currently available from published smaller-scale mapping.
- Collaborated with USGS to characterize tephra and tsunami sand deposits at Petersen Bay, Sanak Island, to evaluate recurrence of tsunamis along the Aleutian megathrust.
- Published lidar data for the communities of Unalakleet and Golovin in support of DGGS's coastal hazards assessment activities.
- Published a preliminary hazards report for the Passage Canal–Portage–Valdez area.
- Published a report on contemporary shoreline retreat rates at Port Heiden.
- Published an engineering-geologic map for an area along the Dalton Highway between Galbraith Lake and Slope Mountain, southern Arctic Foothills.
- Delivered 40 public presentations about geologic hazards in Alaska, including technical talks, speaking at or teaching classes, and speaking at public meetings.

- Provided administrative and scientific support for the Alaska Seismic Hazards Safety Commission. The Commission produces a separate annual report.
- Supported the Alaska Energy Authority by reviewing alternative energy project proposals for potential geologic hazards that should be addressed in project implementation.
- Completed agency reviews regarding potential geologic hazards and engineering-geologic considerations for multiple DNR land disposals; area plans; resource development and subdivision projects; proposed pipeline and hydroelectric projects; Environmental Impact Statements and Resource Management Plans for the U.S. Bureau of Land Management (BLM); and study plans for the Alaska Energy Authority.

VOLCANOLOGY

- Provided all helicopter procurement and fuel logistics support for Alaska Volcano Observatory (AVO) field projects, which were engaged in geophysical monitoring station maintenance, geologic field investigations, and eruption response.
- Published a volcano-hazard assessment for Fisher volcano, Umnak Island.
- Continued to build and improve the geochemical database of volcanic rocks of Alaska. The database now includes more than 7,000 whole-rock analyses, 113 water-chemistry analyses, and 185 glass analyses. AVO also conducted substantial quality assurance and quality control checks. To the best of our knowledge, all published whole-rock analyses of volcanic rocks younger than 2.6 million years are in the database. Staff made significant improvements to the database's internal and public search interfaces, wrote a help document, and have published the database and its interface.
- Published the Quaternary vents of Alaska database, which now includes 1,187 vents, a geographic and volcano-based hierarchy, vent types, locations, age descriptions, and references.
- DGGS staff responded to about 300 emails from the public through the AVO website email interface.
- Completed significant updates to GeoDIVA (Geologic Database of Information on Volcanoes of Alaska), including expansion of the on-line reference library (currently contains ~4,800 references) and additions to the eruption histories of Cleveland, Veniaminof, and Pavlof volcanoes. The eruption histories provide a timeline of events and impacts of the 2013 eruptions. Began populating a more-robust set of database tables to hold sample age information.
- Played a significant role in the response to eruptions at Pavlof, Shishaldin, and Cleveland volcanoes, and in monitoring the 2014 unrest at Semisopochnoi. Eruption response tasks include keeping the website running smoothly, accurately and efficiently distributing information, updating the database and social media sites (Facebook and Twitter) with eruption activity and impacts, answering emails and phone calls from the public, distributing and archiving eruption history and impact information within AVO, and participating in seismic and remote-sensing watches.
- Began construction and population of a tephra database for Alaska tephra (volcanic ash) data—including descriptions, analyses, age information, and correlations. Basic age search has been added to internal geochemistry search.
- Several programming updates have increased efficiency of information flow and volcanic activity observation and reporting, including: (1) automatic text alert to staff when an email report of ash is received, (2) major database and php software upgrade for all AVO servers, (3) upgraded internal AVO calendar import and export functions (Outlook/Gmail, etc.), (4) developed an online reporting form for remote-sensing observations, (5) new user authentication mechanisms added to define roles and permissions for individual users—internal tools (logs, image database, news items, etc.) updated to take advantage of new user authentication, (6) updated public website with a more subtle graphical look, (7) mobile internal page updated (observation logs and volcano monitoring dashboards), and (8) updated USGS Volcano Notification Service (VNS) to use Amazon email service for mass emails.
- Transferred more than 800 boxes of rocks (AVO's rock library) from unheated storage behind the UAF Geophysical Institute to heated, well-lit space at the old University Park building. Inventoried and archived about 60 new boxes of volcanic rock samples.

GEOLOGIC COMMUNICATIONS

- Published 53 new geologic maps and reports (total 1,014 pages and 66 sheets); distributed 429 hard-copy publications; served 1,811 digital data files and 300,740 PDF web documents via free downloads from the DGGS website (www.dggs.alaska.gov); responded personally to more than 2,000 geologic information requests; and recorded nearly 7.1 million web page views (a 17 percent increase from FY2013). Additionally, DGGS ended the year with 1,434 followers on Twitter, 411 subscribers to the division's RSS feed, and more than 35,000 visits to the DGGS Facebook page.
- Joined the DOI (digital object identifier) system that creates permanent links to online documents—a system widely used by the academic and scientific communities. This step created DOIs for all 4,866 DGGS publications, linking to each citation web page, improving the discoverability of DGGS maps and reports and the permanence of their location on the internet. The project required the development of an automatic submission process that was integrated into the existing publications system to create DOIs for new DGGS publications.

- Received funds from Alaska DOT&PF and began a new project to compile bedrock localities of Naturally Occurring Asbestos (NOA) and develop statewide NOA-potential bedrock maps. Submitted draft database-driven map products to DOT&PF in 2014. Final deliverables will be published by DGGS in FY2015.
- Secured funding from the National Geological and Geophysical Data Preservation Program (NGGDPP) to develop an interface for indexing and annotating staff field photos and begin the inventory process for our extensive field photo collection.
- Enhanced basic website search tool (available in the upper right corner of DGGS web pages) to quickly search all website content—the comprehensive collection of bibliographic references in the publications catalog, the text files of reports and maps in the catalog, and all records in the Alaska Geologic Data Index.
- Expanded the DGGS publications catalog by loading bibliographic references for Alaska-related geology and geophysics Master's theses and Ph.D. dissertations, along with abstracts and links where available. The inclusion of this bibliography continues to make the DGGS catalog one of the most extensive indexes of Alaska-related geologic publications.
- Loaded geochemistry data from all DGGS publications released from 2009 through 2014 into the Webgeochem application, in anticipation of an FY2015 complete redesign effort for the geochemical application into a more robust interactive web map interface to better serve its users.
- Continued maintenance and support of the following DGGS applications: Publications application, Webgeochem, Digital Data Distribution system, Geologic Map Index of Alaska, Airborne GeophysWeb, Alaska Geologic Data Index, and other web mapping applications in our Digital Data Series.
- Attended and presented information about DGGS publications and available Alaska geologic data at six conferences: ESRI International Users Conference (won the conference's Best Instructional Presentation Award); ESRI Mining User Group meeting at Alaska Miners Association Conference; Alaska Surveying and Mapping Conference; Digital Mapping Techniques conference; and distributed information at Alaska Miners Association Conferences in Fairbanks and Anchorage.
- Received funds from the Alaska Division of Oil and Gas to complete cartographic work on the Mesozoic Subcrop Map of Cook Inlet Basin, which will be published in FY2015.
- Managed production coordination and publication of Alaska's Mineral Industry 2012 (Special Report 68) and Alaska's Mineral Industry 2013 (Special Report 69). Contributed to report as author, performed data compilation, and coordinated among multiple agencies and authors to obtain information for the report.
- Served on community-of-use technical committees for the development of national geologic data standards and the U.S. Geological Survey topographic data program.
- Contributed 87 DGGS publication records to the U.S. Geological Survey's National Geologic Map Database to be searchable in their publicly accessible mapView application and Catalog Search.
- Compiled FGDC-compliant metadata for all DGGS digital data releases, posting the publication files in the appropriate places on the DGGS servers, and populating the enterprise database fields that allow us to make the digital data distribution files web accessible. Edited or created new metadata files and produced digital data distribution files for seven legacy reports. Created metadata and digital data distribution files for 26 new publications.
- Facilitated the publication of tabular, raster, nonstandard map-based geospatial data files such as imagery, geochemistry, geochronology, and tsunami inundation lines. In collaboration with DGGS authors, developed division-wide standards for table structure and overall organization of geochemistry, Ar/Ar geochronology, and U-Pb geochronology digital data distribution files. These standards allow us provide analytical data in a consistent manner and ensure that we systematically obtain and publish the necessary documentation.
- Prepared data tables from various analytical labs for publication. This work included tracking down missing documentation, providing assistance in reviewing summary reports that typically accompany data releases, and working with authors throughout the publication process to ensure that their products include information necessary to produce a FGDC-compliant metadata file.
- Developed a semi-automated process for generating FGDC-compliant metadata, such that scripts dynamically extract about 90 percent of the required information from the division's enterprise database or directly from the tabular data files. Reduced the time it takes to generate a geochemistry metadata file from about a week to about 2–4 hours.
- Used the recently updated U.S. Geological Survey GEOLEX database records to add several hundred new stratum keywords to our database reference tables. Quality-controlled existing records to provide greater consistency between our stratum keyword usage and the USGS preferred form.
- Provided ongoing support to Association of American State Geologists to maintain and develop their website MySQL content management database that populates the site.
- The DGGS library received a complete collection of Quaternary Research journals from retired DGGS geologist Dick Reger, now a consultant in Soldotna. Retired U.S. Geological Survey geologist Florence Weber's collection of early USGS reports and geologic textbooks (16 boxes) was donated to our library. Kinross contributed 24 boxes of reports and books (early DGGS, U.S. Bureau of Mines, U.S. Geological Survey, Bureau of Land Management, UAF's Mineral Industry Research Laboratory, and contractors). Additionally, retiring professors have donated portions of their libraries.

GEOLOGIC MATERIALS CENTER

- The Geologic Materials Center (GMC) hosted 340 visits by industry, government, and academic personnel to examine rock samples and processed materials. Collaboration from these visits helped acquire 610 processed slides, and oil and gas samples representing 530,474 feet from 71 wells, and led to the publication of nine new laboratory data reports derived from third-party analyses.
- Generous sample and data donations made by the Bureau of Land Management, Redstar Gold, the IRF Group, Calista Corporation, ExxonMobil, Linc Energy, Goldrich Mining Corporation, and The Pennsylvania State University Fletcher L. Byrom Earth & Mineral Sciences Library helped grow and improve the GMC's priceless archive.
- Hosted a well-attended ribbon-cutting ceremony, which included a keynote address by Governor Parnell and speeches by DNR Commissioner Balash and DOA Commissioner Thayer, on October 29, 2014, at the new facility in Anchorage, marking the successful completion of renovation upgrades to the new Alaska GMC.
- GMC staff successfully completed all necessary preparations prior to the planned August 4, 2014, relocation to Anchorage, which included (1) curating and reboxing thousands of samples, (2) entering tens of thousands of new items into the inventory database, (3) performing a shelf-by-shelf inventory audit of the entire sample collection, (4) packing up all office supplies, lab equipment, maps, reports, and tools, and (5) establishing logistical plans and relocation protocols with a moving contractor.
- Completed a year-long effort to redesign the Geologic Materials Center inventory, archive database, and sample-tracking systems. The new systems offer staff and visitors an extensive search functionality not previously available, including a web-map interface with spatial searches by quadrangle, region, place, mining district, and geographic bounding box. Custom software was built to allow GMC staff to query and manage inventory wirelessly in their new 100,000-square-foot facility using dedicated handheld computers. The effort also involved a top-to-bottom audit of the existing inventory; more than 95,000 samples were audited by hand, using software created explicitly for that purpose.
- Made significant progress on a shelf-by-shelf inventory audit of the entire sample collection. Samples and boxes on 5,826 shelves (99.9% of collection) have passed a rigorous quality control process using barcode scanners and information stored in the GMC's new database. This arduous procedure has remarkably improved the accuracy of the GMC's inventory and has made it easier to relocate samples.
- Completed a major curating project to rescue and repackage more than 13,000 Bureau of Land Management pulp samples kept in a dilapidated storage building adjacent to the GMC's main warehouse. The pulp samples are key to a large-scale mineral reanalysis program in the state and the results from this multi-month effort will help improve sample accessibility and ensure their future protection.
- Served 2,951 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 14,877 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 more than 90 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.

KEY ISSUES FOR FY2015–2016

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 mission and will be doing everything possible to meet the needs of our end users.

Our efforts to provide geologic data to the resource exploration and development industries will be tested as users demand quicker and more comprehensive information. Challenges associated with this arise from a static Division personnel count, our inability to rapidly adjust to the changing needs of the resource development community with the current number of personnel, and 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 is committed to maintaining 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 two of the 44 minerals that are imported at greater than 50 percent. DGGS is working diligently 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 the investment chain is the acquisition of new geologic data using modern technology. DGGS will continue 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 also be challenged to provide the necessary information to assist in developing these new resources.

Cyclical commodity prices create spikes in the exploration cycle, which creates challenges for DGGS. During boom times, 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.

Cyclical commodity prices also result in surges in demand for commodity-specific geoscience data. The latest hot commodity may not be what we have been working on recently. DGGS must be forward-looking to anticipate demands for geoscience data. DGGS will be pushed to move at the required speeds during these commodity price fluctuations.
Industrial mineral use in the state will continue to increase as development of many types require special materials. Currently the bulk of these products are imported. Local production would boost the Alaska economy. The cost of industrial commodities can profoundly impact project economics. DGGS will be challenged to secure the necessary funding and allocate staff time to meet industry needs for information on these commodities.

INFRASTRUCTURE PROJECTS AND PUBLIC SAFETY

Construction materials are in critically short supply in numerous areas of the state. The lack of affordable basic construction materials such as sand and gravel, rock, riprap, and railroad ballast for road, bridge, rail, airport, and community construction projects can dramatically affect project economics, making some projects uneconomic or unaffordable. This especially impacts development projects in areas where little is known about construction materials, as well as rural communities where alternatives may be limited.

Despite an abundance of geologic hazards in Alaska, there is a lack of systematic, statewide data to allow project proponents to quickly assess natural hazards and risks to their projects. Large projects to develop Alaska's natural resources and sustain the state's economy require baseline geologic data and hazards analysis to enable engineering and permitting to be completed in a reasonable timeframe, and for the environment to be properly protected. Unfortunately, most areas have only minimal data, and very little of the detailed information necessary to undertake these activities. Providing geologic data for infrastructure design, construction, and maintenance will remain a key challenge for DGGS.

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 impacts. 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 and geologic expertise 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 factors 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.

The expansion of Arctic shipping lanes from Asia to Europe highlights the paucity of basic coastal and maritime data along Alaska's western and northern coasts. The likely future expansion of this marine transportation corridor, and possible opening of the Northwest Passage, will test DGGS's ability to provide the necessary data on coastal and near-shore areas.

CHANGES IN LOCAL ENERGY SUPPLY AND CONSUMPTION

Sustained high energy prices have a significant impact on the economy 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 local 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. Providing targeted geologic data where it will help local governments understand the locally available resources, and the development challenges associated with them, will remain a key DGGS goal.

Misinformation about viable alternative energy sources is rampant and many expensive mistakes can be avoided by getting accurate information into the hands of local governments and decision makers. DGGS must provide pertinent and timely data on numerous fronts, and address the existence 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.

A complete, or even partial, retooling of Alaska'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 costly mistakes of the past. The Alaska Energy Authority has completed several rounds of its 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 energy future.

A CHANGING ARCTIC CLIMATE

As climate change effects are more widely observed around the world, their Arctic impacts also become more broadly appreciated. DGGS geoscientists can play a leading role in guiding areas of research into the effects of climate change in the Arctic. As the geological survey for the nation's only Arctic state, DGGS will be challenged to help address the effects of Arctic climate change, and to identify areas of critical need for the state.

Over the coming years Alaska will be a national focal point for indications and impacts of climate change. DGGS's ability to not only guide, but also 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 for the coast and in areas where communities and infrastructure are impacted by thaw settlement from melting permafrost, erosion and landslide hazards, sea-level changes, and changes in hydrologic systems, including both surface and subsurface aquifers.

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 requires that up-to-date regional or statewide 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 types of information to be collected and areas to be studied; 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. DGGS will be challenged to continue developing and applying innovative methods and technologies for data acquisition and analysis. Matching innovative methods to the right research in the critical areas will allow us to maximize limited staff and funding.

THE ALASKA GEOLOGIC MATERIALS CENTER

Our ability to develop the state's natural resources and maintain a robust economy 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 14 million feet of drilling from 1,700 oil and gas exploration and development wells, 280,000 feet of mineral core from 1,800 exploratory boreholes, 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.

The Governor's FY2014 budget included a capital appropriation to begin the process of replacing the aging GMC 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 were made during summer 2014, and are essentially complete. The building was ceremonially opened on October 29, 2014, and will be fully functional following the collection relocation in spring 2015.

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.

A key challenge will be to safely and efficiently relocate the collection from its current location in Eagle River to the new site on Penland Parkway in Anchorage with minimal disruption to users. 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. Another critical issue for DGGS will be securing operations funding to ensure the facility continues to serve long into the future. To meet this particular challenge, we will be instituting fees for the various services available at the new facility. This will be an adjustment for our users, but is necessitated by the higher operating and maintenance costs at the new facility. These fees will be in line with those charged at other similar facilities in North America.

DATA PRESERVATION AND DISTRIBUTION

Digital mapping techniques, changes in database design, vast volumes of data, and ever-changing computer software and hardware test DGGS's ability to meet an increasingly diverse customer base. No longer are paper maps and reports sufficient; digital maps, databases, social media presence, and interactive online maps are among our growing list of distribution methods that are all necessary in an increasingly electronic world. DGGS must continue developing and optimizing its data acquisition, storage, and distribution methods to discover new and more efficient ways to disseminate the information to those that need it.

DGGS FY2015 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 with DGGS staff.

The FY2015 DGGS program focuses on projects designed to foster the creation of Alaska natural-resource jobs and revenue, and to mitigate adverse effects of geologic hazards on life and property. 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 companies, 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, DGGS also provides access to physical geologic samples collected by private companies and government agencies.

FY2015 Division Expense Budget
(estimated expenses in thousands of dollars)

Program	General Fund	CIP	Federal Receipts	Interagency & Program Receipts	Total
Energy Resources	$627.2	$910.7	$22.9	$167.8	**$1,728.6**
Mineral Resources	1,490.4	1,237.0	127.7	- -	**2,855.1**
Engineering Geology	661.6	388.8	2.3	1,923.0	**2,975.7**
Volcanology	- -	- -	800.1	- -	**800.1**
Geologic Communications	1,258.4	- -	- -	37.0	**1,295.4**
Geologic Materials Center	959.0	10.9	10.2	50.0	**1,030.1**
Administrative Services	548.1	10.0	- -	41.6	**599.7**
Seismic Hazards Safety Commission	10.0	- -	- -	- -	**10.0**
Total by Funding Source	**$5,554.7**	**$2,557.4**	**$963.2**	**$2,219.4**	**$11,294.7**

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 increasingly 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, acquired using modern technologies, 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 multi-year study of this basin in 2006, 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 2014 DGGS conducted stratigraphic and structural studies along the western margin of lower Cook Inlet in the Iniskin and Tuxedni Bay areas, which included reconnaissance bedrock geologic mapping. Strata in these areas represent the only exposures of the primary Mesozoic oil source rocks in the basin and virtually unexplored potential reservoir rocks underlying currently producing areas in upper Cook Inlet. In summer 2014 DGGS also conducted reconnaissance geologic mapping (1:63,360 scale) of nearly 300 square miles between Chinitna and Tuxedni bays and measured a nearly complete section through the oil-prone, organic-rich Red Glacier Formation.

Many sedimentary basins in Alaska have geologic characteristics 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 2014 in the Susitna basin, with a focus on characterizing the gas potential of Cenozoic coals and carbonaceous mudstones. 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. As mentioned above, field studies continued in 2014 in the Susitna basin, where coal seams were sampled to help characterize their grade and natural gas source potential. Analysis of data from these initial studies is ongoing. As part of an integrated DGGS geologic data management system, the Energy Resources Section is adding to its 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 2014 with the release and publication of a comprehensive Alaska geothermal dataset as part of the National Geothermal Data System (http://www.geothermaldata.org). 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 Cook Inlet basin.
3. Collect and publish new geologic data to stimulate exploration for natural gas in the Susitna and Nenana basins.
4. Begin developing a searchable digital database for the Energy Section's data, which will ultimately allow petroleum companies, state policy makers, and the general public to access relevant data pertaining to the energy resource potential of 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.

FY2015 ENERGY RESOURCES PROJECTS

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

- Cook Inlet basin analysis program – p. 32
- Geologic mapping of the Iniskin–Tuxedni Region, lower Cook Inlet – p. 33
- State of Alaska contributions to the National Geothermal Data System – p. 34
- Alaska Coal Database—National Coal Resource Database System – p. 35
- Hydrocarbon potential of the Nenana basin – p. 36
- Brooks Range foothills and North Slope program – p. 37
- Natural gas potential of the Susitna basin – p. 38

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

- Provide written evaluations of mineable coal potential for lease areas in response to requests from Division of Mining, Land, and Water.
- Respond to 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 metals, base-metals, and strategic minerals is at an all-time high, and Alaska's mineral resources play a growing and 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, the DGGS Mineral Resources Section 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 strategy 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 FY2012 with a data survey and compilation of existing information on rare-earth-element occurrences in the state, and expanded significantly in FY2013 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 fund base budget, 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 project summaries for the following Mineral Resources projects appear in the section Project Summaries—FY2014

- Airborne geophysical survey of Wrangellia, south-central Alaska – p. 39
- Airborne geophysical survey of the East Styx area, south-central Alaska – p. 40
- Airborne geophysical survey of the Tok area, eastern interior Alaska – p. 41
- Airborne geophysical survey of the Tonsina area, south-central Alaska – p. 42
- Strategic and critical minerals assessment project – p. 43
- Strategic and critical minerals assessment in the western Wrangellia terrane, south-central Alaska – p. 44
- Strategic and critical minerals assessment in the Ray Mountains area, north-central Alaska – p. 45
- Geologic mapping in the Styx River area, Lime Hills C-1 Quadrangle, western Alaska Range – p. 46
- Geologic mapping in the eastern Moran area, Tanana and Melozitna quadrangles, Alaska – p. 47
- Geologic mapping in the Talkeetna Mountains, south-central Alaska – p. 48
- Bedrock geologic mapping in the Tolovana mining district, Livengood Quadrangle, Alaska – p. 49
- Bedrock geology and mineral-resource assessment along infrastructure corridors between Delta Junction and the Canadian Border – p. 50
- Alaska's Mineral Industry Report – p. 51

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 such as 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

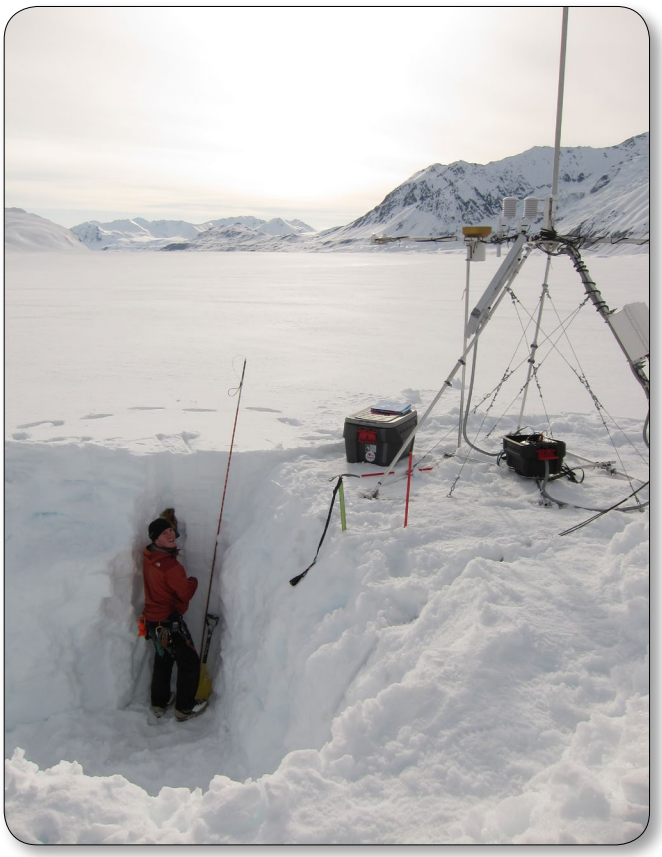
mitigation efforts should be concentrated. These maps are critical for emergency planning and the allocation of emergency-response resources prior to an adverse event.

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.

An emerging new research program, initiated in 2013, aims to collect and interpret the hydrologic data needed for managing Alaska's water 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 is leading research efforts that focus on understanding groundwater-related issues impacting the state, with a primary emphasis on groundwater analysis and aquifer modeling and mapping in oil and gas basins and other areas of high development potential. In collaboration with the University of Alaska Fairbanks and with input from DNR's Division of Mining, Land, and Water, several projects are underway and baseline data are being gathered to guide future DGGS research.

Major projects, developed in response to the overwhelming need for baseline geologic data 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 coastal communities in Alaska that are at risk for serious storm-wave erosion and flooding. Identifying and developing long-term solutions for critical data gaps in the coastal environment are a key focus of the Coastal Hazards program as it looks ahead to meeting future challenges. Thawing permafrost and possible sea-level changes are also a growing concern for many Alaska 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 and Cryosphere Hazards program performs geologic studies to identify high-risk areas where proactive mitigation efforts will be needed to minimize possible impacts. As part of this program, DGGS is completing a multi-year glacier change and hydrology study of the upper Susitna drainage basin as part of pre-licensing work for the proposed 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.

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 fault-related hazards in Alaska. A major ongoing project is fault assessment and hazards evaluation along the route of the proposed Alaska Stand Alone Pipeline (ASAP). The focus of FY2014 work was to better characterize crossing locations and fault rupture parameters, such as type of fault, width of deformation, single-event displacement, and orientation, to aid pipeline engineers in design and routing decisions. An additional focus was to determine which faults could pose a surface fault rupture hazard to the proposed pipeline.



A multi-year project of geologic mapping and hazards evaluation of a proposed natural gas pipeline corridor from Delta Junction to the Canada border is in the final stages of completion. This project, headed by the Engineering Geology Section but also involving members of the Mineral Resources Section, is providing detailed geologic information on which to base alignment decisions, engineering design, permitting, and planning for future development along the Alaska Highway. Following acquisition of high-resolution airborne geophysical data in 2006, DGGS began collecting field data from Delta Junction eastward. Fieldwork was

largely complete by 2010, with a minor amount of additional field assessment in 2011–2013, and final reports and maps are to be published in 2015. Work on the project was expanded to include the assessment of surficial geology and geologic hazards along alternative gas pipeline routes. With federal and State support, DGGS contracted for high-resolution lidar (Light Detection and Ranging) surveys of all the proposed gas pipeline corridors in 2010–2011. Analysis of these data has provided significant new insights into the surficial geology and hazards evaluations that will be incorporated into the final reports.

Engineering Geology Section programs are financed from a mixture of sources: general fund, interagency receipts, federal receipts, and Capital Improvement Project funding.

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 GEOLOGY PROJECTS

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

- Applied engineering geology and neotectonics research program – p. 52
- Alaska Stand Alone Pipeline (ASAP) geohazards study – p. 53
- Geology, geohazards, and resources along proposed natural gas pipeline corridors – p. 54
- Fault characterization and geologic hazards of the Yukon crossing area – p. 55
- Geohazard evaluation and geologic mapping for coastal communities – p. 56
- Unstable slopes along the Haines Highway – p. 57
- Dalton Highway frozen debris lobes – p. 58
- Climate and cryosphere hazards – p. 59
- Snow avalanche susceptibility – p. 60
- Glacier and runoff changes in the upper Susitna basin – p. 61
- Baseline investigations of coastal features and processes – p. 62
- Coastal data and tools for emergency and disaster support – p. 63
- Water level documentation and vertical datum resources – p. 64
- Tsunami inundation mapping for Alaska coastal communities – p. 65
- Hydrogeologic studies – p. 66
- Legacy surficial- and engineering-geologic STATEMAP projects – p. 67

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 2013 caused flight cancellations in the region, and ash fell on the communities of Sand Point, Nelson Lagoon, Cold Bay, and King Cove.

Each of the three component agencies of AVO 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 intra-observatory communication and data sharing, and providing notices of eruptions and unrest to users in public, private, and government sectors. The database and information dissemination tools built around the database have emerged as the most powerful among volcano observatories worldwide, and portions of the software designed and written at DGGS are in use at other observatories, both nationally and internationally. All partner agencies of AVO 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 project summaries for the following Volcanology projects appear in the section Project Summaries—FY2014:

- Eruption response – p. 68
- Alaska tephra database – p. 69
- GeoDIVA – p. 70
- Hazard communications – p. 71
- Internal communications – p. 72
- Rock sample archive – p. 73
- Website – p. 74

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. 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.
- 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; maintain, update, and improve the DGGS website; create and maintain online mapping applications; and ensure all Division staff members have the infrastructure (Geographic Information System [GIS] tools, network, computer equipment, etc.) and skilled assistance 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 and other related products, generated by staff from the Division's technical projects, describing Alaska's geologic resources and hazards. The maps, reports, and online applications 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/web-based 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. Making the Division's geologic information available in a timely way and in easy-to-use formats 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 group ensures that information produced by the Division on a wide range of topics is delivered to the public. Information 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; designs, edits, and produces technical and educational geologic maps and reports in printed and digital formats; manages the DGGS library so that reports (by DGGS and other agencies) are available 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.

GeoComm created and maintains DGGS's comprehensive digital geologic database to fulfill 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-compliant 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 FY1998 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. 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, interagency receipts, and federal receipts.

Objectives

1. Disseminate timely, 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 project summaries for the following Geologic Communications projects appear in the section Project Summaries—FY2014:

- Web applications – p. 75
- Digital data applications – p. 76
- GIS project – p. 77
- Asbestos map – p. 78
- Website database – p. 79
- Outreach and publications – p. 80

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. DGGS 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. The GMC archive is a continually growing asset that is compounding in value over time at little cost to the State.

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 funds, and in July 2013 officially acquired a building to house the new GMC. Renovation upgrades to the new Anchorage facility were completed in late October 2014. This 100,000-square foot facility will help safeguard the future accessibility and security of the valuable geologic samples stored by the GMC. DGGS managers, working with others in the

Department of Natural Resources, DOA, ECI/Hyer Inc., and GMC staff, have finalized a plan to move the current collection as early as March 2015, with full opening of the new facility slated for July 2015.

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 to the cost of delivering all new samples, sample preparation and analyses, sample and data logs, and occasionally donates large quantities of samples.

For more details, see GMC briefing on page 81.

Objectives

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

ADMINISTRATIVE SERVICES

The Administrative Services group provides financial control and administrative support for all 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

WELCOME

Abraham Emond joined the DGGS Mineral Resources section in March 2014 and works on the DGGS geophysical program alongside Laurel Burns and Gina Graham. Abraham's primary responsibility is acquisition, publication, and management of airborne electromagnetic and magnetic data under the AGGMI and SCM programs. Abraham had the good fortune to see the beautiful 2014 Tonsina survey area first hand and collect outcrop and hand-sample petrophysical data.

Abraham grew up in New England. Colorado School of Mines was an easy choice for Abraham's 1999 bachelor's degree in Geophysics. After several years in the Unexploded Ordnance detection industry, including two years at Oak Ridge National Lab in Tennessee, Abraham began graduate school at the University of Utah in 2004. Abraham defended his thesis in December 2006, graduating in 2007. In January 2007 Abraham joined Rio Tinto's Salt Lake City-based North American exploration team. Starting in 2009, Abraham worked as a consulting geophysicist with junior exploration companies until joining DGGS.

Abraham, his wife, Sonja, and their daughter, Julianna, enjoyed their first summer and fall exploring Alaska—by foot, raft, car, bike, ski, and plane.

Nina Harun joined DGGS's Energy Section in a permanent position in July 2014. Originally from New Jersey, Nina earned a B.S. in Geology from Beloit College in Wisconsin. She came to Alaska to pursue a master's of science in geology at the University of Alaska Fairbanks, where her thesis was on the depositional environments and petrography of the Ivishak Sandstone in the northeastern Brooks Range. Following this research, she attended the University of Texas at Austin and studied clastic petrography. Nina accepted a position in the oil industry with Unocal Corp. in Houston, TX, and Lafayette, LA. At Unocal, Nina evaluated offshore blocks and generated prospects in the Gulf of Mexico using 3-D seismic, well, and synthetic seismic data for lease sales and field development projects. She then returned to Alaska to focus on her family. After taking GIS courses at UAF, Nina joined DGGS in a temporary position in April 2013 to work on Alaska's component of the National Geothermal Data System project and assist in creating a new Geothermal Sites of Alaska map.

Shortly after beginning her new, permanent position, Nina participated in the Susitna Basin field project, concentrating on coal deposits. Nina's interests lie in tectonics and sedimentation and their relationship to hydrocarbon development. She is particularly interested in depositional systems, sandstone diagenesis, and provenance. Along with sedimentology and mapping projects, Nina is tasked with developing a comprehensive Energy Section analytical database and furthering the use of GIS technology in the section.

Mike Hendricks joined DGGS as a geospatial analyst in August 2014. He moved from West Point, New York, with his wife, Charlene, and youngest daughter, Erin, after 28 years in the military. His two oldest daughters, Kristen and Ellen, regrettably still remain in New York . . . at least for now.

Mike grew up in Wisconsin, northern Virginia, and eventually Delaware, where he received his undergraduate degree in Civil Engineering. As an Army Engineer and Geospatial Information Officer, he worked and lived with his family over the years in Frankfurt, Germany; Monterey, California; Columbia, South Carolina; West Point, New York; Honolulu, Hawaii; and Bangor, Maine. While in Bangor, he earned his Ph.D. in Spatial Information Engineering from the University of Maine at Orono in 2004.

For the past ten years Mike served on the faculty of the United States Military Academy's Geospatial Information Science Program at West Point. While in that position, he taught GIS and conducted applied research in spatio-temporal analysis

and land navigation education using location-based technology. He developed and managed the "Geospatially Enabled Land Navigation Training Support System," a multiyear project that incorporates GPS tracking, mobile computing, 2D and 3D geovisualizations, and simulations. With this system he helped train more than 10,000 future Army officers to effectively plan routes and travel over the landscape.

While at West Point Mike also served as the coach of West Point's Orienteering Team, a running (or cross-country skiing) sport where competitors use a compass and a large-scale topographic map to race over the terrain. To continue his interest and participation in relatively obscure sports, he and his daughter Erin wasted no time upon arriving in Fairbanks and joined the Fairbanks Curling Club. He is enjoying the great mountain views from his home up in the hills, and is looking forward to gardening with his wife during the long summer days.

Dave LePain rejoined DGGS in late January 2014 as chief of the Energy Resources Section. His technical focus for the past 20 years has been reconstructing depositional systems with the ultimate goal of predicting reservoir potential and sand body geometries. He is currently applying his expertise in the Cook Inlet and Susitna basins. Prior to shifting focus to southern Alaska, he worked on various Cretaceous units in the foothills belt on the North Slope and spent five years studying the sedimentology and tectonic significance of the Carboniferous Endicott Group in the range-front region of ANWR. In 2012 and 2013, Dave was a research geologist at Saudi Aramco's Advanced Research Center in Dhahran, Saudi Arabia, where he focused on integrating outcrop analog and subsurface data to build plausible static reservoir models.

Dave enjoys new challenges, having worked for Mobil Exploration and Production as a summer intern, Shell Offshore, Inc., as an exploration geologist, the Wisconsin Geological and Natural History Survey (University of Wisconsin Extension) as a bedrock geologist and, most recently, Saudi Aramco. Dave earned his Ph.D. in geology from the University of Alaska Fairbanks in 1993.

GOOD-BYE

Andrea Loveland joined DGGS as the STATEMAP project intern for the Energy Resources Section in 2004, assisting geologists in the field and in the office with various mapping projects. In 2006, she was hired as a full-time Energy Section geologist and participated in geologic mapping projects on the North Slope and Bristol Bay.

Originally from Wyoming, Andrea attended the University of Wyoming where she received a Bachelor's degree in geology. After graduating in 2002, Andrea moved to Alaska to pursue a Master's degree at the University of Alaska Fairbanks. Her research focused on the fracture evolution and structural history of the northeastern Brooks Range.

In April 2014, Andrea relocated to Wyoming and is currently a geologist with the Wyoming State Geological Survey.

PROJECT SUMMARIES—FY2015

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 50 projects that DGGS is pursuing in FY2015 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.

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COOK INLET BASIN ANALYSIS PROGRAM

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 hydrocarbon exploration investment to help meet the growing energy needs of south-central Alaska. This collaborative effort involving DGGS, the Alaska Division of Oil & Gas (DOG), the University of Alaska Fairbanks (UAF), and the U.S. Geological Survey (USGS) relies heavily on performing detailed field and subsurface studies and geologic mapping 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. However, most of these structures were found and tested early in the exploration history of the basin. Since 2006, DGGS has been investigating the potential for stratigraphic traps in Cenozoic strata and, more recently, has focused on investigating the potential for conventional and unconventional reservoirs capable of hosting oil and gas in the older, deeper Mesozoic strata in the basin. Developing a better understanding of the petroleum potential of the Mesozoic interval is important because it remains virtually unexplored yet contains the oil source rocks for fields in upper Cook Inlet.

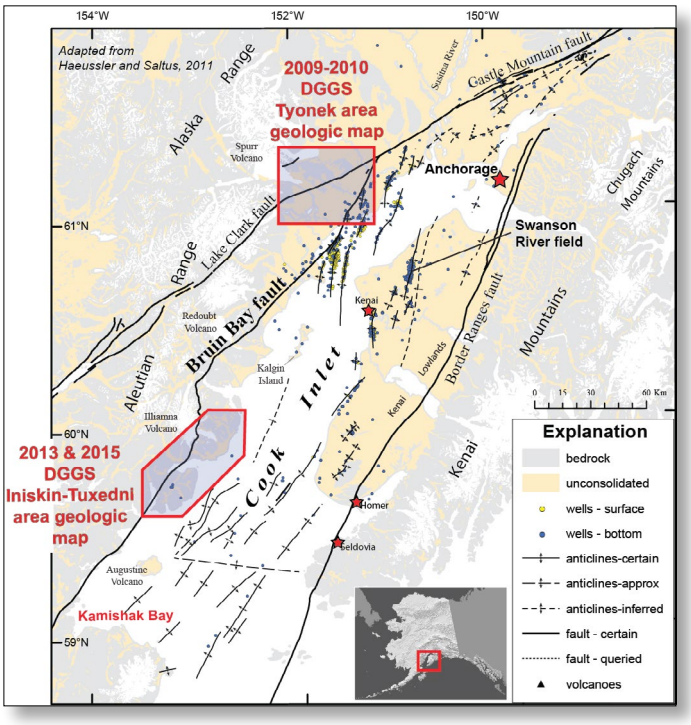

Figure 1. Generalized geologic map of Cook Inlet basin highlighting past and present hydrocarbon study areas and geologic mapping targets in the Cook Inlet basin. Modified from Haeussler and Saltus, 2011, U.S. Geological Survey Professional Paper 1776-D.

Field studies of Mesozoic strata in the Kamishak Bay and Iniskin Peninsula areas (figs. 1 and 2) focused on Jurassic- and Cretaceous-age rocks, both of which contain intervals that are oil saturated, indicating that they had sufficient conventional permeability and porosity to allow liquid hydrocarbons to flow through them in the past. Samples collected at both locations are helping to identify the hydrocarbon source rocks and determine whether 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 the summer of 2013 and proposed geologic mapping of the Red Glacier area in 2015, are focused on the depositional environment, organic geochemistry, and thermal maturity of oil source rocks, along with how major geologic structures, such as the Bruin Bay fault, influenced the basin's stratigraphic architecture. We are continuing fracture studies of Mesozoic rocks in the Iniskin Peninsula–Tuxedni Bay area to understand the stratigraphic and structural controls on their development and to gather baseline data on unconventional fracture porosity and hydrocarbon migration pathways.

This project is funded by the State of Alaska and the USGS, 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 recently published edited volumes highlighting the significant findings from our 2012–2014 field seasons (http://dx.doi.org/10.14509/24824, http://dx.doi.org/10.14509/27303). Additional publications will be released as they become available.

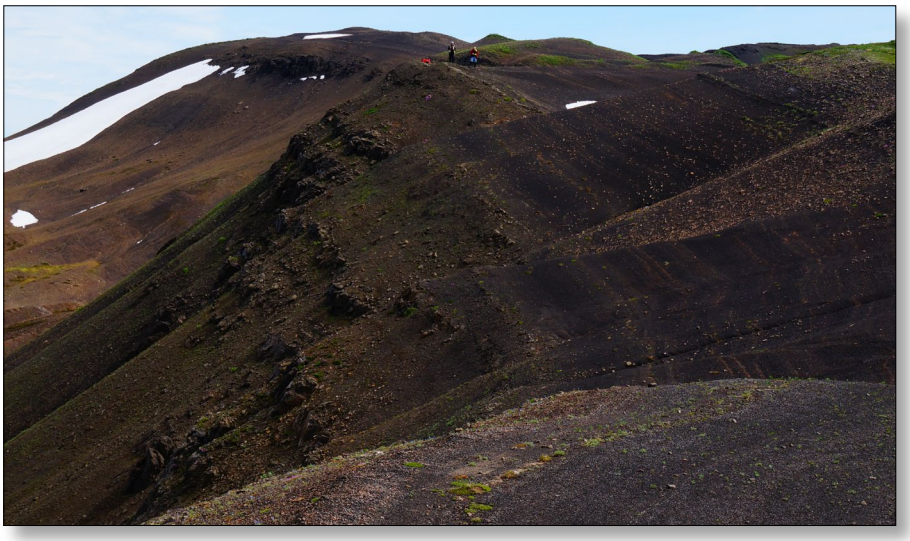

Figure 2. DGGS geologist David LePain and U.S. Geological Survey geologist Rick Stanley studying strata of the Red Glacier Formation; the organic-rich oil source rock in Cook Inlet basin.

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

GEOLOGIC MAPPING OF THE INISKIN–TUXEDNI REGION, LOWER COOK INLET

The Alaska Division of Geological & Geophysical Surveys (DGGS) is conducting a program in Cook Inlet basin focused on understanding how sediment composition, stratigraphic architecture, and geologic structure control potential conventional and unconventional (tight) hydrocarbon reservoir systems (see Cook Inlet Basin Analysis summary). This program includes detailed geologic mapping within younger, shallower Cenozoic and older, deeper Mesozoic stratigraphic intervals where outcrop relations are complex, poorly understood, and important for understanding the principal components of the petroleum system.

During summer 2013, DGGS, with assistance from the Division of Oil and Gas (DOG), completed 1:63,360-scale geologic mapping of approximately 240 square miles of Mesozoic stratigraphy on the Iniskin Peninsula, located west of Homer across Cook Inlet (figs. 1 and 2). Mapping of an additional ~270 square miles encompassing much of the adjacent region to the northeast between Chinitna and Tuxedni bays will be completed in 2015. This area was the location of some of the earliest oil exploration in Alaska, extending from the early 1900s to the 1950s, but it has remained idle since then. The Iniskin Peninsula–Tuxedni Bay region (fig. 1) is important to understanding Cook Inlet's Mesozoic petroleum system because it hosts numerous oil seeps and the only surface exposures of the primary oil source rock in the basin (the Red Glacier Formation) accessible for study. Despite this, the older stratigraphic intervals of the basin remain only lightly explored. Our new mapping is guided by nearly 25 new measured stratigraphic sections, new geochronology, and kinematic structural analysis, some of which is detailed in a series of short progress reports published in 2014 (http://dx.doi.org/10.14509/27303) and a forthcoming series of reports due to be published in early 2015. The final published products 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 important, previously unrecognized stratigraphic and structural relationships and represents a major step forward in understanding the geologic evolution of the northwestern margin of the basin.

Mapping in 2013 was completed with partial funding from the U.S. Geological Survey's STATEMAP program.

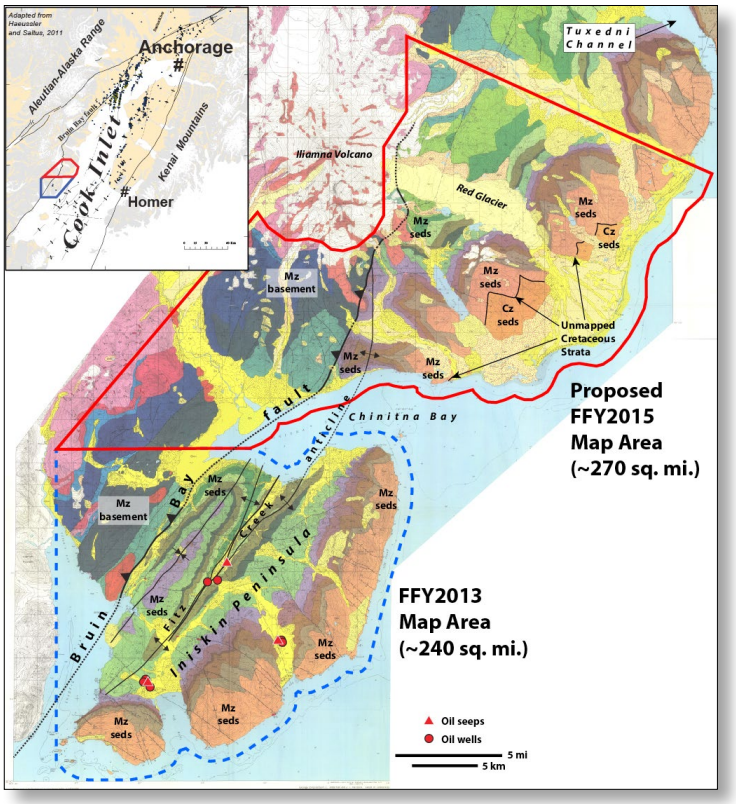

Figure 1. Locations of FY2013 (blue outline) and proposed FY2015 (red outline) geologic mapping of Mesozoic stratigraphy on the west side of Cook Inlet basin, with regional inset map of Cook Inlet.

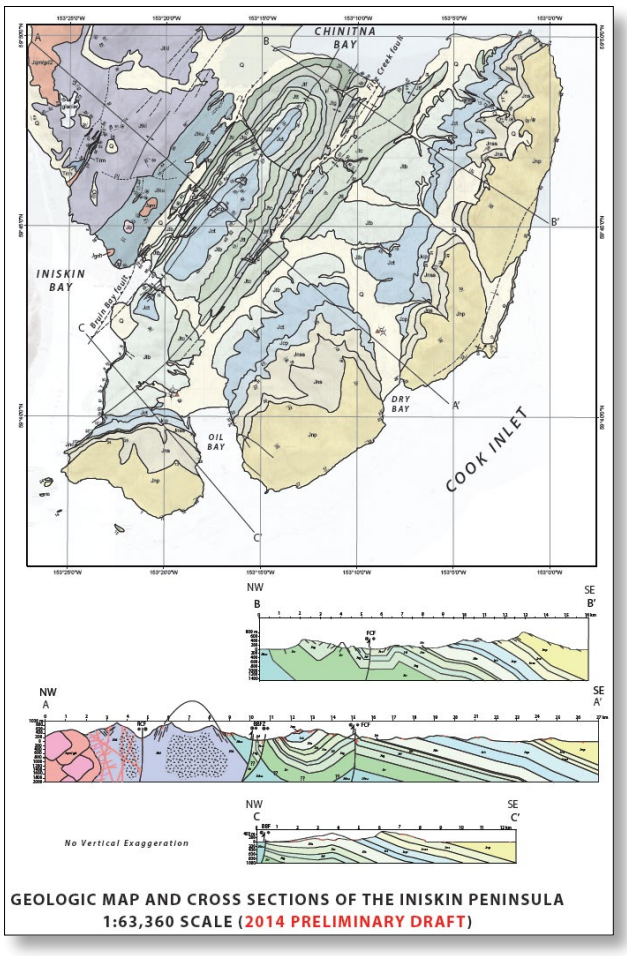

Figure 2. DGGS preliminary geologic map and structural cross sections of the Iniskin Peninsula.

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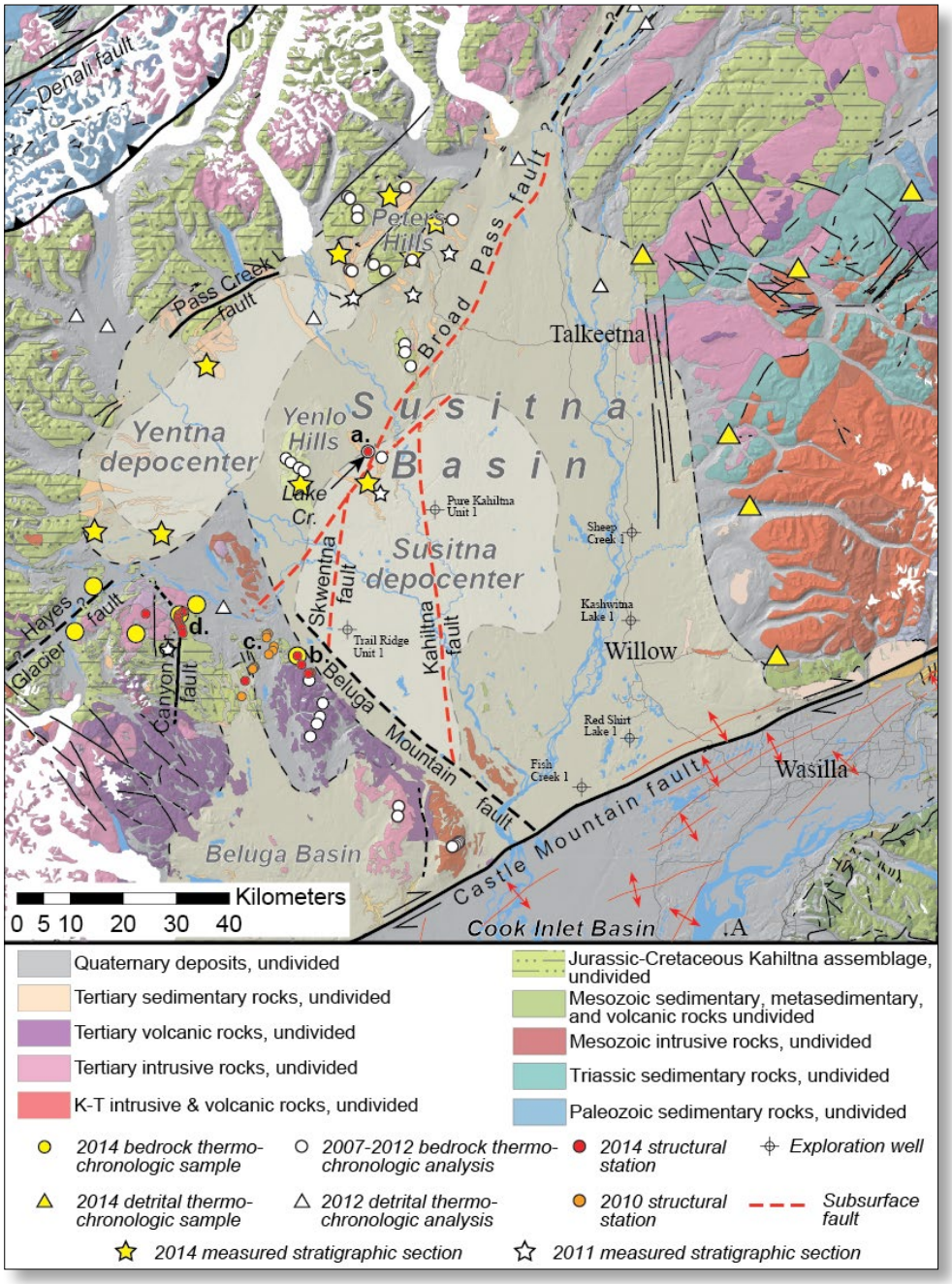
NATURAL GAS POTENTIAL OF THE SUSITNA BASIN

Alaska suffers from some of the highest domestic energy prices in the nation, particularly in rural areas and regions that are far removed from developed energy resources and lack sufficient infrastructure for low-cost delivery. These challenges could be mitigated by finding local sources of energy that have the potential to supply more affordable energy for local consumption.

The Alaska Division of Geological & Geophysical Surveys (DGGS), in collaboration with the Division of Oil & Gas (DOG), has responded to these challenges by reviewing publicly available data on sedimentary basins throughout Alaska to identify basins whose geology suggests significant natural gas potential (http://dx.doi.org/10.14509/24264).

We have identified the Susitna basin in south-central Alaska as having significant gas potential to help meet in-state needs based on its geology and relative proximity to infrastructure. However, this basin has not been adequately explored, and little geologic data exists to help attract exploration interest. The Susitna basin analysis project will help develop a better understanding of the possible presence of a functioning petroleum system. Preliminary fieldwork was completed in summer 2011, and a progress report was published in early 2013 (http://dx.doi.org/10.14509/25015). Additional fieldwork was completed in summer 2014, with a summary report expected to be published in 2014 or early 2015.

The Susitna basin (approximately 5,000 square miles) is thought to host some of the same coal-bearing, gas-prone rocks as neighboring Cook Inlet, which is a major gas-producing region. DGGS and DOG, in collaboration with the U.S. Geological Survey, have studied and described coal-bearing strata at several locations in the basin and collected more than 400 samples for various analyses related to evaluating reservoir quality, coal quality and its methane potential, and geologic development of the region. Structural studies and thermochronologic sampling along the basin margin will help to constrain how the basin evolved through time, which is important for understanding the timing of potential structural trap development and gas generation.



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

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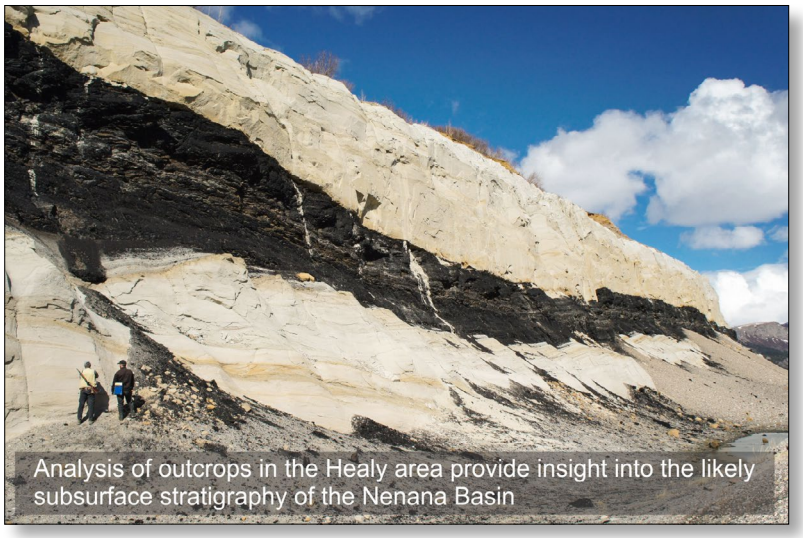
HYDROCARBON POTENTIAL OF THE NENANA BASIN

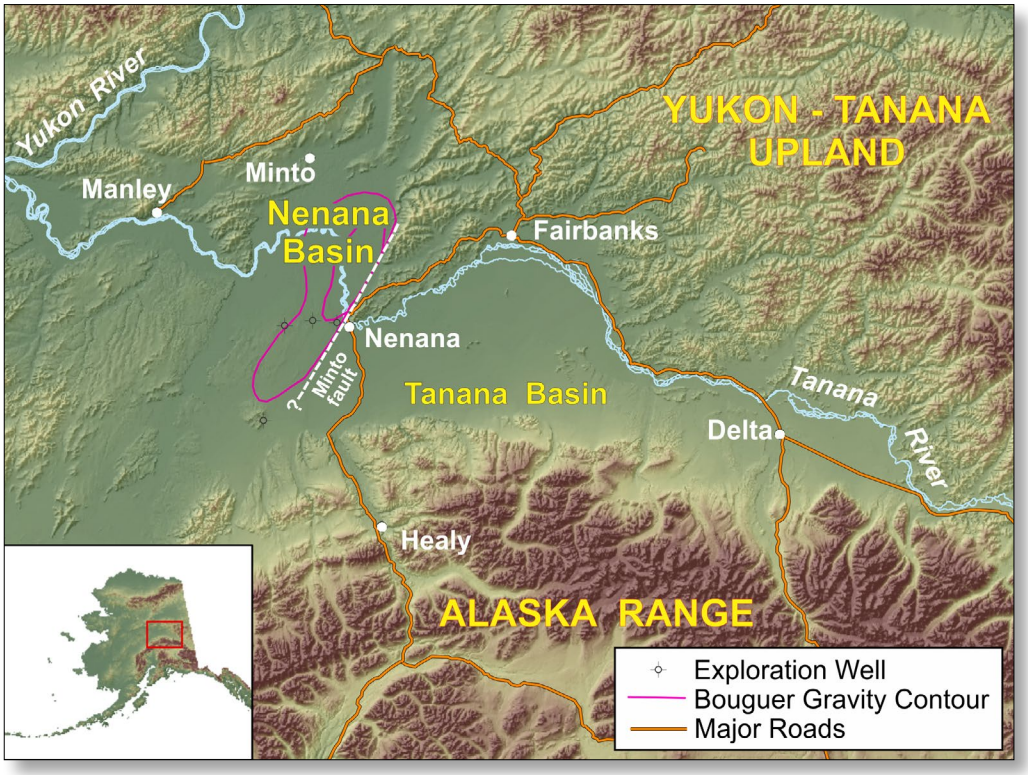
Alaska faces significant challenges in supplying reliable, affordable energy to much of the state's population, particularly in rural areas and interior regions. This is because no adequate energy sources at reasonable cost have been identified to serve domestic needs over the next few decades. These challenges could be met by finding local resources with the potential to supply more affordable energy for nearby consumption.


Analysis of outcrops in the Healy area provide insight into the likely subsurface stratigraphy of the Nenana Basin

The Alaska Division of Geological & Geophysical Surveys (DGGS), in collaboration with the Division of Oil & Gas (DOG), has responded to these challenges by reviewing publicly available data on sedimentary basins throughout Alaska to identify those with geology that suggests significant natural gas potential (http://dx.doi.org/10.14509/24264). The Nenana and Susitna basins (see Susitna project summary) were recognized as having potential to help meet in-state needs based on their geologic properties and proximity to infrastructure.

The Nenana basin in interior Alaska is largely defined based on geophysical data. Available information indicates the basin may be deep enough to host a viable petroleum system. Recent exploration activity led by Doyon Limited and their partners has included acquiring modern seismic data and drilling two new wells. Although no commercial discoveries were made, the efforts yielded improved, new information on the basin's subsurface, including geochemical data suggesting the presence of hydrocarbon source rocks.

No known Tertiary sediments (key to hydrocarbon potential in this basin) are exposed immediately around the Nenana basin; therefore, to improve our understanding of the subsurface stratigraphy, DGGS conducted reconnaissance fieldwork in the northern foothills of the Alaska Range, where the nearest correlative rocks can be examined in outcrop. This preliminary work was carried out in conjunction with DOG and the U.S. Geological Survey and summarized in a recent DGGS publication (http://dx.doi.org/10.14509/24880).



Samples collected during that campaign are undergoing additional analytical studies and results will be released in future reports. The final phase of this project will involve examining drill cuttings from the recent exploration wells, including supplementary analysis of source rock character, sandstone provenance, and biostratigraphy.

This project also involves collaboration with geophysicists at the University of Alaska Fairbanks who are utilizing seismology to investigate the crustal structure of the basin. This work will inform ongoing seismic hazard assessments by DGGS in support of potential pipeline corridors near the active Minto fault (see ASAP briefing sheet).

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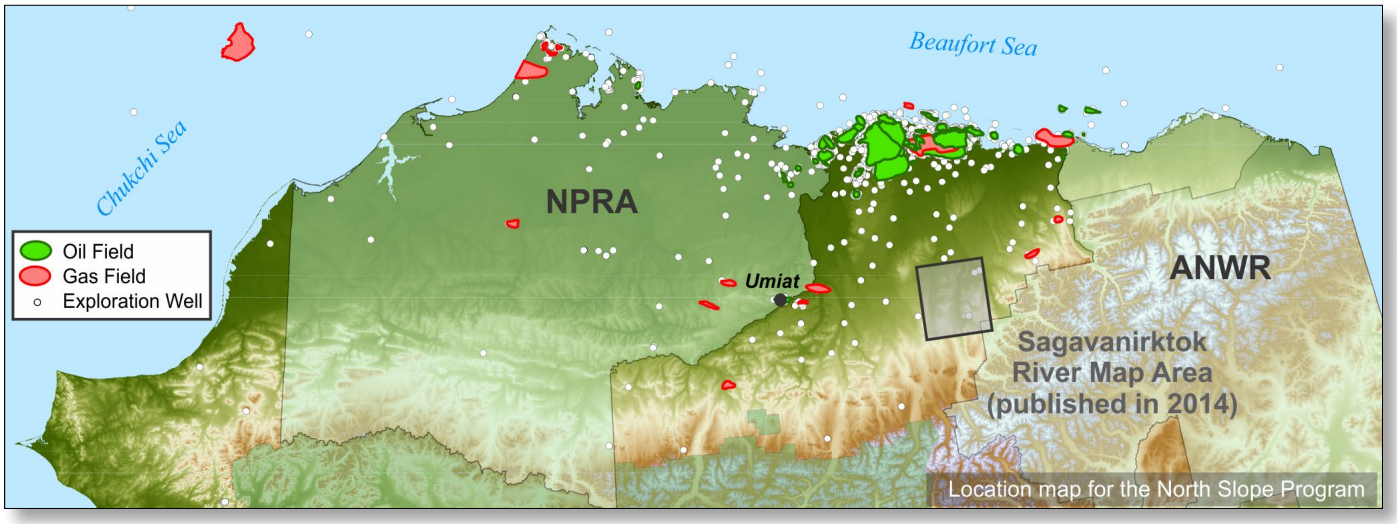
BROOKS RANGE FOOTHILLS & NORTH SLOPE PROGRAM

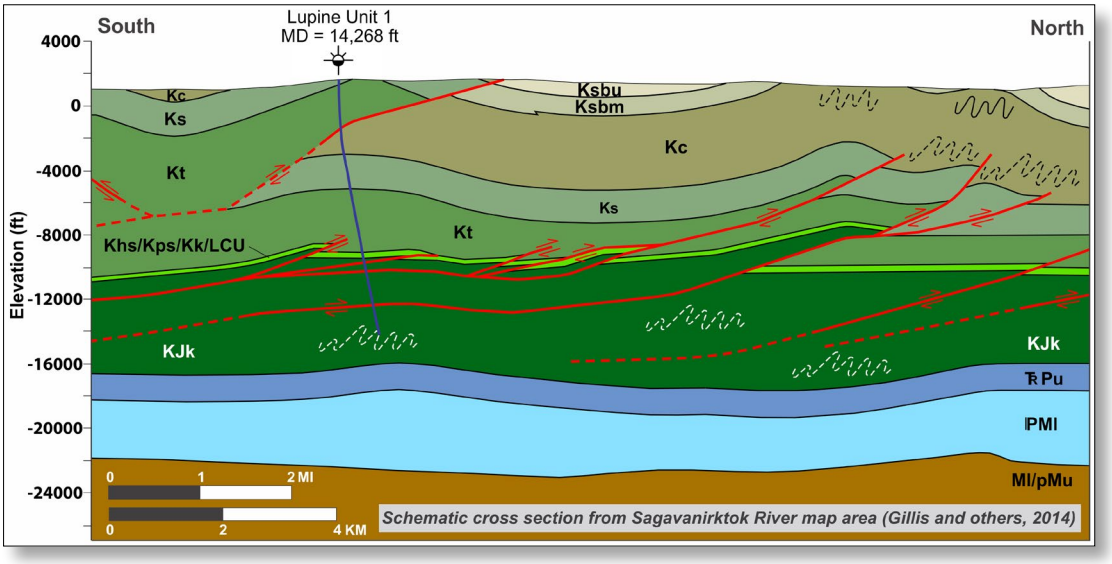
Northern Alaska is a world-class petroleum province that includes some of the most prospective onshore regions remaining in North America. Despite this potential, the North Slope remains underexplored relative to other sedimentary basins around the world. New exploration ventures are hampered by the limited amount of published geologic data, much of which is reconnaissance in nature. This problem is particularly acute for smaller companies with limited access to proprietary industry data. In an effort to stimulate hydrocarbon exploration 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 the regional petroleum system and entice new exploration investment.



Detailed analysis of outcrop geology leads to improved models for where hydrocarbons will most likely accumulate in the subsurface. Our fieldwork involves examination of the sedimentology and stratigraphy of key 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 Division of Oil and Gas to interpret available seismic and well data on the North Slope. The integration of our surface structural and stratigraphic observations with subsurface data has led to an improved understanding of basin evolution and regional exploration potential. DGGS also regularly conducts bedrock geologic mapping as an integral component of the Brooks Range Foothills and North Slope Program, and recently published an important new map of the Sagavanirktok River area.

Recent lease and exploration activity on the North Slope has drawn attention to the region's potential for unconventional shale oil targets. The key geologic characteristics of this type of accumulation are poorly understood in northern Alaska. To address this knowledge gap, we initiated a collaborative study between DGGS, the U.S. Geological Survey, and the University of Alaska Fairbanks. This ongoing project has acquired key surface and subsurface data that will improve our understanding of this prospective hydrocarbon play.

DGGS will publish two new 1:63,360-scale geologic maps in the upcoming year, including one encompassing the discovered oil and gas fields in the Umiat–Gubik area. In addition, a collection of topical structural and stratigraphic studies will be released, which will provide important new constraints on the regional petroleum system.



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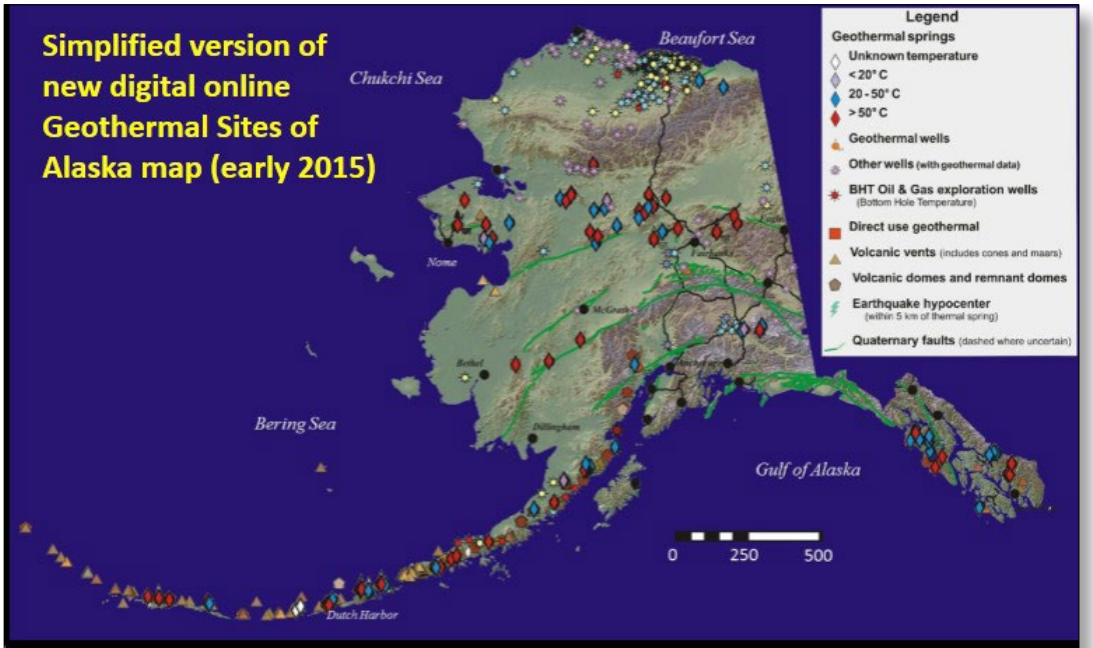
STATE OF ALASKA CONTRIBUTIONS TO THE NATIONAL GEOTHERMAL DATA SYSTEM

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-based data. This national project, involving all 50 states, is organized by the Association of American State Geologists and administered by the Arizona Geological Survey. The NGDS is providing large amounts of geothermal-relevant geoscience data to the public and industry through a single website that was officially launched on April 30, 2014, http://www.geothermaldata.org/. The NGDS website serves unstructured data (such as PowerPoint, image, and pdf files), structured data (such as Excel, xml, and csv files), and interoperable standardized data. The NGDS is based upon well-documented interchange formats and standardized data exchange protocols, making it possible to view and analyze data using a variety of programs and to merge additional data sources into a content model. 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.

The NGDS program allowed the Alaska Division of Geological & Geophysical Surveys (DGGS) to compile vast amounts of paper-only scientific data generated during earlier geothermal studies and exploration activities throughout Alaska and load this information into the online NGDS for easier access. A new cycle of geothermal exploration currently underway in Alaska is producing abundant new geothermal data that is being entered into the NGDS. Geothermal exploration at Pilgrim Hot Springs on the Seward Peninsula 60 mi north of the city of Nome is benefiting from integration of legacy and newly-acquired NGDS data (including aqueous chemistry, borehole, geoprobe, and ground-based geophysics such as magnetotellurics) with remote-sensing imagery and airborne geophysics to locate the hottest thermal upflow zone. Ongoing geothermal exploration at Akutan in the Aleutian Islands has contributed new geothermal data to the NGDS, and is anticipated to benefit from other data stored in the NGDS. Industry and academia are now able to readily access this data for use in collaborative efforts at both sites. Bottom-hole temperature observations from 567 oil and gas exploration drill holes now archived in the NGDS are currently being used to construct a new geothermal heat-flow map of Alaska.



New & Legacy Data Includes:	
Geothermal springs	97
Aqueous geochemistry	653
Geothermal wells data (from 9 wells)	121
BHT data from oil & gas wells (supplied by the petroleum industry)	409
Volcanic vents and fumarole records	395
Earthquake event data near hot springs within 5 km	1,974
Direct use geothermal sites	15

Preliminary version of the new Geothermal Sites of Alaska map, available online in digital format in early 2015. Table summarizes the data included in the NGDS and new online map.

DGGS is creating an online digital Geothermal Sites of Alaska map using the content model templates developed for and archived in the NGDS. This new ArcGIS-based map (preliminary simplified version of the map above) incorporates the related geothermal NGDS datasets into shapefiles. This map will be available online for the public by February 2015.

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ALASKA COAL DATABASE—NATIONAL COAL RESOURCE DATABASE SYSTEM

The long-term goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) participation in the U.S. Geological Survey's (USGS) National Coal Resource Database System (NCRDS) cooperative program is to record all known coal occurrences in Alaska and archive the information in a single, readily accessible database available at the USGS 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. Alaska's identified coal resources (all ranks) total about 160 billion short tons, yet hypothetical and speculative resources are as high as 5.5 trillion short tons. While 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.

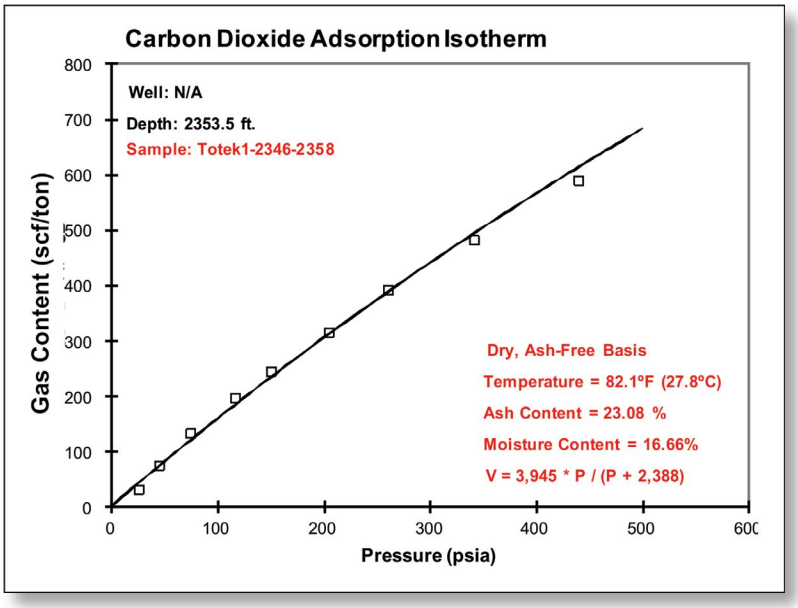

Figure 1. Example of carbon dioxide pressure isotherm from the Totek Hills well, Nenana basin, at a depth of 2,353 ft.

We continue to submit coal samples collected by field crews conducting studies in Alaska's coal provinces for proximate and ultimate analyses. We focus only on thicker, potentially mineable coal seams that have not been sampled previously. The project continues to make progress refining the legacy Alaska NCRDS data.

During 2014 we evaluated high-pressure gas adsorption analytical data for well and outcrop samples from the Cook Inlet, North Slope, and Nenana basins (fig. 1). We are finishing the final report describing the gas holding capacity of coal seams for both methane and carbon dioxide in these basins. This new report, to be released in 2015, highlights the economic and carbon-sink potential for coal deposits in these three basins and is the first actual CO_2 adsorption data for coal seams in Alaska (rather than hypothetical data based on estimated coal rank).

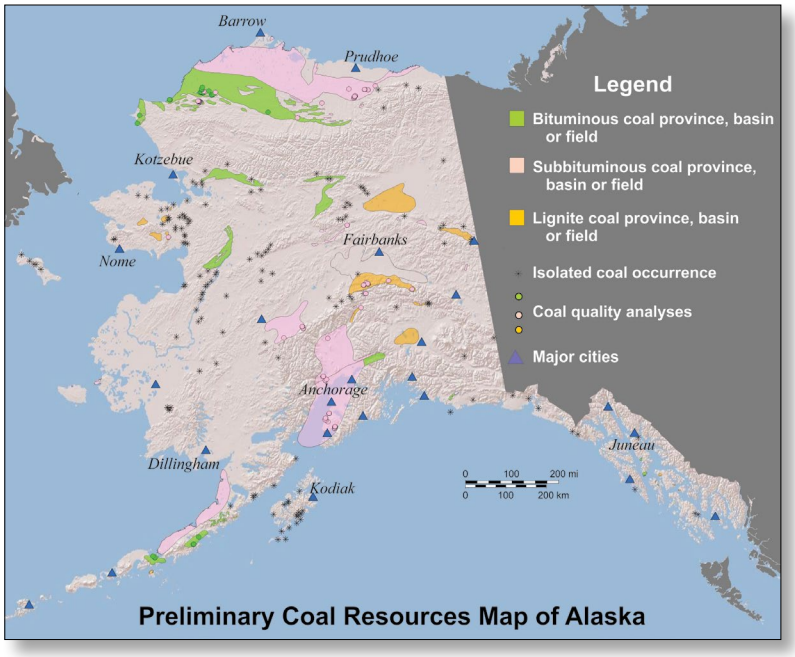

Figure 2. Preliminary draft version of GIS-based Coal Resources of Alaska map that displays coal provinces, basins, coal fields, and isolated coal occurrences and incorporates NCRDS coal quality point source data

The database for Alaska coal quality and stratigraphic information continues to grow and we are incorporating this data and the appropriate Geographic Information System (GIS) files into a new digital Alaska coal resources map. This new coal resources map (fig. 2) meshes well with the NCRDS work by incorporating the coal data into a meaningful and useful format. Where available, the map contains compiled geology layers and coal isopachs, where calculated. We are also incorporating the Alaska abandoned coal-mine inventory, which has never been accessible in a digital format. The complete coal dataset incorporated into this new GIS map will allow for calculations of coal resources in areas with sufficient coal-thickness point-source data. At completion of the current 5-year NCRDS program in September 2015 the entire Alaska NCRDS dataset will be incorporated into the GIS map, with the goal of creating an online, interactive Alaska coal resource map on the DGGS website.

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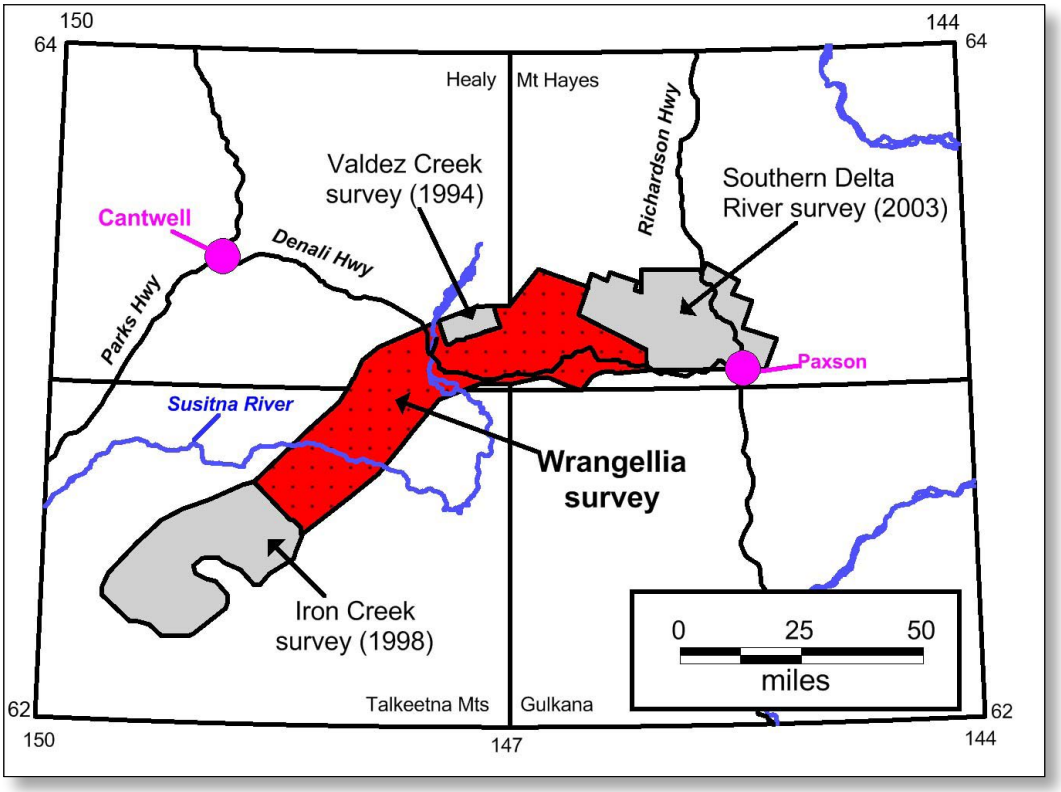
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF WRANGELLIA, SOUTH-CENTRAL ALASKA

The goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is to enhance the understanding 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 nominations from Alaska's geologic community. Products resulting from this program generally include aeromagnetic, airborne-electromagnetic, and geologic maps as well as other geological, geochemical, and geophysical data compilations. The AGGMI program and resulting new geologic knowledge are recognized world-wide and have encouraged millions of dollars of venture capital expenditures in the local economies of the surveyed mining districts. These venture capital expenditures have led to discovery and delineation of new mineral resources.

As part of the State-funded AGGMI program, the Strategic and Critical Minerals Assessment Project is geophysically surveying 1,322 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 and is composed mainly of State lands, with lesser areas of U.S. Bureau of Land Management-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 contributed additional, privately-funded airborne geophysical data for the area that will be included in DGGS's published survey.

The majority of the Wrangellia survey area is underlain by late 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 were released as DGGS Geophysical Reports in January 2014. A second publication, containing a project report, interpretation, and electromagnetic anomalies, is expected to be released in 2015. 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.

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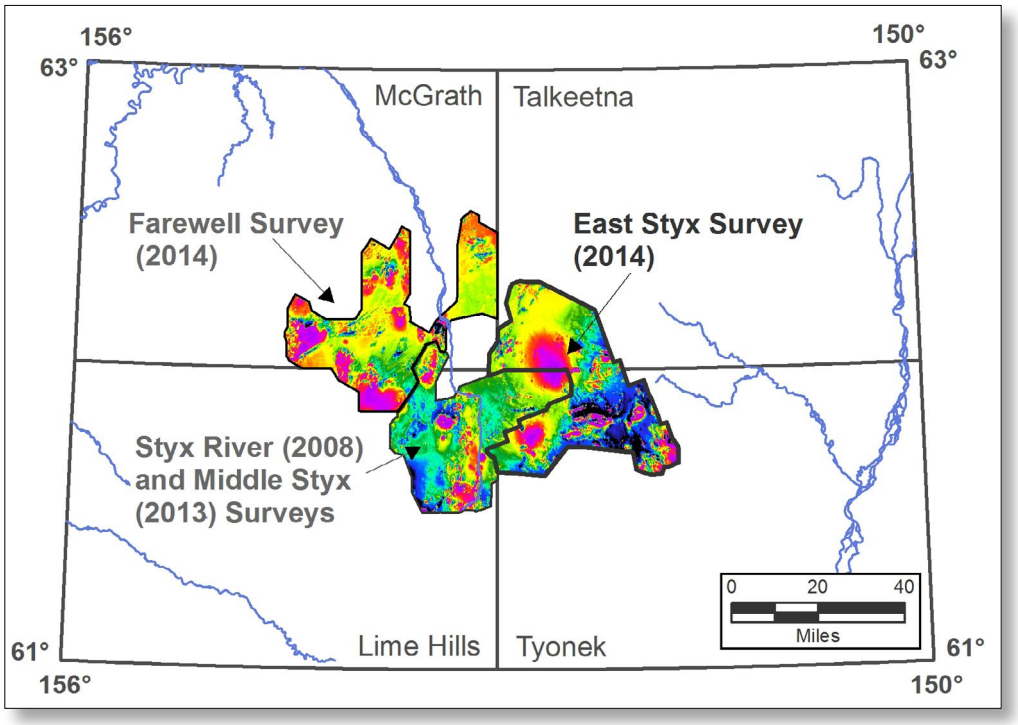
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE EAST STYX AREA, SOUTH-CENTRAL ALASKA

The goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is to enhance the understanding 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 nominations from Alaska's geologic community. Products resulting from this program generally include aeromagnetic, airborne-electromagnetic, and geologic maps as well as other geological, geochemical, and geophysical data compilations. The AGGMI program and resulting new geologic knowledge are recognized world-wide and have encouraged millions of dollars of venture capital expenditures in the local economies of the surveyed mining districts. These venture capital expenditures have led to discovery and delineation of new mineral resources.

Through the state-funded AGGMI program, DGGS geophysically surveyed 1,060 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 were acquired, and the data were released in November 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 that may be 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.



Merged aeromagnetic data for the East Styx, Styx River, Middle Styx, and Farewell surveys. Merged grids will be released this fiscal year.

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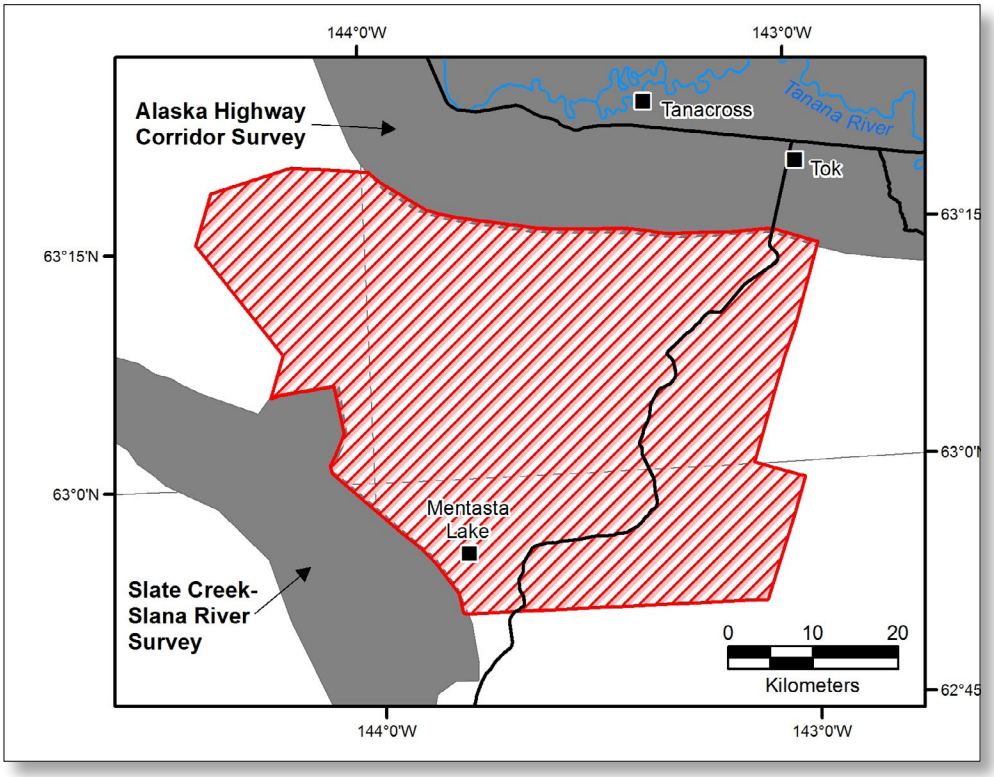
AIRBORNE GEOPHYSICAL/GEOLOGICAL MINERAL INVENTORY PROGRAM: AIRBORNE GEOPHYSICAL SURVEY OF THE TOK AREA, EASTERN INTERIOR ALASKA

The goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is to enhance the understanding 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 nominations from Alaska's geologic community. Products resulting from this program generally include aeromagnetic, airborne-electromagnetic, and geologic maps as well as other geological, geochemical, and geophysical data compilations. The AGGMI program and resulting new geologic knowledge are recognized world-wide and have encouraged millions of dollars of venture capital expenditures in the local economies of the surveyed mining districts. These venture capital expenditures have led to discovery and delineation of new mineral resources.

Through the State-funded AGGMI program, DGGS is geophysically surveying 989 square miles in an area centered roughly 35 miles west–southwest of Tok in the Mt. Hayes, Tanacross, Gulkana, and Nabesna quadrangles (see figure). Most of the area surveyed is in the Tok mining district; a minor portion is in the Chistochina district. The Tok survey area is bordered by two previous airborne-geophysical surveys: the 2006 Alaska Highway Corridor, and 2008 Slate Creek–Slana River surveys. The area is a mixture of State-owned and -selected land, Native-owned land, and Federally-owned land. Data will be released during spring 2015 as line, grid, and vector data as well as in map form.

The survey area contains numerous copper, gold, and gold–silver–copper prospects identified in the Alaska Resource Data Files (http://ardf.wr.usgs.gov/). The western part of the survey area covers several important volcanogenic massive sulfide (VMS) deposits with significant drill-identified polymetallic resources known collectively as the Delta Mineral Belt. Immediately northeast of the survey area recent exploration has discovered a large pyrrhotite-bearing gold–copper skarn deposit that is likely related to a concealed porphyry copper system. A lack of identified prospects in the eastern and central parts of the airborne geophysical survey area corresponds with a gap in detailed public-domain geologic data; regional geologic trends suggest that the mineralized host rocks should be present throughout the survey area. The survey data will increase the geologic understanding of the area and provide a framework for further mineral exploration. The new information is intended to catalyze new private-sector exploration, discovery and, ultimately, development and production. In addition the geophysical survey covers the eastern end of the identified rupture zone of the 2002 magnitude 7.9 earthquake on the Denali fault, and is being used to help understand the effects of future faults on the transportation corridor that passes through the area.



Tok survey location map with survey boundary (red line), prior surveys (grey polygons), towns (black squares), major highways (black), and rivers (blue).

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

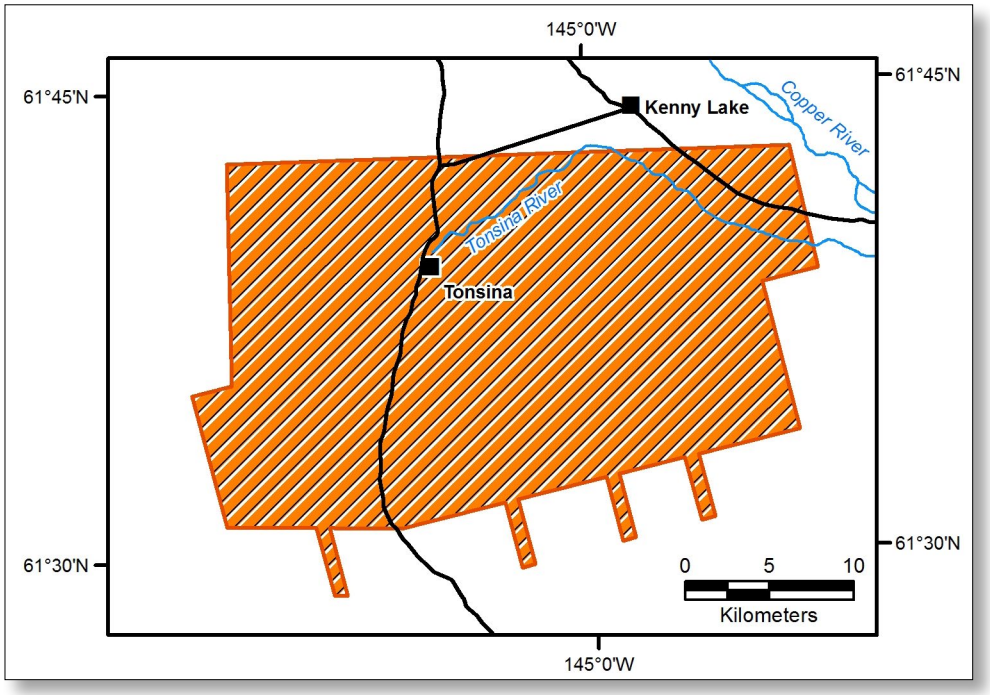
The goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) Airborne Geophysical/Geological Mineral Inventory (AGGMI) program is to enhance the understanding of Alaska's mineral resources and catalyze private-sector mineral development. The program seeks to delineate mineral zones on 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 nominations from Alaska's geologic community. Products resulting from this program generally include aeromagnetic, airborne-electromagnetic, and geologic maps as well as other geological, geochemical, and geophysical data compilations. The AGGMI program and resulting new geologic knowledge are recognized world-wide and have encouraged millions of dollars of venture capital expenditures in the local economies of the surveyed mining districts. These venture capital expenditures have led to discovery and delineation of new mineral resources.

Through the State-funded AGGMI's Strategic and Critical Minerals program, DGGS geophysically surveyed 266 square miles in the Tonsina area, about 56 miles northeast of Valdez and 37 miles south of Glennallen (see figure). The survey area crosses the Richardson Highway and encompasses portions of the Chugach Mountains and lowlands of the Copper River basin in the Valdez Quadrangle, and includes part of the Nelchina mining district. Land status includes State-owned and -selected with lesser amounts of Native-owned and –selected, as well as lands managed by the U.S. Bureau of Land Management. To support interpretations of the geophysical data, DGGS geologists collected a suite of outcrop and hand samples; the samples are well distributed in the survey area and represent most lithologies present. The airborne geophysical data, including gridded data, line data, and maps, will be published in January 2015. It is expected that these products will have wide distribution.

The Tonsina geophysical survey area is transected by the west–northwest-trending Border Ranges fault that juxtaposes the Pennisular terrane, which includes Nelchina River Gabbronorite (NRG) and Tonsina mafic–ultramafic complex, on the north against metasedimentary and metavolcanic rocks of the Cretaceous Chugach terrane to the south. Based on the regional aeromagnetic signature and sparse outcrop, gabbroic rocks of the NRG are present in the northern and northwestern part of the survey area. The Tonsina ultramafic complex, in the central and northeastern parts of the survey area, is even more magnetic than the gabbronorite, and is locally a granulitic gabbronorite. The NRG has been interpreted as part of the Jurassic Talkeetna island arc with the Tonsina complex representing part of the associated mantle. The Chugach terrane in the survey area consists of typically nonmagnetic, metamorphosed rocks of an accretionary wedge.

Approximately 65 percent of the survey area is covered by unconsolidated Quaternary deposits. Mineral occurrences in the survey area include: ultramafic rocks with associated platinum-group elements (PGE), chromite, and nickel–copper sulfides in ultramafic and mafic rocks; metamorphic-related Late Cretaceous to Tertiary age, low-sulfide, gold-bearing quartz veins in the Chugach terrane; and placer gold with minor scheelite in Holocene alluvial gravels.

The new airborne geophysical data will better define the extent and location of the PGE-bearing ultramafic rocks in areas lacking outcrop, increase the structural knowledge of the area, and improve the geologic mapping. The new information is designed to catalyze new private-sector exploration, discovery and, ultimately, development and production in the region.



Tonsina survey location map with survey boundary (orange line), towns (black squares), major highways (black), and major rivers (blue).

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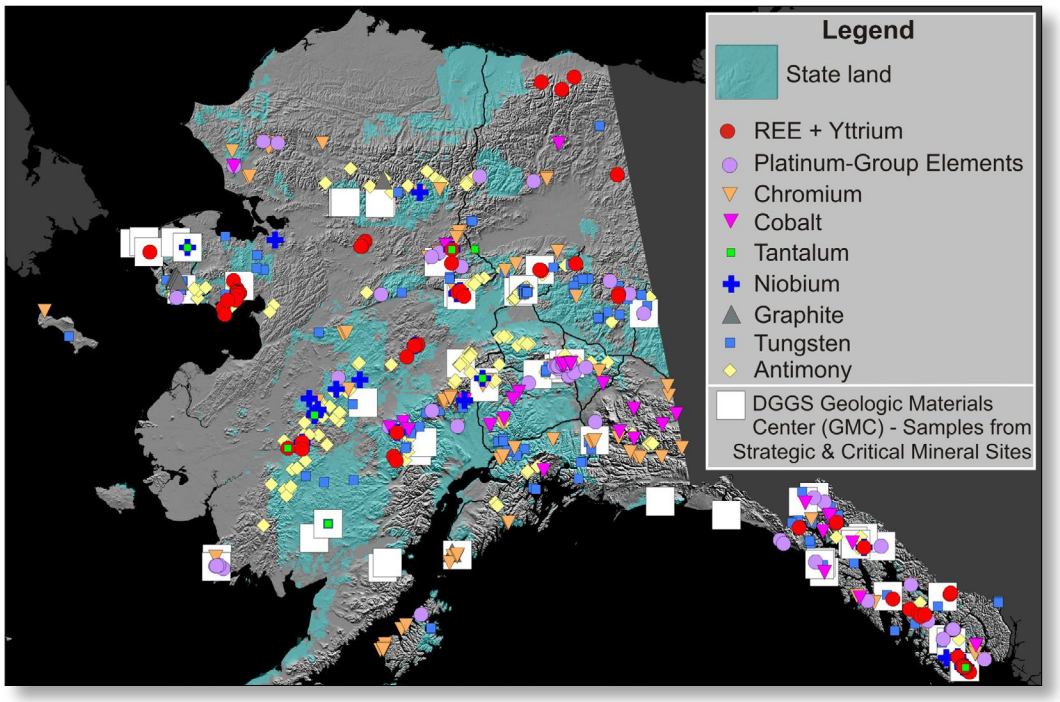
STRATEGIC AND CRITICAL MINERALS ASSESSMENT PROJECT

Strategic and critical minerals (SCMs) are essential for our modern, technology-based society. 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 rely heavily on REEs. In many cases there are no effective non-REE substitutes. The current U.S. Geological Survey 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 to comprehensively evaluate Alaska's statewide SCM potential. Many areas of Alaska are geologically favorable for hosting SCMs, but the lack of basic geologic data hinders evaluation of their potential. Alaska has hundreds of known SCM occurrences (see figure) and millions of acres of selected or conveyed lands could 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 (http://www.dggs.alaska.gov).

In 2014 DGGS contracted for two SCM-related airborne geophysical surveys: the 266-square-mile Tonsina Survey in south-central Alaska (see project description) and the 989-square-mile Tok Survey in east-central Alaska (see project description). DGGS also conducted a 450-square-mile mapping project in the western Wrangellia Terrane to evaluate its SCM potential (see project description). Additionally, DGGS has compiled more than 29,039 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. DGGS also obtained 1,682 new geochemical analyses for statewide historical samples from State land that are stored at the USGS National Geochemical Sample Archive. Publication of additional geochemical data is planned for 2015. In summer 2015, DGGS will conduct geologic fieldwork and mapping in additional areas with SCM potential.

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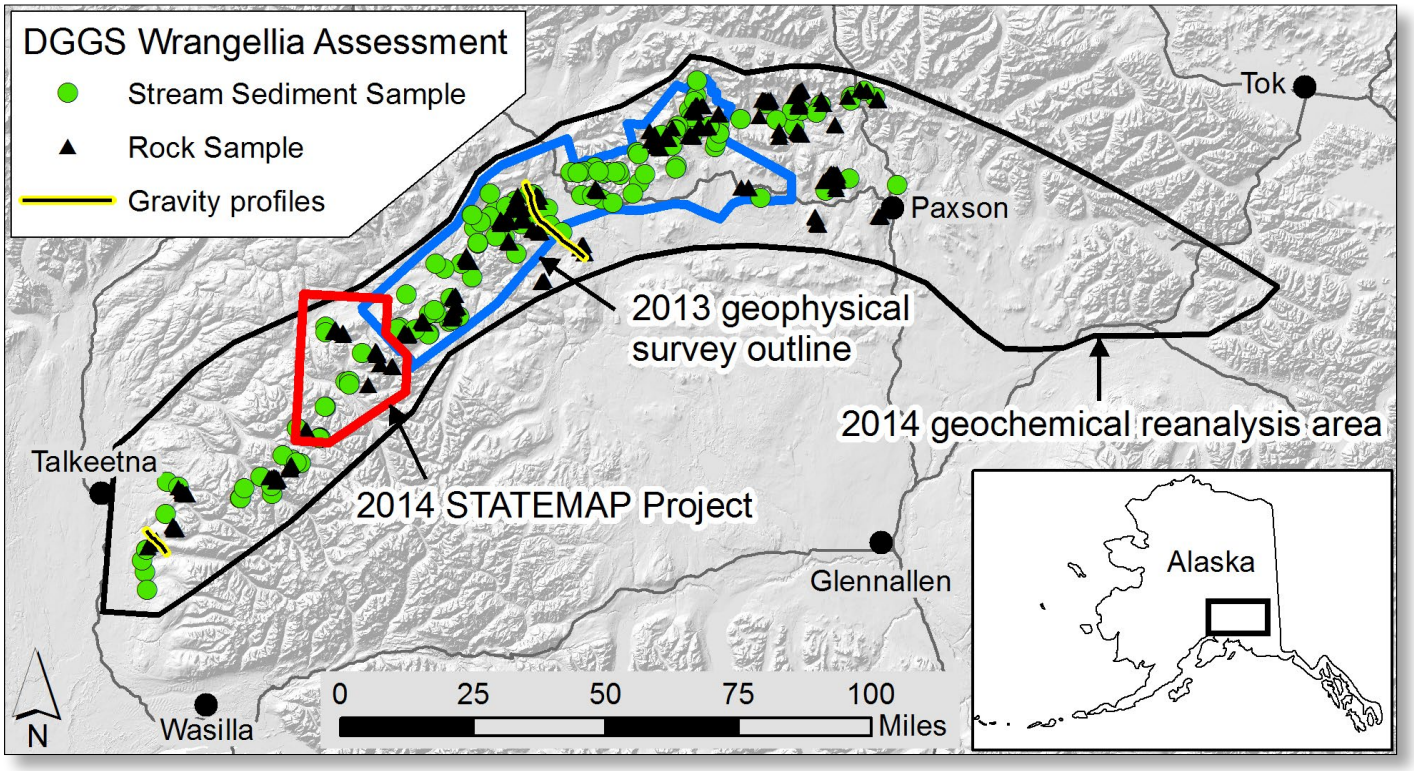
STRATEGIC AND CRITICAL MINERALS ASSESSMENT IN THE WESTERN WRANGELLIA TERRANE, SOUTH-CENTRAL ALASKA

During 2014 the Alaska Division of Geological & Geophysical Surveys (DGGS) continued 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* project.

The Wrangellia project includes components of exploration geochemistry, geophysics, and targeted geologic mapping. Our initial three-week 2013 field reconnaissance program encompassed 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 reanalyzed more than 1,600 archived stream-sediment samples using modern, high-sensitivity analytical methods (see project overview). DGGS also contracted a 1,400-square-mile airborne magnetic and electromagnetic survey over prospective Ni–Cu–PGE areas in the northern Talkeetna Mountains (see project description). Finally, in 2014 the DGGS Mineral Resources Section completed 450 square miles of geologic mapping in the Talkeetna Mountains (see project description) as part of the USGS STATEMAP program.

These investigations have filled significant gaps in the geologic knowledge base and allowed for a more accurate assessment of the mineral potential of the project area. Notable results thus far include the mapping, geochemical characterization, petrologic study, and radiometric dating of a PGE-prospective Late Triassic mafic to ultramafic intrusion; major revisions to the distribution of Late Triassic volcanic rocks; and the mapping of a series of previously unrecognized northeasterly-trending faults in the Talkeetna Mountains.

Wrangellia-related work resulted in five raw-data file publications and four public presentations during 2014; additional reports are in progress. These data will be synthesized in a final Report of Investigations focusing on the geology and PGE mineral potential of the project area.

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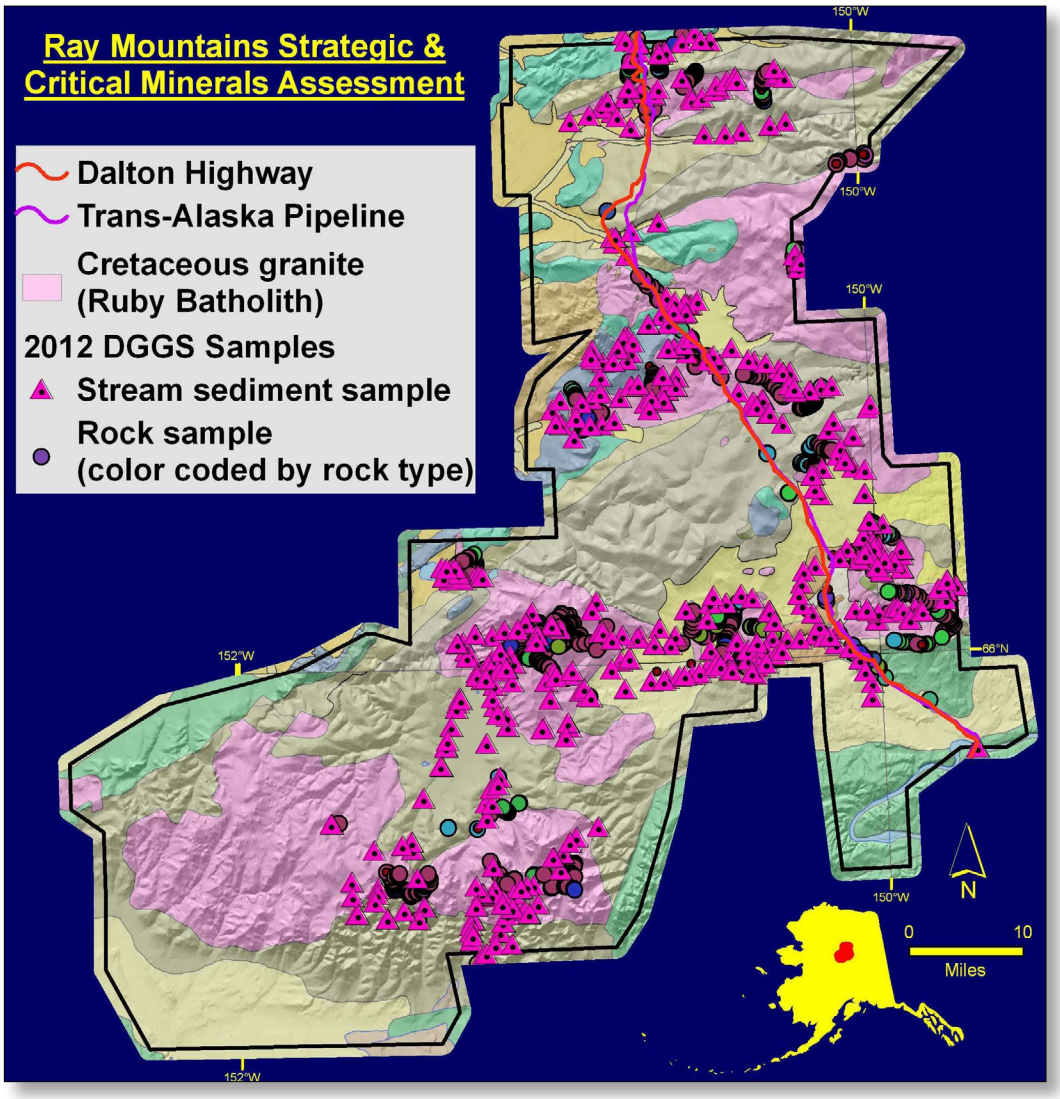
STRATEGIC AND CRITICAL MINERALS ASSESSMENT IN THE RAY MOUNTAINS AREA, NORTH-CENTRAL ALASKA



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. This 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 allows for science-based prioritization of the State-selected and top-filed lands based on their strategic and critical mineral-resource potential. Reports including $^{40}Ar/^{39}Ar$ data were released in 2014. Additional data, interpretations, and a report of investigations will be completed and made available on the DGGS website in 2015.

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. The alluvial REE resource of the area is being explored by Ucore Rare Metals.

Initial results indicate that the Cretaceous granites of the Ruby Batholith are variably enriched in REEs, which 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 are using preliminary results of this study to make informed and logical decisions on prioritization of State-selected lands for potential transfer to State ownership.

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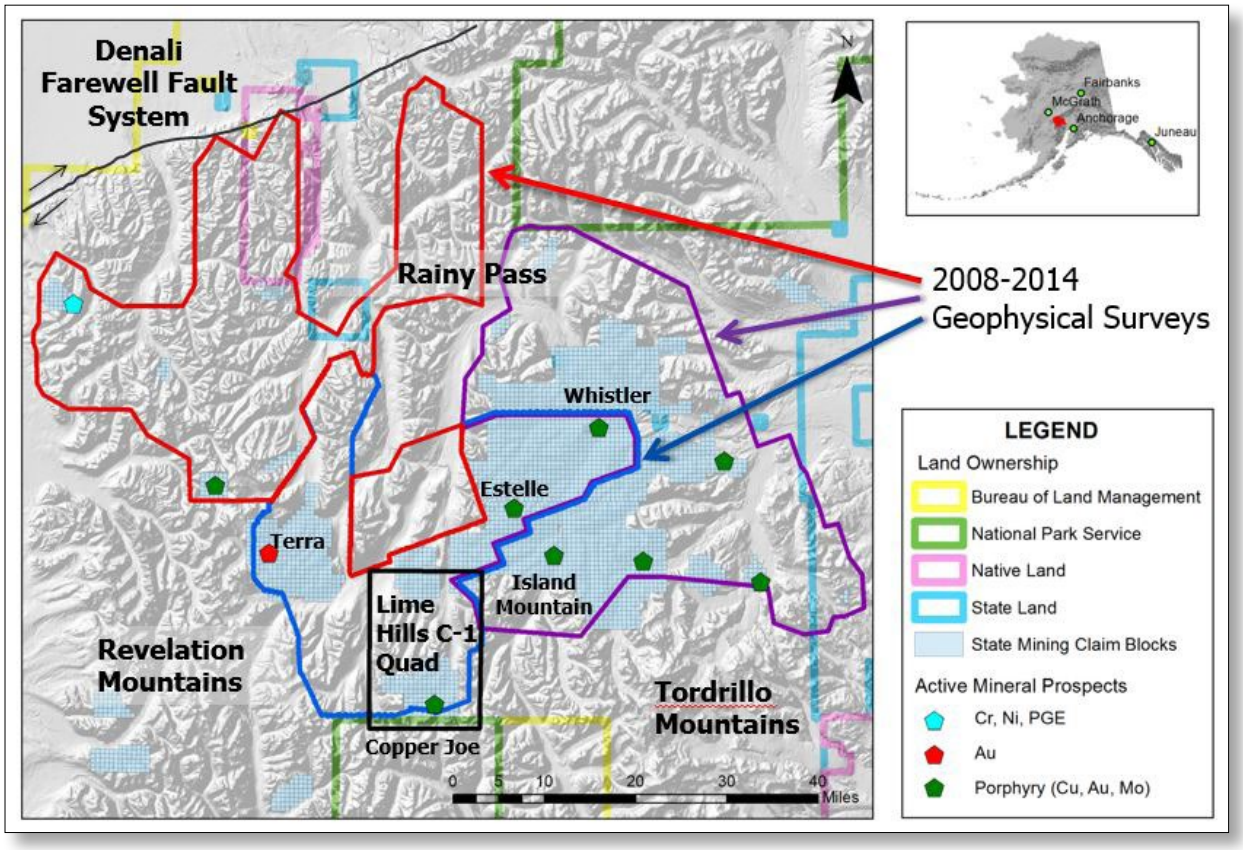
GEOLOGIC MAPPING AND NEW GEOLOGIC DATES IN THE STYX RIVER AREA, LIME HILLS C-1 QUADRANGLE, WESTERN ALASKA RANGE

The Division of Geological & Geophysical Surveys Mineral Resources Section conducted field investigations for the Styx River Project in the Lime Hills C-1 Quadrangle during 2013 as part of the State-funded Airborne Geophysical/Geological Mineral Inventory (AGGMI) program. DGGS geologists' observations and mapping were aided by airborne geophysical data from the 2008 Styx River survey. During their time in the field, two other surveys were flown nearby: Farewell and East Styx. These results were just released in July and November 2014; the Dalzell Creek and Middle Styx Surveys were released October 2013. The DGGS geologic map area is in the southern part of the geophysical surveys.



As is evident from the numerous mining claims coinciding with the recent DGGS geophysical surveys, this is an area of significant mineral-resource potential on State-owned land. Millrock Resources and Kiska Metals have large mining claims to the northeast of the Lime Hills C-1 Quadrangle in the Mount Estelle pluton and at the Whistler porphyry copper–gold–molybdenum system. To the northwest of the map area, WestMountain Gold is exploring gold and polymetallic veins at the base of the Revelation Mountains. The area also hosts reduced intrusion-related gold, lead–zinc skarns, molybdenum-bearing quartz veins, sediment-hosted base metals, platinum-group elements, and rare-earth elements. The majority of these mineral occurrences are related to numerous Late Cretaceous and Tertiary age intrusive complexes, dikes, and volcanic rocks.

New $^{40}Ar/^{39}Ar$ radiometric ages of selected igneous and mineralized rocks from the map area released in 2014, along with previously published and other unpublished data, indicate that the large Mount Estelle plutonic complex, host to numerous copper, molybdenum, and gold prospects, has crystallization ages ranging from 63 to 70 million years old, a much longer timespan than previously thought. Alteration closely associated with porphyry copper–molybdenum-style mineralization at the Copper Joe prospect, 10 miles south of the Mount Estelle Pluton, ranges from 10 to 11 million years old. The Copper Joe prospect comprises an altered area approximately 2 miles in diameter that is visible in the DGGS airborne geophysical data. The new Copper Joe age is much younger than any mineralization previously recognized in the region and potentially opens new targets for exploration of copper–molybdenum deposits in this part of the state.

The new map for the Lime Hills C-1 Quadrangle will be released in 2015. Significant improvements include further subdivision of map units from previous mapping and refinement of the plutonic and volcanic history. This work will result in a 1:63,360-scale geologic map and supporting interpretive text that will foster a better understanding of the geology and mineral potential of the area.

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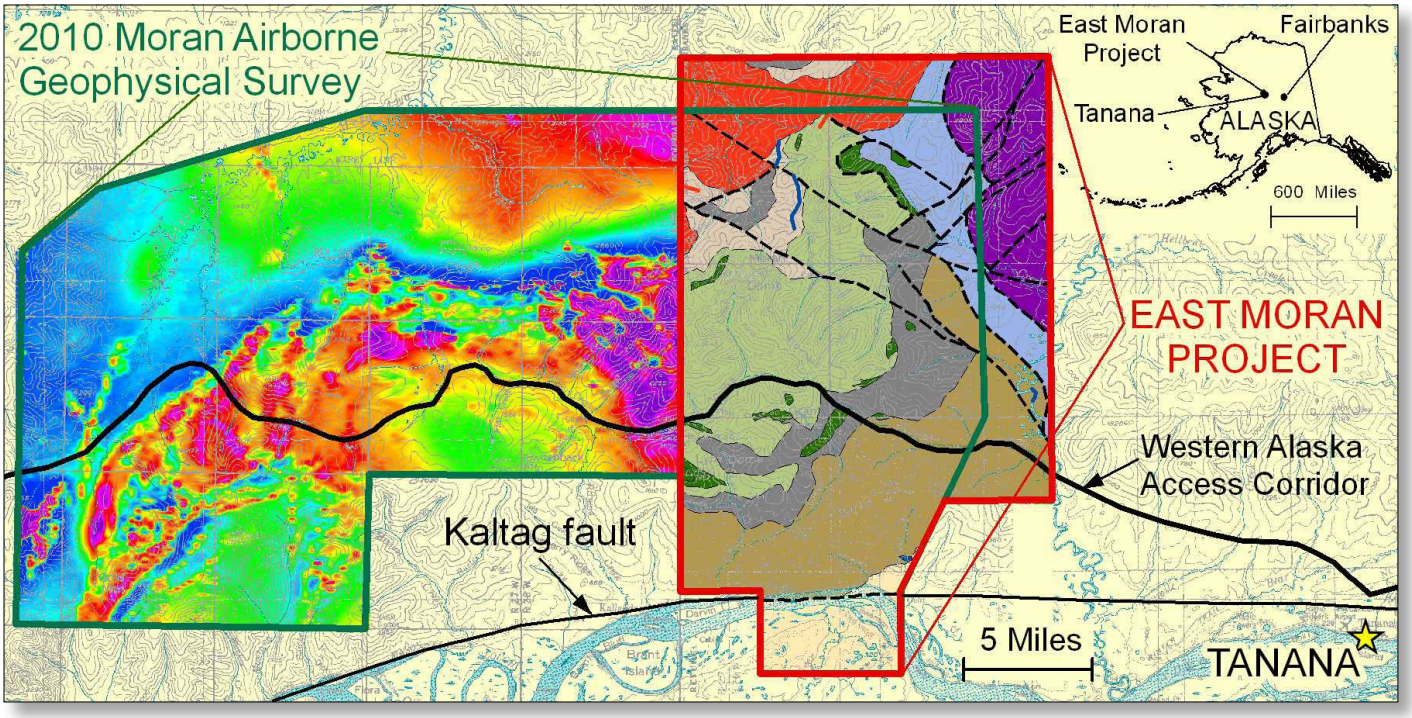
GEOLOGIC MAPPING IN THE EASTERN MORAN AREA, TANANA AND MELOZITNA QUADRANGLES, ALASKA

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 in 2012 and 2014, and additional products, including geochronologic data and the final 1:63,360-scale geologic map, will be published in 2015. 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 far 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 stimulate 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.

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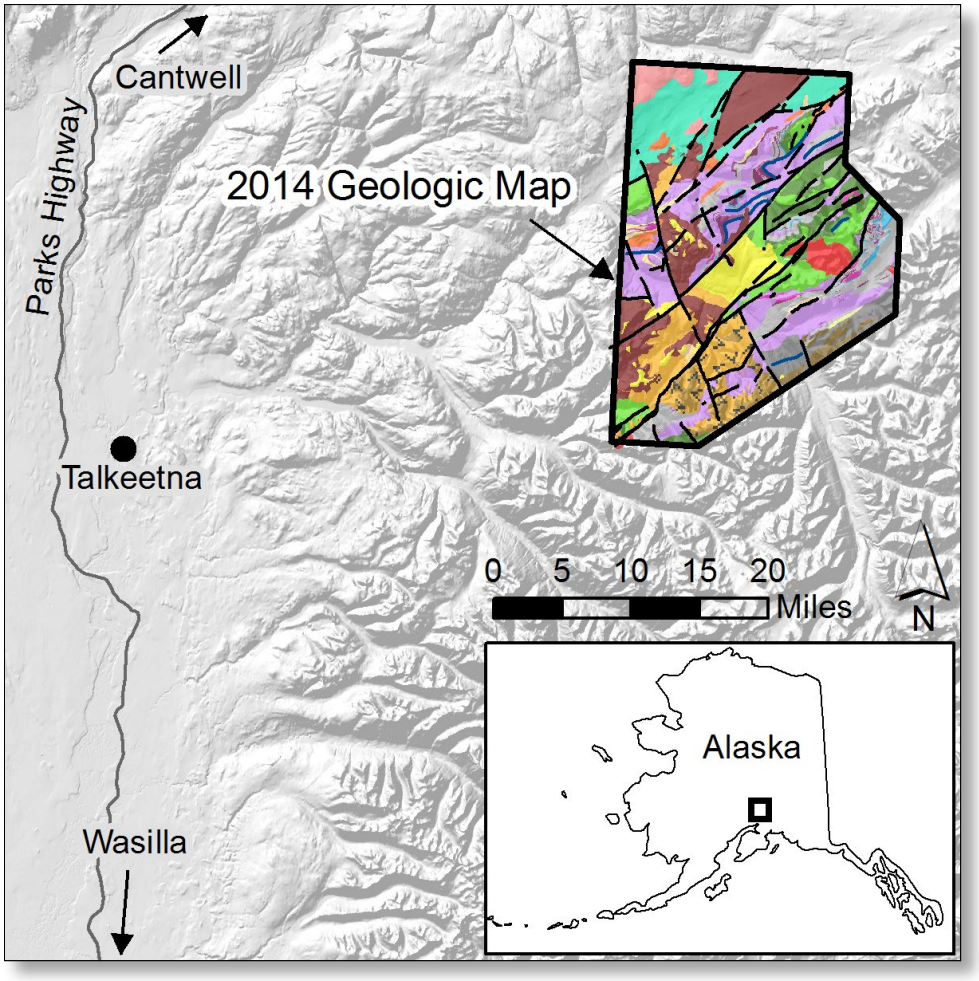
GEOLOGIC MAPPING IN THE TALKEETNA MOUNTAINS, SOUTH-CENTRAL ALASKA

The Division of Geological & Geophysical Surveys' (DGGS) Minerals Resources section completed 450 square miles of bedrock and surficial-geologic mapping in the Talkeetna Mountains Quadrangle during 2014 (see figure). This work is part of a multi-year effort to improve the geologic understanding of the Wrangellia geologic terrane, a belt of rocks that hosts a significant deposit of the strategic and critical platinum-group elements (PGEs), nickel, copper, and cobalt in the Yukon Territory but is poorly understood where it occurs in the Talkeetna Mountains of Alaska. This work is jointly funded through the State's *Strategic and Critical Minerals Assessment* project (see project description) and the U.S. Geological Survey's STATEMAP Program.

DGGS mapping shows that the study area contains a broad section of the Wrangellia stratigraphy, including the Late Triassic gabbros, which are regionally prospective for PGE mineralization. The oldest rocks in the area are volcanic rocks, overlain by sandstone, siltstone, chert, and Permian limestone. These sedimentary units host numerous sills of Late Triassic gabbro, ranging from <1 meter to several hundred meters thick. The extrusive equivalents of these sills are the >1-kilometer-thick Nikolai Greenstone, which outcrops across the center of the map area.



Along the southern boundary of the map area, the Wrangellia stratigraphy is cut by Jurassic granodiorite plutons of the Talkeetna Arc. At the northern edge of the map Wrangellia rocks are fault-juxtaposed against Jurassic to Cretaceous flysch, and both are intruded by plutons of mid-Cretaceous to Paleogene age. A series of Paleogene subaerial arc volcanic rocks varying continuously from basalt to rhyolite in composition unconformably overlie the Mesozoic and Paleozoic rocks in the southern portion of the map.

The entire area is cut by a series of prominent northeasterly-striking faults, including the range-front fault that separates mountainous Wrangellia from the Fog Lakes lowland and Kahiltna flysch. Where these structures are exposed, they have normal-oblique kinematic indicators consistent with evolution in a complex strike-slip tectonic setting.

Geochemical results show a diverse array of mostly structurally controlled mineralization associated with the prominent northeast-striking fault systems. These quartz and sulfide veins and breccias have widely varying metal associations, including copper, silver, gold, and molybdenum.

The surficial-geology mapping component utilized fieldwork and remotely-sensed data, including aerial photographs and IfSAR. The surficial geologist visited numerous exposures and evaluated several soil pits, identified potential sand and gravel resources, mapped areas of slope instability, and refined previously mapped contacts of glacial drift units.

Products of this work will include a 1:50,000-scale comprehensive geologic map and accompanying report, as well as interim supporting geochemical and geochronological data reports.

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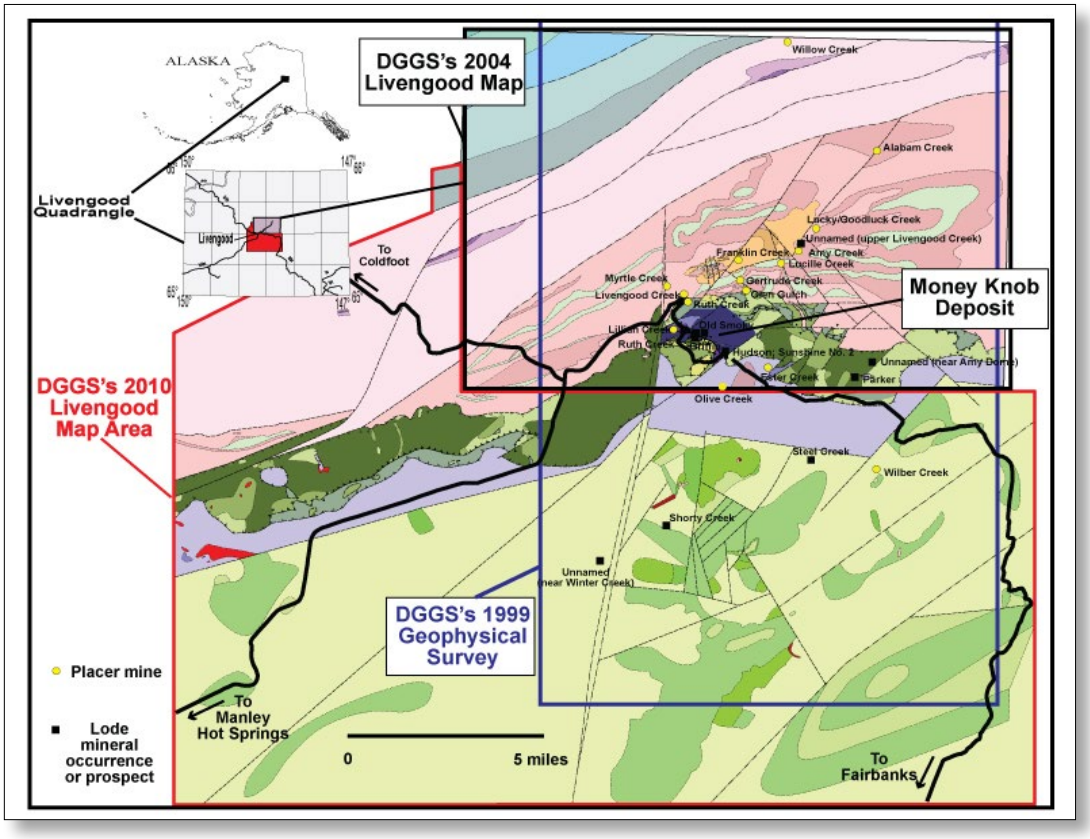
BEDROCK GEOLOGIC MAPPING IN THE TOLOVANA MINING DISTRICT, LIVENGOOD QUADRANGLE, ALASKA

Historic and active placer mines 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 report for an area that includes the northern portion of the 1999 geophysical survey (see figure). Subsequent mineral industry exploration in this 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, a Cu–Au–Mo porphyry signature, and, locally, Au values in rock and soil samples. Felsic igneous rocks spatially associated with the Shorty Creek prospect are compositionally different and 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 alkalic Cascaden Ridge pluton, 8 miles southwest of Money Knob, intrude Devonian sedimentary and volcanic rocks that also act as the host rock in the Money Knob system. The Money Knob prospect is currently being evaluated for possible development and production by International Tower Hill Mines, and the Shorty Creek deposit is being explored by Freegold Ventures.

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 similar in 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 comprehensive geologic map and accompanying interpretive report for the entire Livengood study area will be published in 2015. This publication will summarize the collective findings of the DGGS 2004 and 2010 investigations, and will incorporate 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 the 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.



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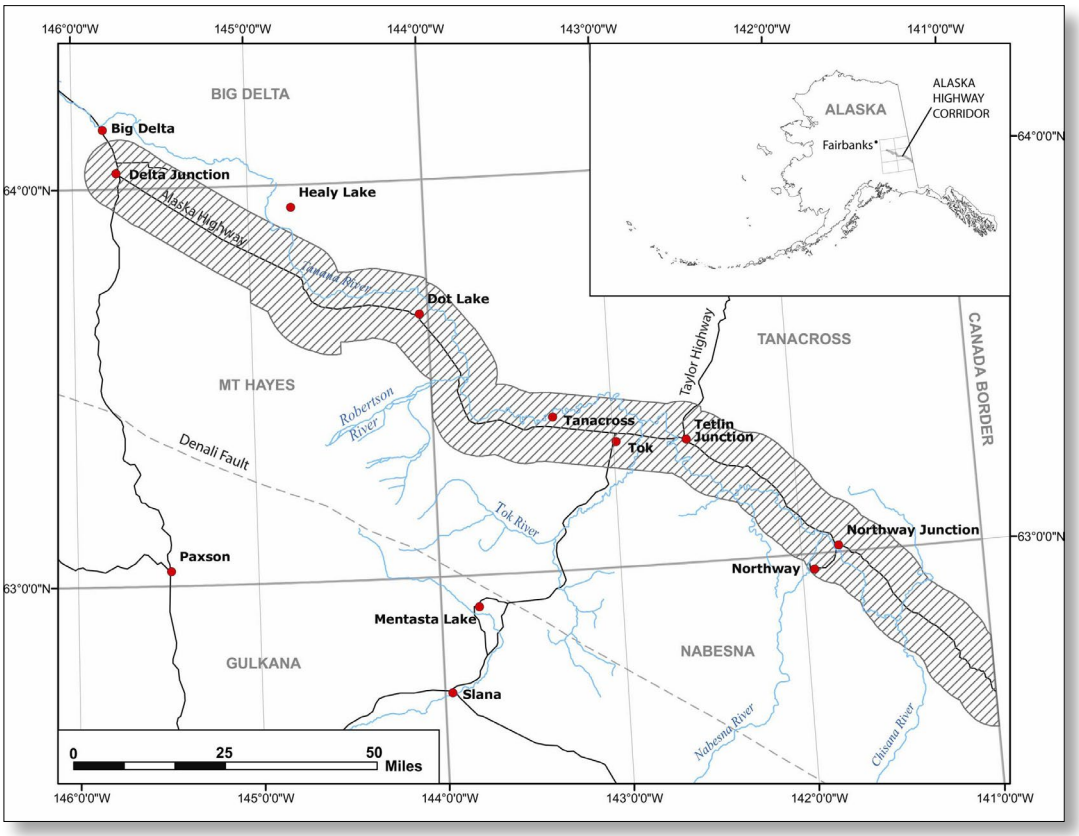
BEDROCK GEOLOGY AND MINERAL-RESOURCE ASSESSMENT ALONG INFRASTRUCTURE CORRIDORS BETWEEN DELTA JUNCTION AND THE CANADIAN BORDER

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. Relatively little geological and geotechnical work has been published relating to this strategically located 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-geologic and geologic-hazards components of the project are described separately.



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 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 intrude 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 on any future infrastructure.

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, apatite fission-track data, and U-Pb and $^{40}Ar/^{39}Ar$ age dates were published in 2014. Bedrock-geologic maps for the three segments of the proposed gas pipeline corridor will be published by the end of 2015.

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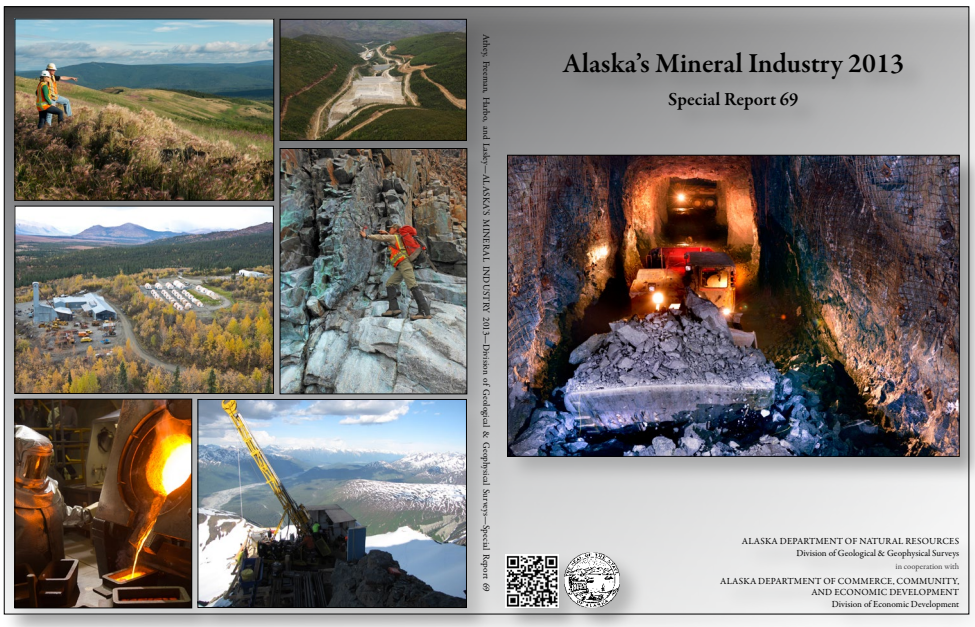
ANNUAL ALASKA MINERAL INDUSTRY REPORT

The Alaska 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 distrib¬ute 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. Staff from DGGS and DED spend a significant amount of effort gathering data through the year from sources such as press releases and corporate annual and financial reports, responses to questionnaires sent to mining entities, and permitting paperwork, as well as through phone interviews with individuals. Other data is gathered from State of Alaska agencies including the Department of Revenue, Department of Labor and Workforce Development, and other divisions of the Department of Natural Resources. 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 coop¬erative 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 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, the 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 continuing to work with industry representatives and the Alaska 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 2013 Alaska mineral industry activity report, released in November 2014, 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 2013, decreasing less than 4 percent to $3,953,000,000, despite declines in metal prices and worldwide mineral investment. Exploration expenditures for 2013 were at least $175,500,000, down about 48 percent from the 2012 reported value of $335,100,000. The drop in exploration expenditures reflects a worldwide decrease in exploration expenditures as well as the transition of the Donlin Gold project from exploration to development. Statewide development expenditures increased by nearly 5 percent, to approximately $358,800,000, and mineral production value remained steady, decreasing less than 1 percent to $3,418,700,000. Alaska gold production exceeded 1 million ounces in 2013, a milestone only achieved once before—in 1906.



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APPLIED ENGINEERING GEOLOGY AND NEOTECTONICS RESEARCH PROGRAM

During 2014 the applied engineering geology and neotectonics research staff at the Alaska Division of Geological & Geophysical Surveys (DGGS) participated in several field investigations, pre-project planning meetings, public outreach, and senior advisory and technical review committees related to state infrastructure projects. The primary focus of the neotectonics research program is to conduct original research on active seismic sources in the state to better characterize fault rupture parameters, earthquake timing and recurrence, and slip rates. These investigations provide up-to-date evaluations and information to other DGGS programs such as the proposed ASAP natural gas pipeline and the tsunami inundation mapping program.

DGGS geologists participated in the following projects:

- Evaluation of the western Denali fault crossing of the proposed Donlin Gold natural gas pipeline.
- Planning meetings related to ongoing characterization of the Akutan geothermal project, with the Alaska Energy Authority.
- Review of a preliminary geohazard assessment for potential power plant sites on Mount Spurr, Alaska.
- Fault mapping and paleoseismic trenching along the route of the proposed Alaska Stand Alone Pipeline (ASAP) natural gas pipeline.
- Paleotsunami assessments in the Aleutian Islands with the U.S. Geological Survey.

As part of the ASAP evaluation (see project description), paleoseismic trenching of the Castle Mountain fault indicates that there have been at least two Holocene earthquakes and that the fault is characterized by a dominantly reverse sense of slip and a relatively smaller component of right-lateral slip (see figure). Surficial-geologic mapping indicates that the Healy Creek fault is characterized by a low slip rate and has not deformed Holocene-age sediments.

Collaborative paleotsunami research on Sanak Island in the Aleutians, conducted with the U.S. Geological Survey, resulted in the discovery of several sand sheets inferred to be related to large tsunamis generated by earthquakes along the Aleutian subduction zone. Ongoing tephrochronologic, radiometric, and micropaleontologic analyses are being used to characterize the timing and origin of the sand sheets.

DGGS geologists continued to participate in the Alaska Seismic Hazards Safety Commission and the Western States Seismic Policy Council. Additionally, DGGS helped coordinate several ceremonies to commemorate the 50th anniversary of the Great Alaska Earthquake of 1964 and participated in a television news special program designed to educate the public on ways to reduce their exposure to seismic risk.

Photograph of the Castle Mountain fault exposed in a paleoseismic trench. Major fault splays, marked by red flags in the center of the image, displace fluvial gravels up on the north (left).

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ALASKA STAND ALONE PIPELINE (ASAP) GEOHAZARDS STUDY

In 2014, the Alaska Division of Geological & Geophysical Surveys (DGGS) continued field and office geohazards evaluations related to the proposed Alaska Stand Alone Pipeline (ASAP). The ASAP project has been proposed to transport natural gas from the North Slope to southern Alaska and, potentially, foreign markets from gas liquefaction plants located in several possible locations including Nikiski, Port MacKenzie, and Valdez.

DGGS's main objective in the geohazards investigation is to characterize the various geologic hazards that could potentially affect pipeline route feasibility, design, and construction. A comprehensive evaluation of geohazards along the entire proposed route was completed in previous field seasons, including assessment of the locations of landslides, tectonic faults, rock glaciers, avalanche chutes, and frozen ground, among others. Particular attention was devoted to inspecting bedrock faults to determine the presence or absence of Quaternary activity. In 2014, DGGS geologists compiled the locations of geologic hazards onto topographic and lidar map sheets in anticipation of a final geologic hazards report to the Alaska Gasline Development Corporation (AGDC) and the State Pipeline Coordinator's Office (SPCO), scheduled to be completed in 2015.

The proposed ASAP pipeline route generally follows the Parks Highway in the vicinity of Cantwell. This view, looking east from the Jack River valley, shows the Denali fault (red line) where it crosses the proposed pipeline route near the Parks Highway.

During the 2014 summer field season, DGGS geologists conducted site-specific field evaluations along tectonic faults that cross the proposed pipeline route between Cook Inlet and Livengood. Specific faults investigated included the Castle Mountain, Denali, Park Road, Healy, Healy Creek, and Stampede faults, the Northern Foothills thrust and associated backthrusts, and the Minto Flats seismic zone. The primary focus of the 2014 field activities was to better characterize crossing locations and fault rupture parameters, such as type of fault, width of deformation, single-event displacement, and orientation, to aid pipeline engineers in design and routing decisions. An additional focus was to determine which faults could pose a surface fault rupture hazard to the proposed pipeline. These objectives were accomplished through surficial-geologic mapping, paleoseismic trenching, and topographic analyses.

The observations from our 2014 efforts indicate that the Castle Mountain, Denali, and Park Road faults and the Northern Foothills thrust present the most significant surface fault rupture hazards to the proposed pipeline. Several other faults were determined to be characterized by low slip rates and/or not to cross the proposed pipeline route. A report detailing the fault crossing results was presented to AGDC in late 2014 and is presently being prepared for publication in 2015.

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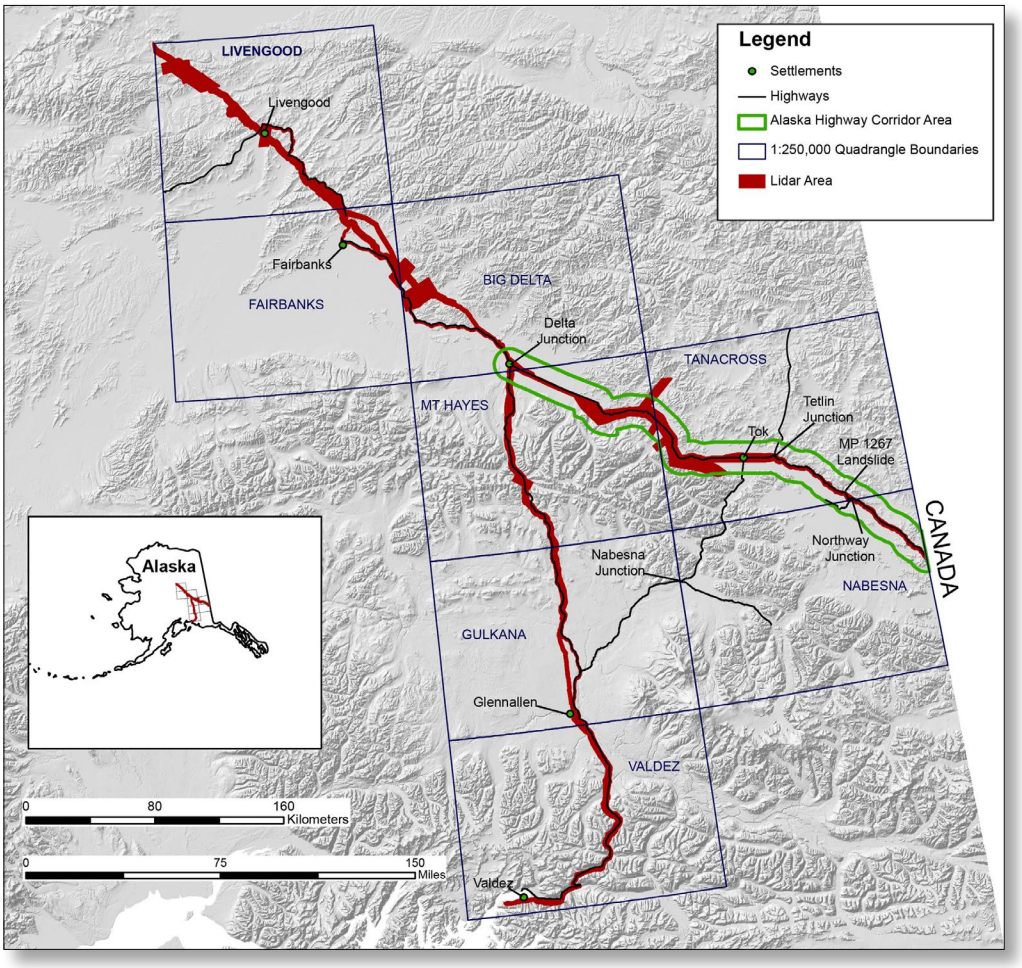
GEOLOGY, GEOHAZARDS, AND RESOURCES ALONG PROPOSED NATURAL GAS PIPELINE CORRIDORS

In 2014 the Alaska Division of Geological & Geophysical Surveys (DGGS) worked to finalize its evaluation of geology, resources, and geologic hazards along proposed natural pipeline corridors in Alaska. These studies included a 12-mile-wide corridor centered on the Alaska Highway from Delta Junction to the Canada border, and in areas of lidar collection along the highway system between Livengood and Valdez (see figure).

For work along the Alaska Highway, DGGS completed writing, and submitted for review, a comprehensive report describing permafrost, surficial geology, and geologic hazards, including active faulting. This report, based on new results from fieldwork and evaluation of lidar published by DGGS in 2011, is updated from previously published preliminary reports. Surficial-geologic, derivative engineering-geologic, and interpretive permafrost maps were also updated from preliminary versions and have been submitted for review as part of the comprehensive final data release. We anticipate the report, maps, and associated seamless GIS data layers will be published in 2015. In conjunction with this report, DGGS continues work finalizing a guidebook describing the roadside geology of the Alaska Highway and the Tok Cutoff from Tok Junction to Nabesna Junction. We anticipate this will be ready for review early in 2015.



Map showing areas of geology and geohazards investigations along proposed natural gas pipeline routes.

In cooperation with St. Lawrence University, DGGS conducted field work in June 2014 to core black spruce trees on an active landslide near milepost 1267 northwest of Northway Junction to evaluate reaction wood and better understand historical movement of the unstable slope (see figure). Preliminary results, presented at the 2014 national meeting of the Geological Society of America, indicate that mass wasting processes were not initiated or affected by the original emplacement of the road in the 1940s and were intermittent until widespread mass movement began in 1989. Thickness of the active layer (seasonal thaw depth) is likely a factor in tree tilting, and tree instability may increase with warming temperatures and increased active layer thickness. When correlating tree ring and climate data it appears that previous summer mean maximum temperatures have a negative effect on tree growth the following year. We anticipate a DGGS report will be published in 2015 summarizing the findings of the study.

DGGS is continuing evaluation of geology and geohazards in areas of lidar collection along the Livengood–Valdez highway corridor. Work continues on developing and refining the GIS database, data and maps are being updated, and we anticipate the resulting geologic atlas will be ready for review in 2015.

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

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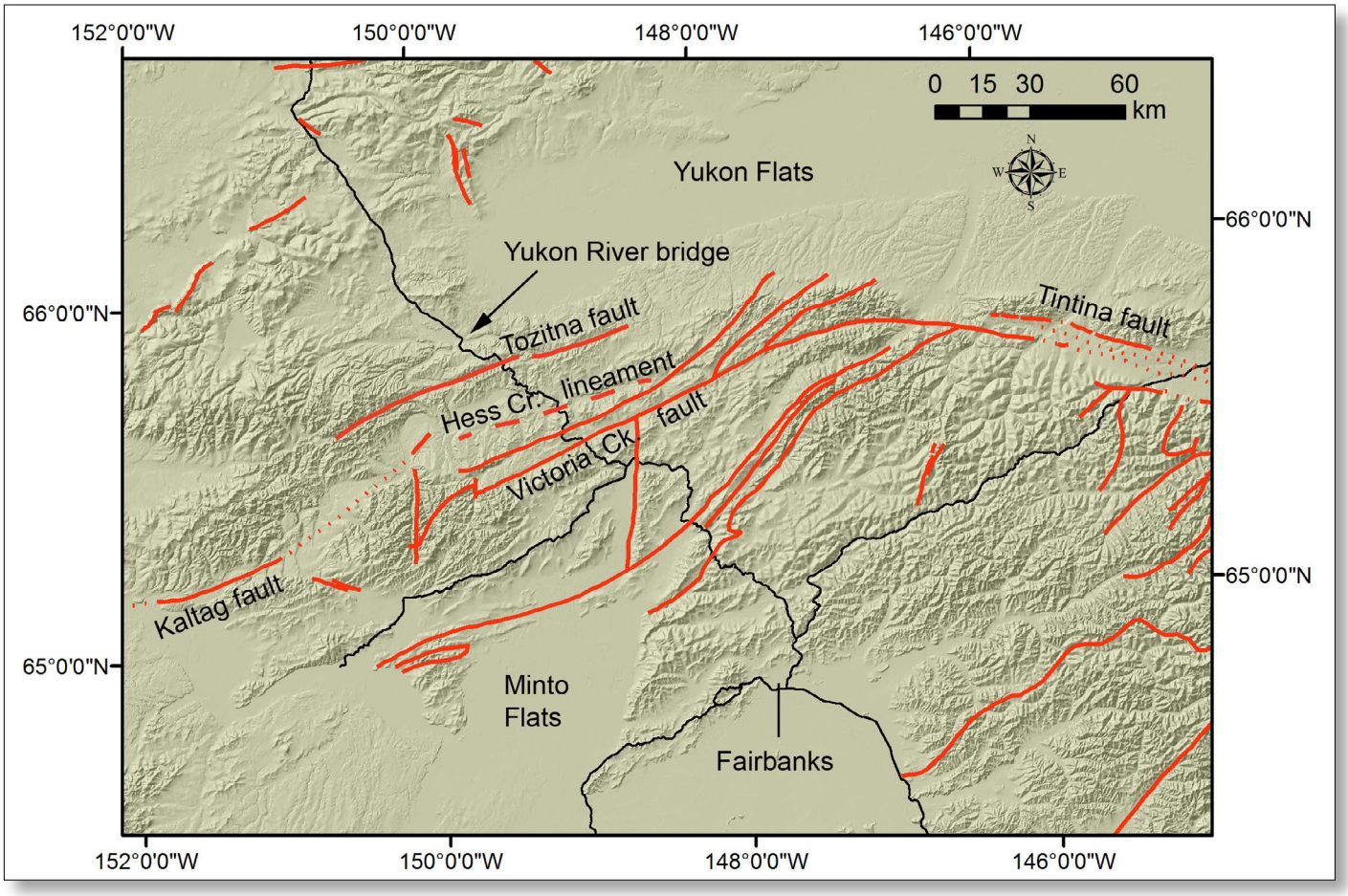
FAULT CHARACTERIZATION AND GEOLOGIC HAZARDS OF THE YUKON CROSSING AREA

The Alaska Division of Geological & Geophysical Surveys (DGGS) has begun a new project of geologic mapping and hazards assessments in the vicinity of the Yukon River bridge along the Dalton Highway (see figure). This area is a critical transportation link and an essential component of the Trans-Alaska Pipeline System, the oil and gas exploration and support industries, and several proposed natural gas pipelines. Geologic conditions in the area are poorly characterized, including factors related to slope stability and the relative activity of several faults. A large landslide occurred in late 2013 adjacent to the Yukon River bridge near the south abutment, heightening awareness of geologic hazards in the area and sparking renewed interest in the local geology. To address concerns about the effects of geologic hazards on existing and future infrastructure, this project was designed to develop a better understanding of seismic and landslide-related hazards through a program of regional mapping and site-specific field investigations.

DGGS has initiated discussions with the Alaska Geologic Mapping Advisory Board regarding a potential STATEMAP project that would utilize matching funds to develop a surficial-geologic map with an emphasis on geologic hazards. Over the next several years DGGS geologists plan to investigate the region between the seismically active Kaltag and Tintina faults to determine whether youthful fault ruptures have extended across the Dalton Highway corridor. Potentially active faults in this area include the Tozitna and Victoria Creek faults, the Hess Creek lineament, and several other unnamed lineaments. Additionally, image analyses and helicopter reconnaissance will be used to delineate the locations of deep-seated landslides, rotational slumps, rockfalls, and avalanche chutes.



Hillshade map of the Yukon River crossing study area, showing potentially active faults in red and major transportation corridors in black.

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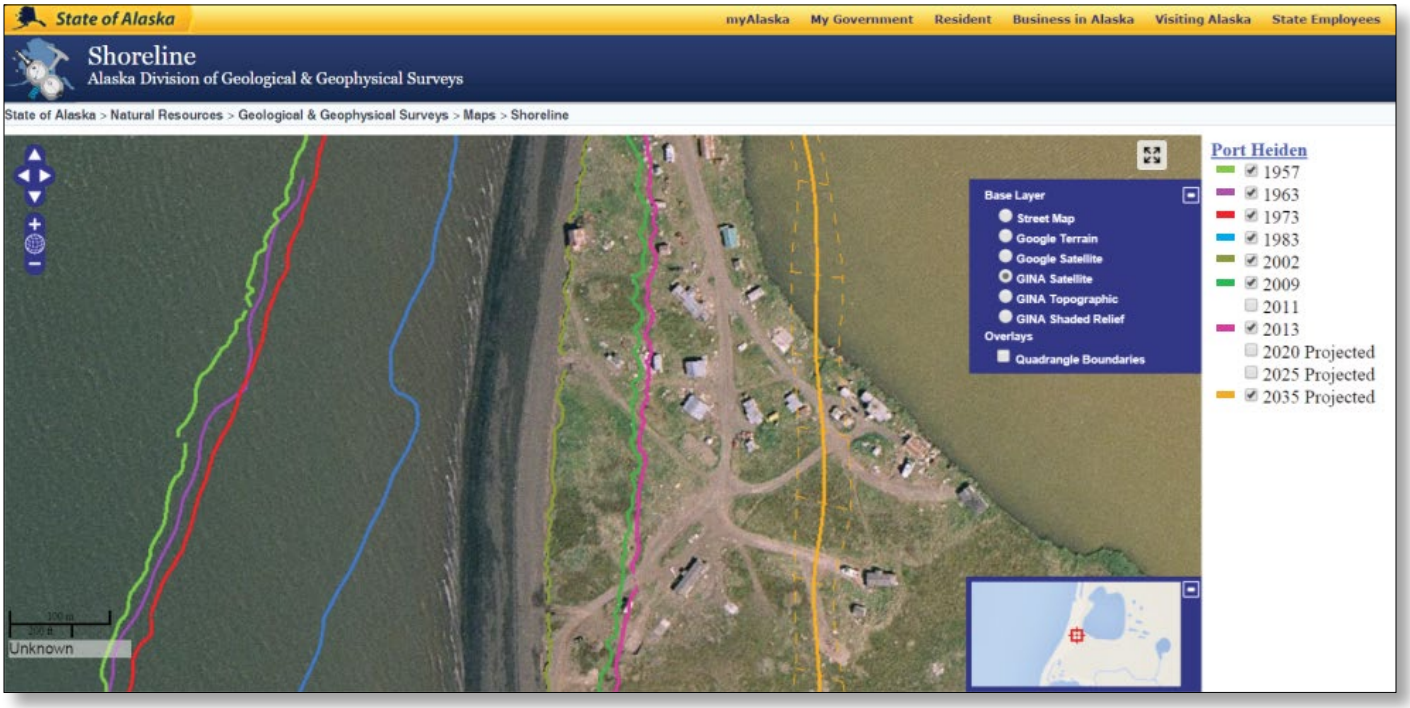
GEOHAZARD EVALUATION AND GEOLOGIC MAPPING FOR COASTAL COMMUNITIES

More than 60 percent of Alaskans reside in coastal communities that 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 form since their establishment, the timing, frequency, and magnitude of new hazard events has not remained constant. As a result of these trends, some Alaska villages experiencing extreme rates of local erosion have been labeled '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 in costly mitigation or adaptation efforts to ensure the protection of human life, property, and the coastal environment amid accelerated erosion rates and thawing 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, the Alaska Division of Geological & Geophysical Surveys (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. Resulting maps and reports identify natural hazards that must be considered in the siting, design, construction, and operations of coastal development projects. Baseline data have been collected in 12 areas thus far and new field projects are scheduled to take place through FY2016.

In 2014 DGGS released the *Alaska Coastal Profile Tool* (http://dx.doi.org/10.14509/27359), the first in a series of interactive coastal vulnerability maps stemming from this work. This interface enables access to beach elevation profile measurements collected throughout the state; users can explore these data as time-series plots and location-based images of the shoreface environment. In 2015 DGGS will release the *Alaska Shoreline Tool,* which displays the positions of historical, contemporary, and projected shoreline positions based on calculated rates of shoreline change (see figure). These new products facilitate access to underlying coastal datasets that are available for download on the DGGS website (http://dggs.alaska.gov).



Screenshot of the interactive Alaska Shoreline Tool under development for release in 2015. Illustrated are historical shoreline positions near Port Heiden, Alaska, overlain on a 2009 aerial image; a projected 2035 shoreline position based on long-term rates of shoreline retreat is shown in gold, with the 90 percent confidence interval for this estimate depicted by paired dashed gold lines.

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UNSTABLE SLOPES ALONG THE HAINES HIGHWAY

Many of the geologic hazards in Alaska are associated with unstable slopes that have the potential to rapidly mobilize with little or no warning, resulting in potential loss of life and significant damage to property, infrastructure, and economy. Changes in the cryosphere (such as thawing permafrost and glacier wastage and retreat), are thought to be responsible for the rising number of mass movements in high-latitude and high-elevation areas. Such changes in Alaska are exacerbated by rising air temperatures, high amounts of precipitation, snow avalanching, and strong ground motions caused by frequent moderate to large earthquakes.

Figure 1. DGGS and DOT&PF scientists and maintenance personnel conduct field-based reconnaissance of the Haines Highway milepost 19 debris fan.

In 2014, the Alaska Division of Geological & Geophysical Surveys (DGGS) began a collaborative study with the Alaska Department of Transportation & Public Facilities (DOT&PF) along the Haines Highway corridor near Haines, Alaska (fig. 1). The intent of this study is to evaluate, monitor, and model geophysical processes, including cryosphere-related changes, along this important transportation corridor where destructive debris flows regularly impact the highway by threatening motorists, damaging infrastructure, and impeding traffic flow. Repeat aerial photography and digital surface model (DSM) generation of this dynamic catchment is the first step to allow DGGS to quantify debris volumes, understand the source of the debris flows, and provide guidance to DOT&PF planners for mitigating the hazard to the roadway (fig. 2).

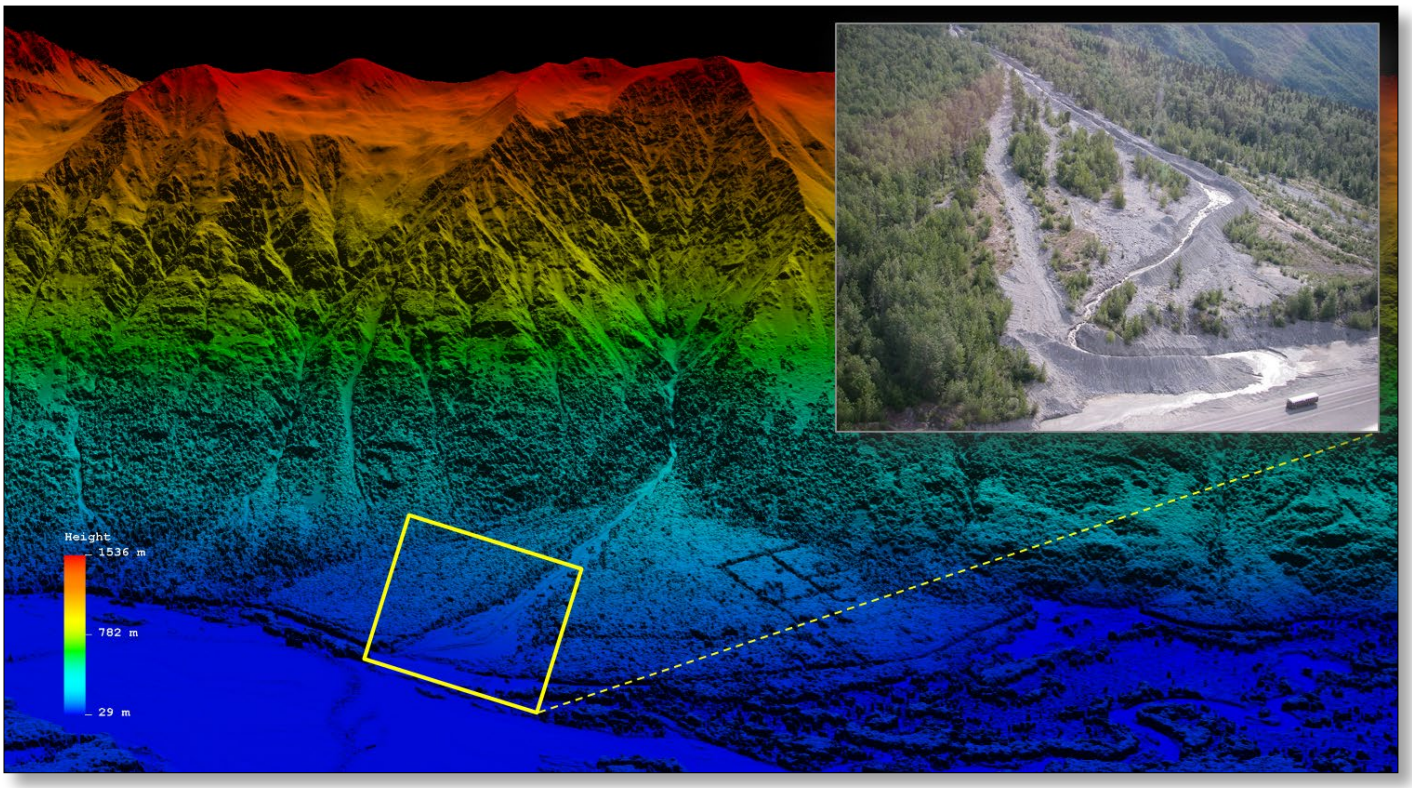

Figure 2. May 2014 photogrammetrically-derived digital surface model (DSM), produced by DGGS scientists, of the Haines Highway milepost 19 catchment.

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DALTON HIGHWAY FROZEN DEBRIS LOBES

In 2014 the Division of Geological & Geophysical Surveys (DGGS), in cooperation with the University of Alaska Fairbanks (UAF), continued its geologic hazard evaluation of frozen debris lobes (FDLs) between mileposts 208 and 231 of the Dalton Highway and along the Trans-Alaska Pipeline System (TAPS) in the southern Brooks Range (fig. 1). The FDLs, slow-moving landslides of soil, rock, and debris, developed on steep slopes underlain by permafrost, are being evaluated in support of critical maintenance decisions by the Alaska Department of Transportation and Public Facilities (ADOT&PF) and Alyeska Pipeline Service Company, and development planning affecting several proposed pipeline projects being considered to transport natural gas from the North Slope to Fairbanks and Cook Inlet. This assessment is particularly important because of the potential for increased instability in a warming climate.

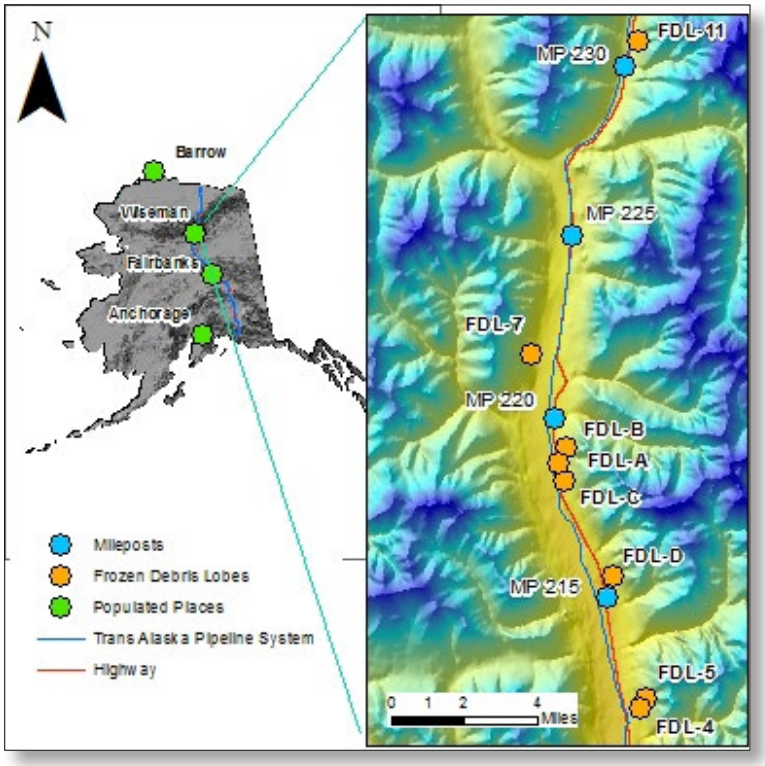

Figure 1. Locations of FDLs under evaluation along the Dalton Highway and TAPS in the southern Brooks Range. FDL-A currently poses the greatest threat to the Dalton Highway.

Repeat measurements of survey markers on eight FDLs using differential GPS, oblique aerial photographs, and field observations of increased thaw slumps, mudflows, and exposed ground ice document increased surface activity during the very wet summer of 2014 (fig. 2). We anticipated the existence of massive ground ice, but this was the first year it was found exposed in such abundance. Its presence in large quantities is significant because it propagates debris movement. Not only is ground ice a significant source of meltwater for mobilizing debris, it also fills stress cracks and exerts force on the surrounding material as it expands. FDL-D, FDL-A, and FDL-7 continue to have the fastest rates of movement (between 0.5 and 2 inches/day), while the other FDLs in the study are moving more slowly (at rates of 0.2 inches/day or less).

Evaluation of the geological and geomorphological characteristics of FDLs and their source basins for a geohazards assessment continues, with data analysis and report writing. Results from our work describing FDL source basins, anticipated to be submitted for pre-publication review in December 2014, show that lithology and slope processes influence the rate and style of material transport and play an important role in FDL development. There does not appear to be a relationship between the size of an FDL and the size of its source basin. A second report evaluating geology and geological hazards of the FDLs, including analysis of slope, relief, and surface morphology and character, is being written as part of a cooperative graduate research assistantship with UAF, and will be submitted for review in late spring 2015.

Figure 2. Photograph of FDL-A taken August 22, 2014, showing evidence of increased activity, including slumping, flowing debris, and disturbed vegetation.

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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 (the cryosphere). Changes in climate can modify natural processes and could increase the magnitude and frequency of certain types of geologic hazards (such as avalanches, floods, erosion, slope instability, thawing permafrost, and glacier lake outburst floods), which, if not properly addressed, could have a damaging effect on Alaska's communities and infrastructure, as well as on the livelihoods and lifestyles of Alaskans.

The Alaska Division of Geological & Geophysical Surveys' (DGGS) Climate and Cryosphere Hazards Program (CCHP) combines field-based observations, remote sensing, and modeling to assess, monitor, and predict the impacts of a changing cryosphere on resources and infrastructure in Alaska.

CCHP Headlines for 2014

- The City of Valdez partners with CCHP to continue climate and cryosphere monitoring in the Valdez area and helps support a multi-agency high-elevation weather station network.
- CCHP launches two new studies with the Alaska Department of Transportation and Public Facilities (DOT&PF), investigating destructive debris flows along the Haines Highway and assessing snow-avalanche potential along Richardson and Dalton highway corridors. See separate project descriptions for details.
- Glacier and Runoff Changes study in the upper Susitna Basin completes its third and final field season as part of the Susitna–Watana Hydroelectric Project pre-licensing studies.
- CCHP takes over support of upper Susitna basin high-elevation weather stations in order to continue the collection of critical meteorological information in an important watershed.
- End-of-winter radar-derived snow water equivalent (SWE) measurements acquired for the third consecutive year over glaciers in central and south-central Alaska.

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

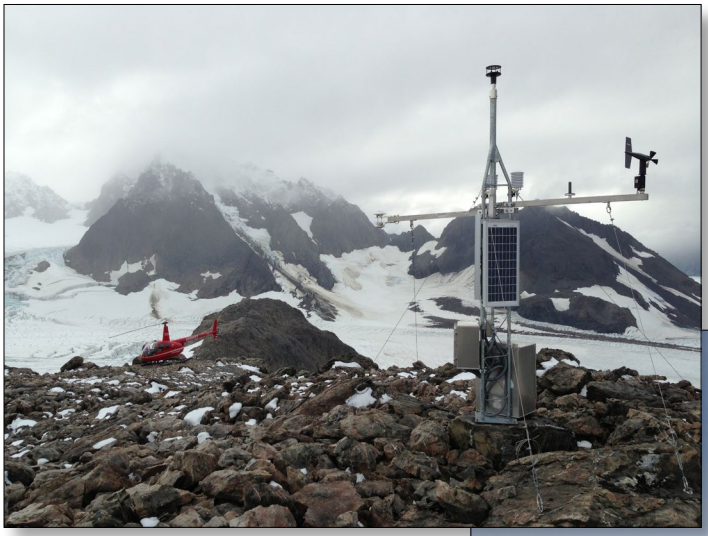

Figure 1. (above) Servicing a high-elevation weather station in the Scott Glacier watershed near Cordova, Alaska.

Figure 2. (right) Calibrating ground-based radar data for snow distribution monitoring in the Valdez Glacier watershed.

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SNOW AVALANCHE SUSCEPTIBILITY

Snow avalanches are dangerous natural hazards that occur in mountainous areas throughout Alaska. In many areas of the state, avalanches threaten public safety and infrastructure and can lead to lengthy closures of important transportation routes. The economic impacts of such avalanches, from the removal of avalanche debris blocking the transportation corridor to the impedance of traffic, can be significant at both the local and state levels.

The Alaska Division of Geological & Geophysical Surveys (DGGS) recently launched a study with the Alaska Department of Transportation & Public Facilities (DOT&PF) along the Richardson and Dalton highway corridors to evaluate the utility of incorporating avalanche susceptibility and prediction models into future DOT maintenance activities, with the goal of decreasing DOT&PF's operating expenses, increasing the functionality of the highway system, and increasing safety for the traveling public.

The first, or pilot, stage of the study is focused on gathering baseline data and generating avalanche incidence and susceptibility maps along the southern Richardson Highway and the Dalton Highway near Atigun Pass using geostatistical modeling techniques. Model-derived avalanche release areas and runout distances will be validated with field-based observations and recent and historical avalanche information, such as the massive avalanches that occurred in 2014 (for example, Keystone Canyon near Valdez) (figs. 1 and 2). The second stage (funding dependent) would involve developing a method to incorporate avalanche prediction models in future DOT activities at an operational level.

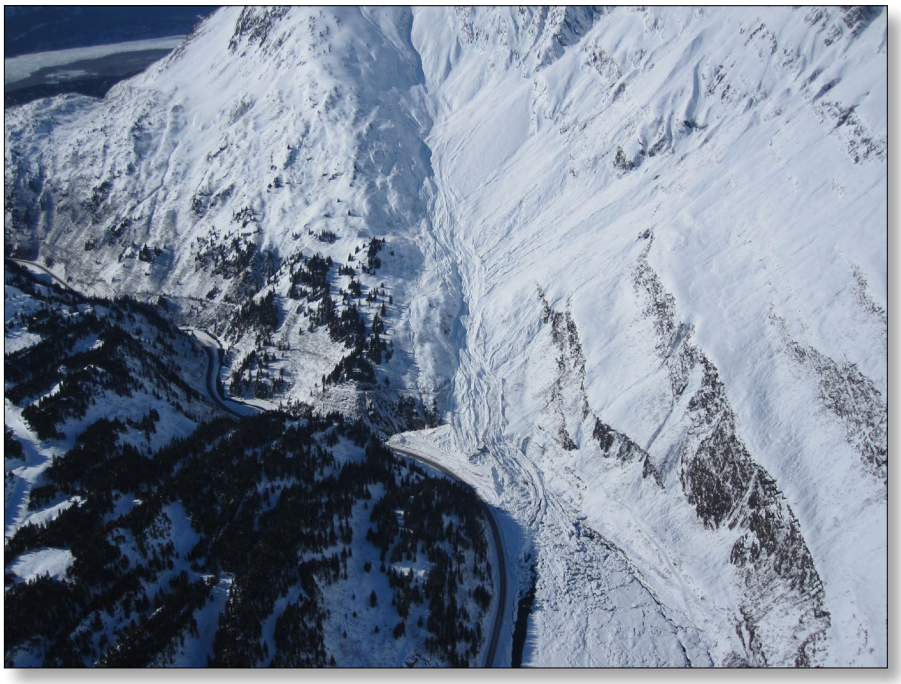

Figure 1. Oblique air photo of the Richardson Highway at Keystone Canyon two months after the large avalanche ("damalanche") that occurred in January 2014 and cut off the community of Valdez from the road system for several days. An enormous deposit of avalanche debris is visible along the side of the highway (lower center), as well as remnants of the lake that formed when the avalanche dammed the Lowe River (lower right).

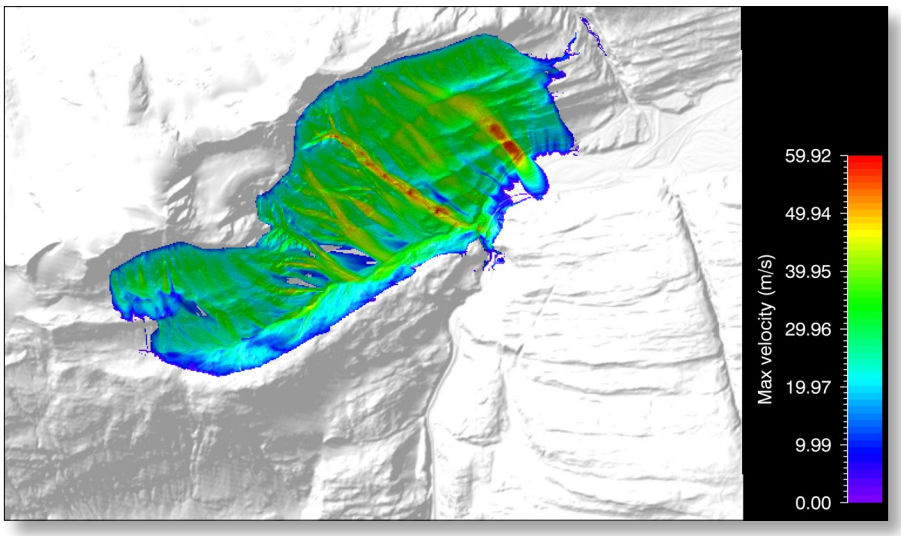

Figure 2. Preliminary snow avalanche model calibration results for Keystone Canyon, Richardson Highway, Alaska.

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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 proposed Susitna–Watana Hydroelectric Project, which aims 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 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 km^2) 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 (UAF) are in the third and final year of a hydrology study of the upper Susitna drainage basin (figs. 1 and 2). The focus of the study 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, and meteorology with computational modeling to provide estimates of recent historical and future runoff into the proposed 63-km-long, 81 km^2 reservoir.

Results from this project are expected to be published in spring 2015.

Figure 1. DGGS and UAF scientists collect data from a 'floating' weather station on West Fork Glacier.

Figure 2. DGGS scientist returns to the helicopter after servicing a high-elevation weather station and telemetry repeater in the upper Susitna basin.

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BASELINE INVESTIGATIONS OF COASTAL FEATURES AND PROCESSES

Figure 1. DGGS intern collects a beach sediment sample from Cannon Beach in Yakutat, Alaska, to determine the shoreface grain size characteristics (August 2013).

Alaska's tidal shoreline is more than 40,000 miles long and is well recognized as being incompletely mapped, under-instrumented, and lacking in fundamental baseline data such as nearshore bathymetry and sediment transport patterns (fig. 1). Alaska's coastal populations depend on access to sound investigations of coastal dynamics to make informed planning decisions that will minimize losses due to new or exacerbated geohazards in the coastal environment.

The Alaska Division of Geological & Geophysical Surveys' (DGGS) Coastal Program is engaged in ongoing investigations and baseline mapping efforts that will expand our understanding of how the coastline has evolved and how it will respond to future short-term and long-term changes. In 2014, DGGS prepared and published several elevation and bathymetric datasets from new and pre-existing lidar, photogrammetry, and field surveys (fig. 2). In 2015, DGGS will be working with federal partners to undertake an extensive project to collect high-resolution othoimagery and elevation data along the western coastline of Alaska. This work will support habitat vulnerability assessments, oil spill response, community planning, erosion/flood hazard mapping, and delineation of an updated shoreline position.

Due to the great expense and multiple logistical challenges associated with equipment deployment and repeat field campaigns in remote areas and under 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, and to avoid duplication of efforts.

Figure 2. Three-dimensional model view of the Unalakleet revetment looking north from the inlet (October 2014 aerial image draped over an experimental photogrammetric digital elevation model).

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COASTAL DATA AND TOOLS FOR EMERGENCY AND DISASTER SUPPORT

Informed emergency response is fueled by access to reliable decision-making tools. The Alaska Division of Geological & Geophysical Surveys' (DGGS) Coastal Program is actively working to close emergency communication gaps with scientific resources, convert available data into more accessible formats, and educate the public about coastal processes. Decision support and planning tools that place an emphasis on education and outreach will maximize opportunities to protect life, infrastructure, and the environment at a grassroots level.

One way in which DGGS supports decision making is by maintaining a scientific field crew at the ready during the fall coastal storm season (fig. 1). The capability to immediately collect field measurements that document the locations and extent of processes, such as flooding and erosion, associated with a specific event is critical for evaluating the reliability of models, forecasts, and existing geohazard maps. These event-specific field operations allow DGGS to obtain a better understanding of extreme events, identify community-specific needs, and provide landscape-change assessments to facilitate community qualification for post-disaster relief funding.

Figure 1. DGGS geologist uses precision GPS equipment to measure the extent and height of storm-wave run-up on bluffs ~10 miles east of Nome, Alaska, immediately after the 2011 Bering Sea storm.

In preparation for the fall 2014 storm season, DGGS teamed up with the National Weather Service and local community leadership to develop a pilot Color-Indexed Elevation Map Series for the western Alaska communities of Shishmaref, Kivalina, Unalakleet, Shaktoolik, and Golovin (fig. 2). This project was designed to streamline communication about forecasted storm surges, local elevations, and potentially impacted infrastructure during storm events that could cause coastal flooding, and it has laid the groundwork for additional maps of this type.

DGGS Coastal Program staff routinely host workshops and give presentations to community residents and emergency responders to raise awareness about coastal geohazards and data resources in Alaska.

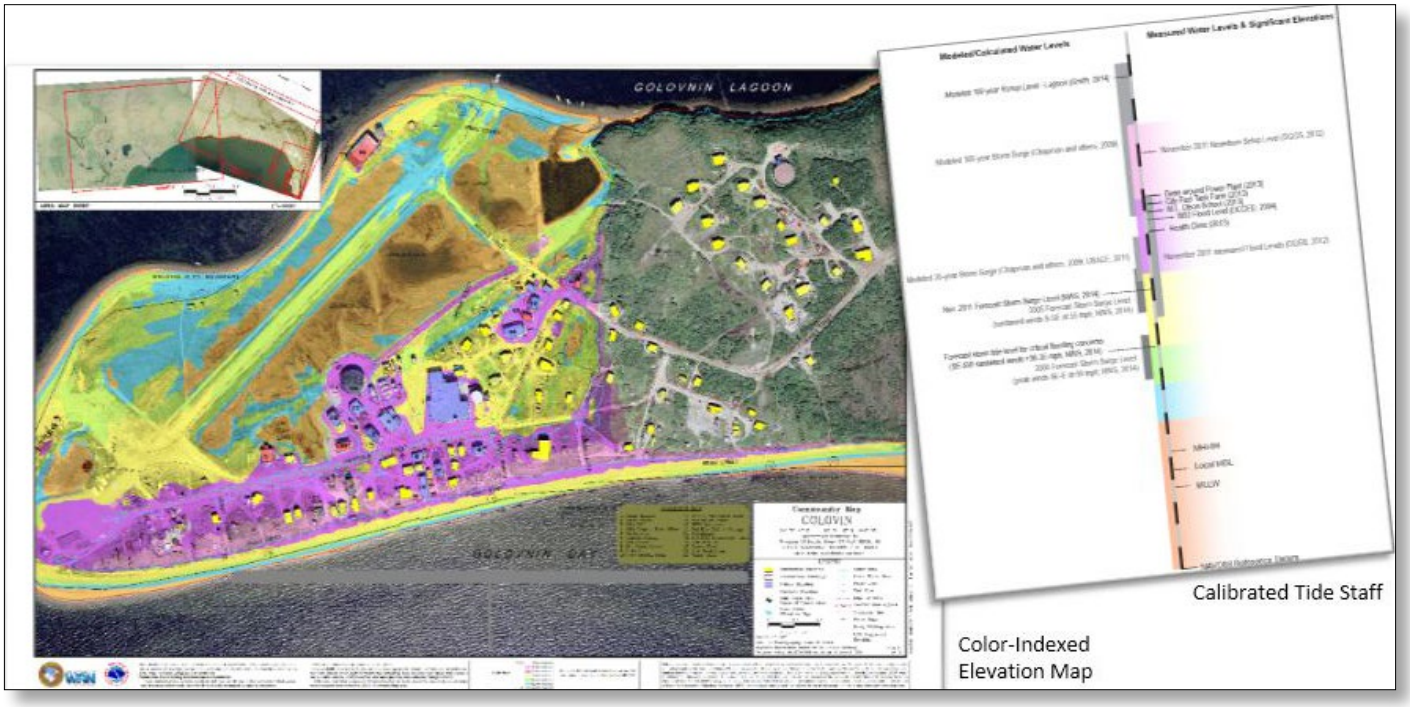

Figure 2. Color-indexed elevation map of Golovin, Alaska, and associated elevation key, in the form of a calibrated tide staff with documented and modeled water levels, displayed in a combined format to facilitate communication about water levels in an emergency situation.

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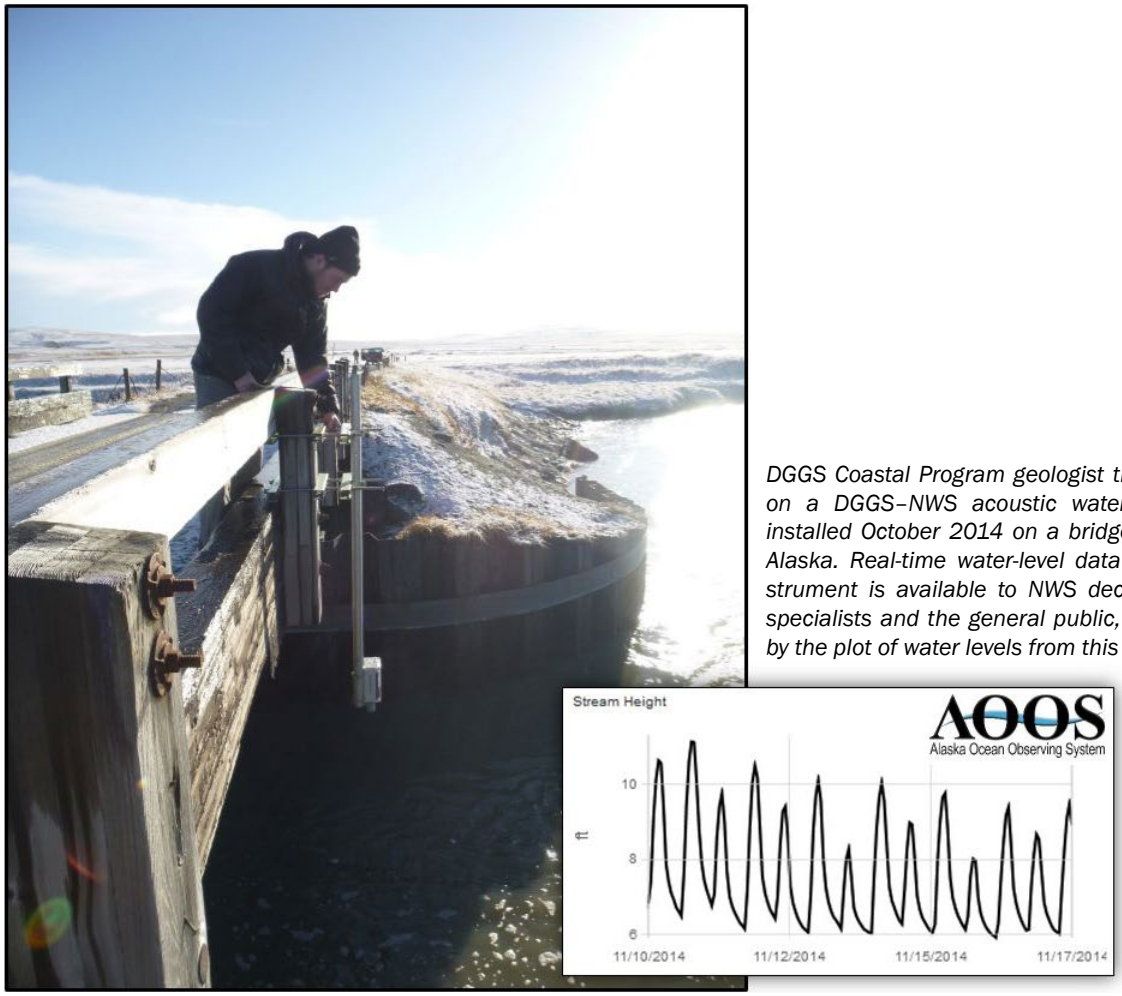
WATER LEVEL DOCUMENTATION AND VERTICAL DATUM RESOURCES

Alaska's coastline is sorely under-instrumented to record water-level variations such as storm surges and long-term sea level trends. There are fewer than 30 continuously active tide gauges in Alaska, with only four located on the western and North Slope coastlines—portions of the state most vulnerable to extreme storm surges and relative sea level rise. Accurate and accessible water-level records that are properly linked to geodetic datums are critical for defining storm surge recurrence intervals, validating modeled water level predictions, and establishing the position of flood zones and land boundaries in the coastal zone.

In partnership with the Alaska Ocean Observing System (AOOS) and the National Weather Service (NWS) Alaska Region, the Alaska Division of Geological & Geophysical Surveys' (DGGS) Coastal Program is seeking effective ways to fill gaps in Alaska's water-level network through a combination of traditional, innovative, and opportunistic water-level stations. In 2014, DGGS worked with staff at NWS to install prototype water-level sensors at two sites in western Alaska (Unalakleet and Tununak; see fig.), and real-time data from these stations is now available via the AOOS website. DGGS also worked on a project on the North Slope funded by the Coastal Marine Institute to vertically calibrate a network of water-level sensors in Barrow, Wainwright, Point Lay, and Point Hope.

To facilitate vertically-sensitive projects such as inundation mapping, DGGS maintains an online Tidal Datum Portal for conversions between geodetic and tidal datums throughout Alaska. This tool assembles the best available data from NOAA (National Oceanic and Atmospheric Administration) sources in one place and provides Alaska-specific recommendations for conducting tidal datum transformations. New content is added to the tool via annual updates each spring. Tidal benchmark re-measurement funded by the Western Alaska Landscape Conservation Cooperative (WALCC) has increased the number of sites in Alaska where tidal benchmarks have published geodetic heights. This work has also supported relative sea level research in collaboration with the University of Alaska Fairbanks.

In 2015 and beyond, the DGGS Coastal Program is looking forward to working with additional partners to create and grow a robust water-level observation network that meets the specialized needs of Alaska stakeholders.



DGGS Coastal Program geologist tightens a bolt on a DGGS–NWS acoustic water-level sensor installed October 2014 on a bridge in Tununak, Alaska. Real-time water-level data from this instrument is available to NWS decision support specialists and the general public, as illustrated by the plot of water levels from this station.

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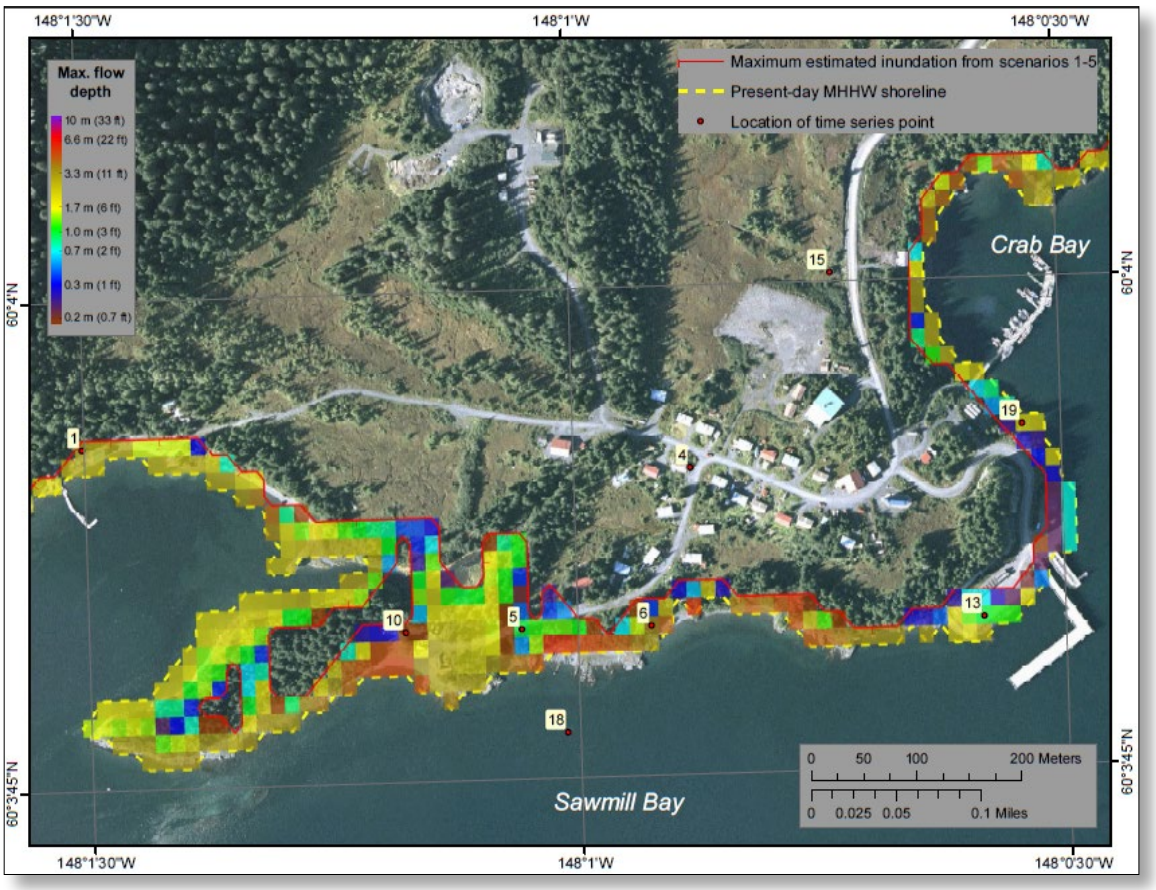
TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

The National Tsunami Hazard Mitigation Program (NTHMP) was created by congressional action in 1995 to address the general lack of tsunami preparedness along the U.S. west coast and Alaska and is intended to reduce the impact of tsunamis through hazard assessment, warning guidance, and mitigation.

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).

The project prioritizes coastal communities for inundation studies based on relative tsunami risk, quality of bathymetric and topographic data, and willingness of community leaders to incorporate results into tsunami preparedness activities. Potential inundation maps 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 onto the local topography (see figure). The background, methodology, and limits of potential inundation for each community are published by DGGS in reports and maps, and Geographic Information System data files are made available to the public for use in local tsunami preparedness programs and public education.



Tsunami inundation map of Chenega Bay, Alaska, showing modeled inundation and potential flow depths from waves generated by hypothetical scenario earthquakes.

Results of our 2013–2014 tsunami inundation modeling efforts were presented at professional meetings of the American Geophysical Union and the Seismological Society of America, as well as at a tsunami detection and modeling workshop held in British Columbia. Outreach meetings and tsunami operations workshops sponsored by DHSEM were led by project team members to inform local community members and emergency responders about the inundation products and facilitate communication, feedback, and education. These meetings were held in Kodiak, Gustavus, and Hoonah.

Final inundation maps and associated reports were published for the communities of Cordova, Tatitlek, Chenega Bay, and northern Sawmill Bay. Maps and reports currently in review include inundation modeling for the communities of Yakutat, Sand Point, Dutch Harbor, and Cold Bay, Alaska. The map and report for Elfin Cove, Gustavus, and Hoonah is in the final stages of production and is expected to be published in early 2015. Previously published tsunami inundation maps and reports and digital geospatial data are archived at DGGS and available for download from the DGGS website.

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HYDROGEOLOGIC STUDIES

The goal of the Alaska Division of Geological & Geophysical Surveys' (DGGS) Hydrogeology Program is to rigorously assess the state's water resources, and to lead research efforts that focus on understanding groundwater-related issues impacting the state. 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 oil and gas exploration on the North Slope is targeting 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 water. In support of ongoing exploration and anticipated future development activities, the Hydrogeology Program is working to understand year-round regional water availability on the North Slope. The focus of this effort is on two distinctly different sources of groundwater: sub-permafrost and inter-permafrost groundwater. Sub-permafrost groundwater is deeper and therefore difficult to reach from the surface, and it has high salinity. Inter-permafrost groundwater is usually of better quality, but because it is closely associated with surface water its extraction is more sensitive for the ecosystem (fig. 1).

Another hydrogeology research effort is the assessment of geothermal resource potential in the state. Pilgrim Hot Springs, a possible source of power for the city of Nome, is one of these resources. Drilling to date has not intercepted the upflow zone of geothermal liquids, and DGGS is helping in the effort to locate the hottest source by numerically simulating geothermal groundwater flow (fig. 2). In the Aleutians, the hot spring system at Akutan volcano has the potential to produce power for the city of Akutan, which includes the largest fish processing plant in the nation.

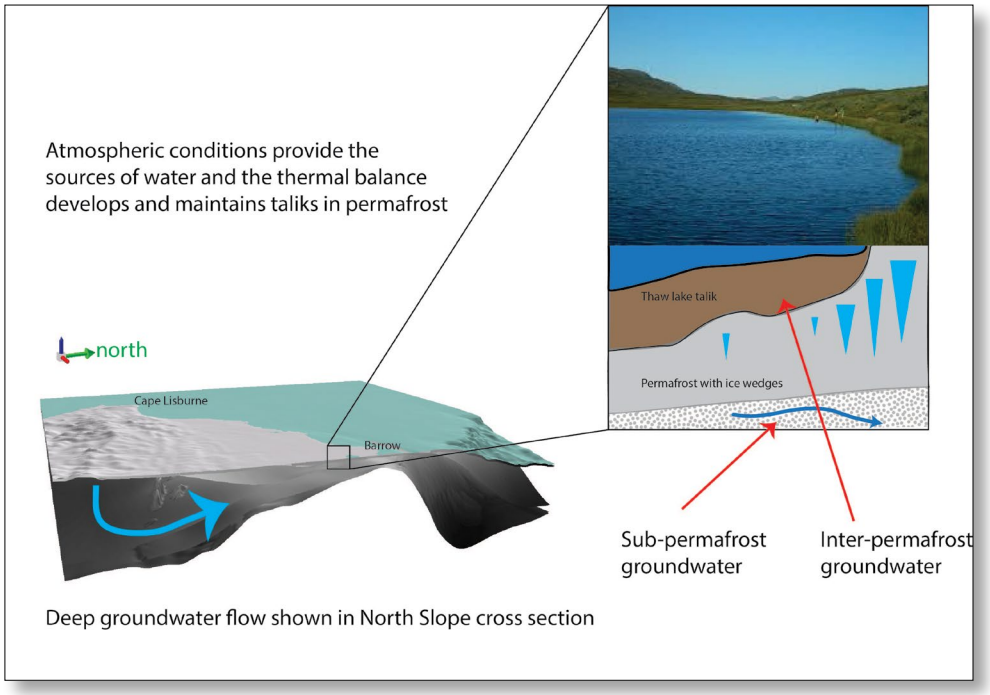

Figure 1. Key water sources of the North Slope and Brooks Range.

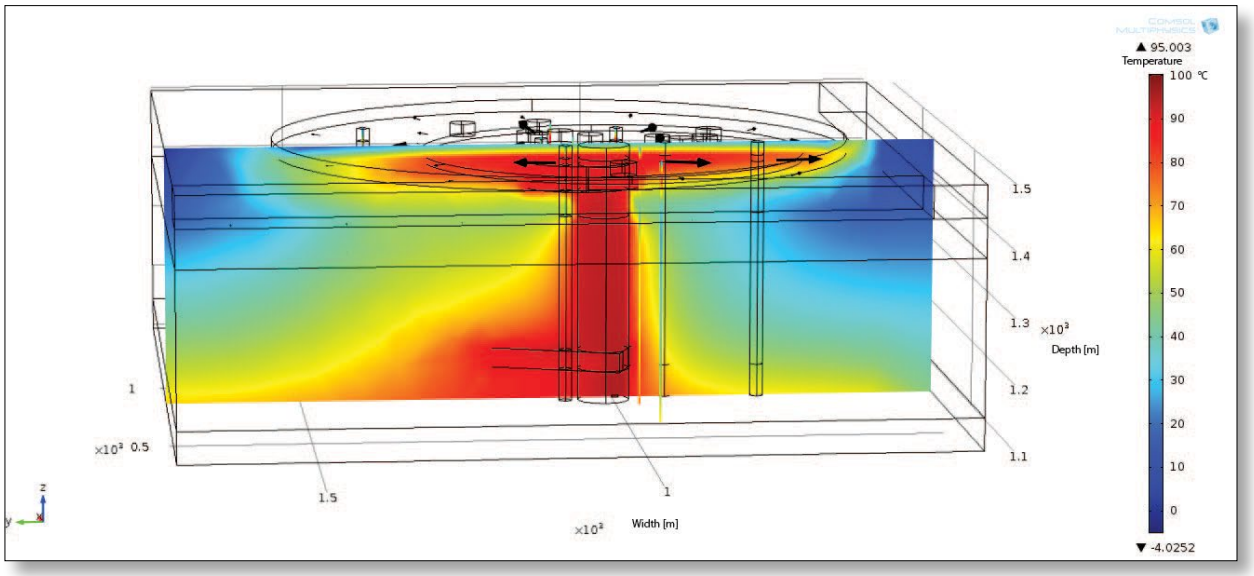

Figure 2. Results of groundwater flow simulation for Pilgrim Hot Springs geothermal anomaly.

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LEGACY SURFICIAL- AND ENGINEERING-GEOLOGIC STATEMAP PROJECTS

The Alaska Division of Geological & Geophysical Surveys (DGGS) Engineering Geology section is working to finalize and publish maps for legacy projects that were supported in part by the U.S. Geological Survey (USGS) STATEMAP program. 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 formally published on a subsequent date.

A 1:63,360-scale map of engineering geology in an 8-mile-wide (13 km) corridor along the Dalton Highway in the northern Brooks Range near Galbraith Lake was published in 2014 (fig. 1). This map was derived from field observations and the completed surficial-geologic map, which was previously published by DGGS as part of the deliverables for the Energy Resources section's 2001 STATEMAP project.

A project to map surficial geology at a scale of 1:63,360 for a 1,212 mi^2 (3,139 km^2) 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 publication (fig. 2). We anticipate releasing the map by early January 2015. 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.

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 mi^2 (2,270 km^2) 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 2015.

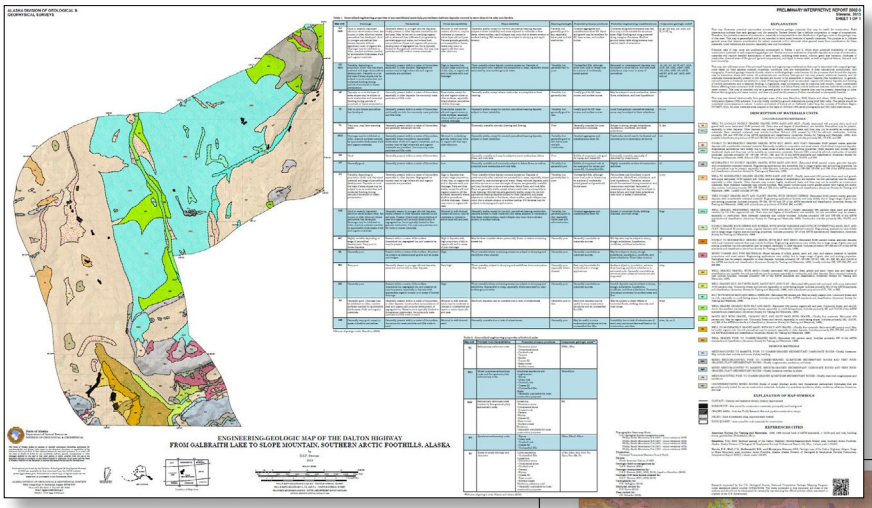

Figure 1. Engineering-geologic map of the Galbraith Lake area, published in 2014.

Surficial-geologic and hazards maps for the coastal communities of Kivalina and Whittier are undergoing co-author review and revision preparatory to external technical review. These maps are products of the Engineering Geology section's 2010 and 2012 STATEMAP projects, respectively, and cover areas of 168 mi^2 (435 km^2) and 100 mi^2 (260 km^2) at scales of 1:63,360 and 1:50,000. We had initially anticipated publication and release of GIS data in late 2014; the current target is late 2015.

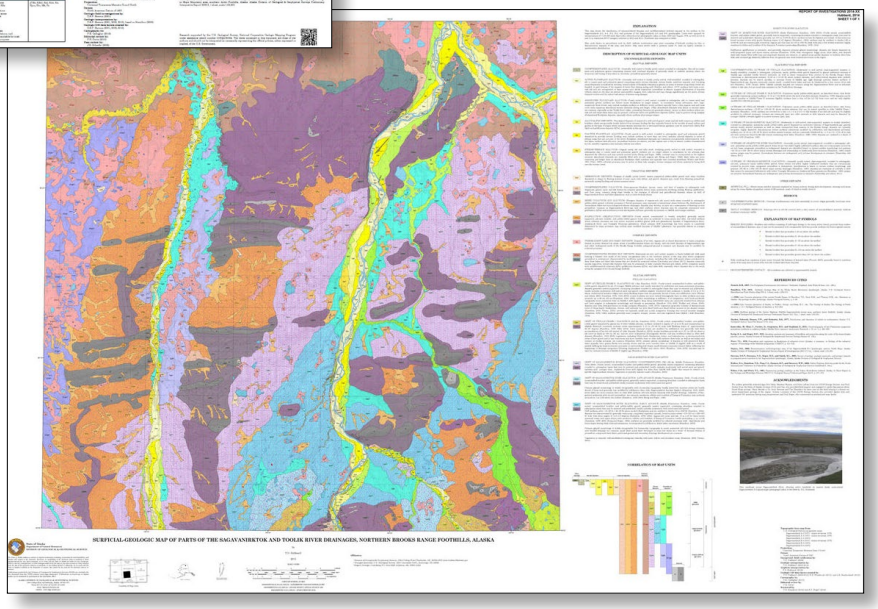

Figure 2. Final pre-publication draft of the DGGS surficial-geologic map of the Sagavanirktok area.

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VOLCANIC ERUPTION RESPONSE: CLEVELAND, SHISHALDIN, AND PAVLOF VOLCANOES

In 2014, volcanic eruptions occurred at Cleveland and Shishaldin volcanoes in the Aleutians, and Pavlof volcano on the Alaska Peninsula. During volcanic eruptions and unrest, DGGS Volcanology Section staff spend a significant amount of time responding to the events. Responsibilities include responding to emails 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.

Eruptions at Cleveland volcano have been ongoing throughout historic time, with only brief cessations in activity. A renewed phase of unrest began in late December 2013, with minor ash plumes detected in satellite data and cloud heights less than ~15,000 feet above sea level. After three months of no detected activity another explosion occurred on June 5, 2014. During the summer of 2014, the Alaska Volcano Observatory (AVO) added seismic, infrasound, and web-camera monitoring equipment on Chuginadak Island (fig. 1). To our knowledge, these are the first-ever geophysical monitoring stations on or near highly-active Cleveland volcano. The work was made possible in part by logistical support from a three-year, multidisciplinary National Science Foundation project on Geological Hazards, Climate Change, and Human/Ecosystems Resilience in the Islands of the Four Mountains, Alaska.

On January 30, 2014, AVO raised the Aviation Color Code at Shishaldin Volcano to yellow after increased surface temperatures were detected in the summit crater. In March, analysis of elevated temperatures detected in satellite imagery indicated that lava was erupting in the summit crater and the color code was increased to orange. An overflight on August 10, 2014, confirmed incandescence in the crater (fig. 2). Due to continued thermal anomalies in satellite imagery and above-background seismic activity, Shishaldin remains at Aviation Color Code orange and we continue to monitor the volcano closely.

The most recent eruption of Pavlof volcano, which began November 12, 2014, intensified on November 15, sending an ash cloud to 25,000 feet above sea level (fig. 3). Lava fountaining and ash clouds could be seen from Cold Bay, and residents reported hearing rumbling during the more intense phases of the eruption. Pavlof, arguably the most active volcano in Alaska, also erupted earlier this year (May 31 through early June), repeating the eruptive style of the 2013 eruption with elevated seismic activity, lava fountaining, and occasional steam, gas, and ash plumes to 22,000 feet above sea level.

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

Figure 1. Steam rises from the summit of Cleveland volcano as viewed on November 19, 2014, from the newly installed web camera on Chuginadak Island, about 15 km (9 mi) east of the volcano's summit.

Figure 2. Incandescence in the summit crater of Shishaldin Volcano on August 10, 2014. Photo by Cyrus Read, USGS.

Figure 3. Satellite image from the NASA/USGS Landsat-8 satellite showing the eruption cloud at Pavlof volcano on November 15, 2014, at 12:46 pm AKST (21:46 UTC). This is just a portion of the eruption cloud, which extended for more than 250 miles to the northwest at the time this image was collected. In this image, the distance from the erupting vent (lower right) to the upper left corner of the image is 45 miles (70 km).

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ALASKA TEPHRA DATABASE

In 2014, DGGS Volcanology Section staff began Phase I of the Alaska Tephra Database development plan. The end result will be the first-ever comprehensive database of Alaska tephra (volcanic ash). This database will house all pertinent information on Alaska tephras 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 (fig. 1). In addition, tephrostratigraphy is an integral part of linking marine, lacustrine, and terrestrial records to aid research in paleoclimate studies and archaeology (fig. 2). Currently, Alaska tephra chemical, stratigraphic, and age data are dispersed in hundreds of publications and unpublished lab results, making efficient querying of data for specific research purposes impossible. Creating and populating a single, comprehensive tephra database and developing web portals for easy access will alleviate this difficulty, and open up Alaska tephra data to geoscientists everywhere.

Phase I accomplishments include: (1) loading of test datasets; (2) ability to query glass geochemical data by sample ID, source volcano, and glass chemistry; and (3) computation of glass chemistry similarity coefficients for multiple tephra samples. Phase II, to begin in 2015, will consist of: (1) sorting tephra datasets in preparation for geochemical and sample metadata upload; (2) developing a streamlined upload process for new data; (3) developing a database schema to store age data; and (4) developing a database schema to hold sample fraction information. Phase III project goals include expanding the database to store sample preparation details and individual grain-point and mineral analyses, and creating a laboratory database interface for post-field sample preparation.

All members of Volcanology Section are involved in this project, 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 1. (left) DGGS geologist Janet Schaefer inspects layers of volcanic ash (tephra) erupted from Makushin volcano, near Dutch Harbor/Unalaska. Photo by USGS geologist Christina Neal, August 9, 2013.
Figure 2. (far left) Photo of 1 meter of lake core extracted from Mother Goose Lake near Chiginagak volcano. More than 50 tephras are preserved in cores like this from Mother Goose Lake, recording more than 3,000 years of volcanic activity at Chiginagak volcano and nearby volcanoes on the Alaska Peninsula. Photo by Chris Kassel, former graduate student at Northern Arizona University.

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GEOLOGIC DATABASE OF INFORMATION ON VOLCANOES OF ALASKA (GEODIVA)

DGGS Volcanology Section 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 Quaternary (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.

GeoDIVA has been developed in modules, and currently uses more than 300 MySQL tables. 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; descriptive text update in progress
Eruption history information	Maintenance mode	Information and references for 627 historical eruptions and non-eruptive events
Images	Updated in 2014	More than 22,000 images
Geologic sample information	Maintenance mode	11,797 samples and metadata
Geochemistry	Maintenance mode	Published in 2014
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	Update planned for 2014-2015	More than 8,200 archived samples have been moved to improved storage; see separate briefing paper
Ash—Is it falling?	Maintenance mode	Website and database for citizen ashfall reporting
Internal logs and contacts	Updated in 2014	Supports internal AVO communications
Vent Inventory	Merging separate database with GeoDIVA	Published in 2014; nearly 1,200 known Quaternary volcanic vents in Alaska
Satellite observations	Planning and test construction	Scheduled for 2015
Tephra data	Planning and test construction	See separate briefing paper
Geochronology	Schema built	Lesser priority than satellite obs and tephra

Our recently-published geochemical database module is available at https://www.avo.alaska.edu/geochem/ and contains more than 5,200 published whole-rock analyses on Quaternary volcanic rocks in Alaska. This database is searchable by map location, volcano, eruption, citation, sample metadata information, or specific geochemical values and analysis types. Users can query the database and retrieve fully-documented .html or .csv tables. This database is a valuable research tool for geoscientists with interests ranging from volcano-specific processes to whole-arc data synthesis.

As part of our in-progress tephra database (see separate briefing paper), we are expanding the sample metadata and analysis abilities of this whole-rock geochemical database to hold electron microprobe analyses of glass grains.

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ALASKA VOLCANO OBSERVATORY (AVO) HAZARD COMMUNICATIONS

One of AVO's primary responsibilities is to provide timely and accurate information on volcanic hazards, and warnings of impending dangerous volcanic activity to local, state, and federal officials and the public. AVO issues event-driven messages that require immediate action (such as warnings of immediate or ongoing eruptions), as well as less time-sensitive scientific publications and information about non-eruptive volcanic phenomena. In all cases, AVO wants information delivered to all interested persons in their most useful format. Code development and programming maintenance for all AVO web-driven communication pathways is a primary responsibility of DGGS Volcanology Section staff.

Time-sensitive, immediate-action messages are crafted in our Hazard Notification System (HANS, developed and maintained by DGGS–AVO staff) and then distributed via HANS to our website (www.avo.alaska.edu); our Volcano Notification Service (VNS, developed and maintained by DGGS–AVO staff) email list; a fax list; our Twitter feed (@alaska_avo); and our Facebook page (http://facebook.com/alaska.avo). During a significant volcanic event or Aviation Color Code change, AVO also makes phone calls to other agencies, in accordance with the Alaska Interagency Operating Plan for Volcanic Ash Episodes. Depending on the volcano and eruption, AVO staff in Anchorage typically call the Federal Aviation Administration (FAA), National Weather Service (NWS), Center Weather Service Unit (CWSU), Joint Base Elmendorf/Richardson, U.S. Air Force Weather Agency (AFWA), Canadian Meteorological Centre, the U.S. Coast Guard, and the Alaska Division of Environmental Conservation. AVO staff in Fairbanks call the Alaska Division of Homeland Security and Emergency Management, the Governor's Office, Eielson Air Force Base, and Fort Wainwright.

AVO also has message products that are less time-sensitive, such as formal scientific publications, updates on current investigations, eruption anniversary science nuggets, selected scenic or informative images, and talks and presentations given to the public. These items are highlighted on our website in our "News" area on the home page, and often posted to Facebook.

Communicating science results and hazard information is a critical responsibility of everyone at AVO. We strive to share timely, accurate, helpful, and consistent information that reaches our many audiences and reflects well on the AVO organization and mission. As an AVO partner, the DGGS Volcanology Section is responsible for delivering AVO's messages via the website, the VNS, Facebook, and Twitter.

Most of our audience is reached via the website, which sees about 80,000 unique visitors per month, even during times of no eruption. About 8,000 people have signed up for color code change emails via VNS, and about 13,300 receive our updates on Twitter. The Facebook page has a modest 2,500 likes, but some images and updates on Facebook reach more than 100,000 people within hours. Facebook also provides a unique form of two-way communication between citizen observers of eruptions and AVO, especially for eruption photos and information about eruption impacts. AVO's foray into social media is relatively new, and DGGS–AVO staff recently crafted a communications policy document to help guide our agency's interactions on social media, as we want to continue to present the highest-quality and most helpful information via all of our media channels.

Pavlof Volcano in eruption on June 2, 2014. Photo courtesy of William Yi, U.S. Coast Guard, submitted to AVO via Facebook.

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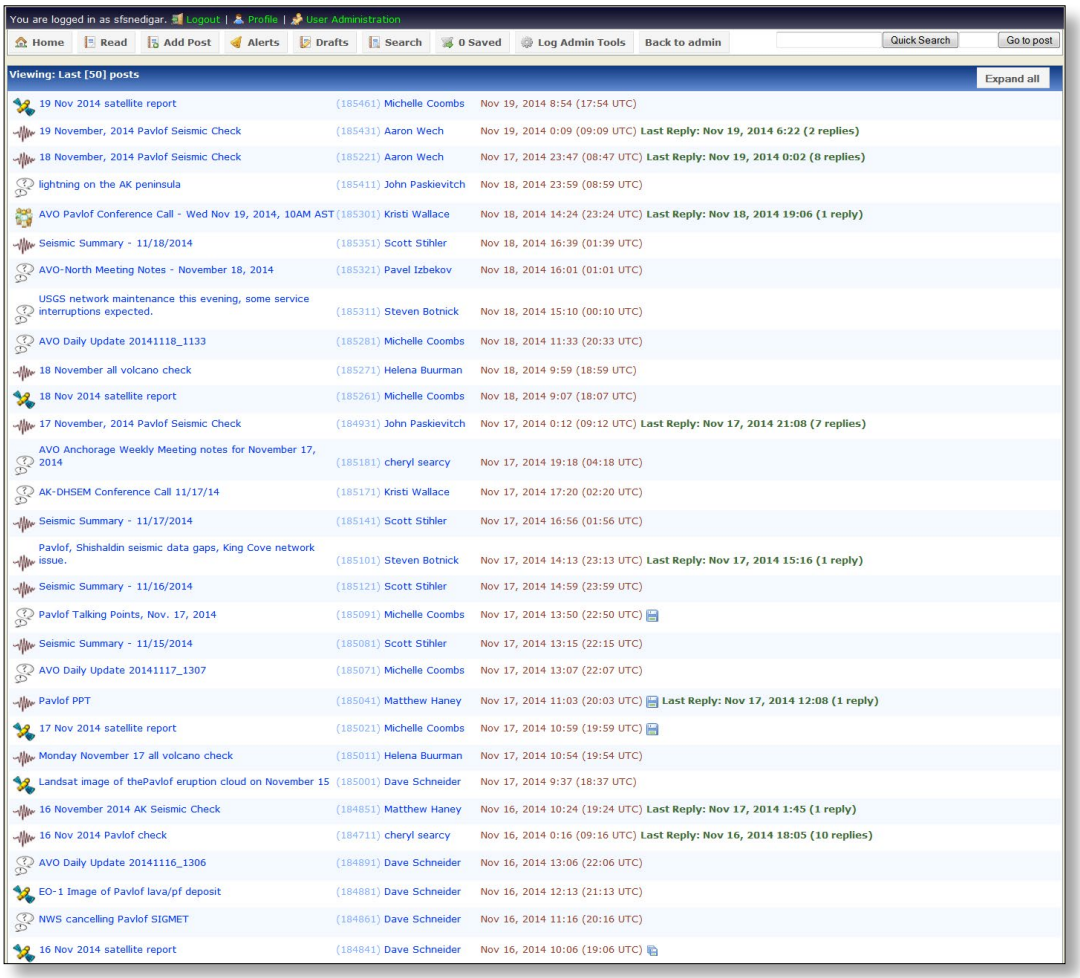
ALASKA VOLCANO OBSERVATORY (AVO) INTERNAL COMMUNICATIONS

The AVO internal website is home to several tools used by AVO scientists to monitor volcanoes as well as share information among Observatory staff. One of the most frequently accessed tools is the communication and observation logging system. All of the daily workings of the Observatory are stored in these searchable logs: daily seismic checks, satellite reports, infrasound observations, GPS observations, formal information products, geologic interpretations, and fieldwork flight following. The logs are accessible by all AVO staff and allow for discussion strings that can include photographs, interpretative graphs, and data files. Code development and programming maintenance for these web-driven communication tools is a primary responsibility of DGGS Volcanology Section staff.

Applications on the internal site are continually refined with software updates and user-requested features and capabilities. Newly added log system features include allowing uploaded images to be displayed in-line with text and emails, auto-recognition of keywords and volcanoes, easy uploading of files and images by url or from the user's computer, and the ability to email a log post to selected addresses.

The user management system that drives access to the logs and other internal applications received a much-needed upgrade this year. Previously, a basic username and password allowed users to access any part of the internal website—much of the website could be viewed without a username at all. Now the site requires individual logins and each user can be assigned specific permissions. For example, individual user accounts can be given permission to only read the logs, or post to the logs, or be restricted to various other sections of the internal site. Accounts can be given an expiration date—useful for managing the access of interns and graduate students.

DGGS Volcanology Section staff are currently upgrading the mobile logs software. This upgrade aims to reproduce most of the functionality of the desktop version of the logs while being easily useable on any mobile device.



During times of heightened volcanic unrest and activity, such as the November 2014 eruption of Pavlof Volcano, the logs are heavily used. This is the main reading page of the logs, showing three days of posts.

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ALASKA VOLCANO OBSERVATORY (AVO) ROCK SAMPLE ARCHIVE

AVO collects rock, tephra, soil, water, and other material samples in support of our scientific objectives to monitor and study Alaska's volcanoes. These materials are currently stored in separate facilities in Anchorage and Fairbanks. AVO's Anchorage-based samples will be moved to the new DGGS Geologic Materials Center facility in 2015, and we plan to also move AVO's Fairbanks-based collection there sometime in future years. DGGS Volcanology Section staff manage and archive the samples stored in Fairbanks.

Figure 1: Hand sample specimen of the post-April 4, 2009, Redoubt lava dome, collected by Kate Bull, DGGS-AVO.

Several years ago, DGGS–AVO inventoried and cataloged all of the hand samples, analysis powders, thin sections, and thin section offcuts held in AVO Fairbanks' "cold storage" building—about 8,200 samples in all. Physical sample locations are tied to sample metadata in our geologic database wherever possible. For some samples, we now can see all of the sample's descriptive information, references, hand sample storage location, analysis results, and images (e.g., photomicrographs, hand sample photos) on one page. DGGS Volcanology Section staff also conduct quality assurance/quality control of AVO whole-rock samples sent to Washington State University GeoAnalytical lab for XRF and ICPMS analysis. We ensure sample and station information are in the database, verify which samples are sent, check the analysis results for accuracy, enter the geochemistry in the database, and distribute the information to AVO geoscientists.

During summer 2014, the University of Alaska Fairbanks Geophysical Institute offered AVO the opportunity to move these samples from an unheated and dimly lit building in the back parking lot of the Geophysical Institute to the repurposed University Park school building—featuring light, heat, plumbing, and cellphone access. Samples were physically moved during fall 2014, but we no longer have a current inventory of which shelves contain which boxes.

Figure 2: AVO/University of Alaska Fairbanks geologist Jess Larsen and graduate student Mariah Tilman carry Augustine samples back to the helicopter for analysis and archiving in Fairbanks. Photo by Michelle Coombs, AVO–USGS.

Beginning in December, 2014, we will reorganize these boxes and shelving, as well as catalog newly arrived samples. We will also populate spreadsheets of sample metadata for the eventual move of these samples to the GMC facility in Anchorage.

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ALASKA VOLCANO OBSERVATORY (AVO) WEBSITE

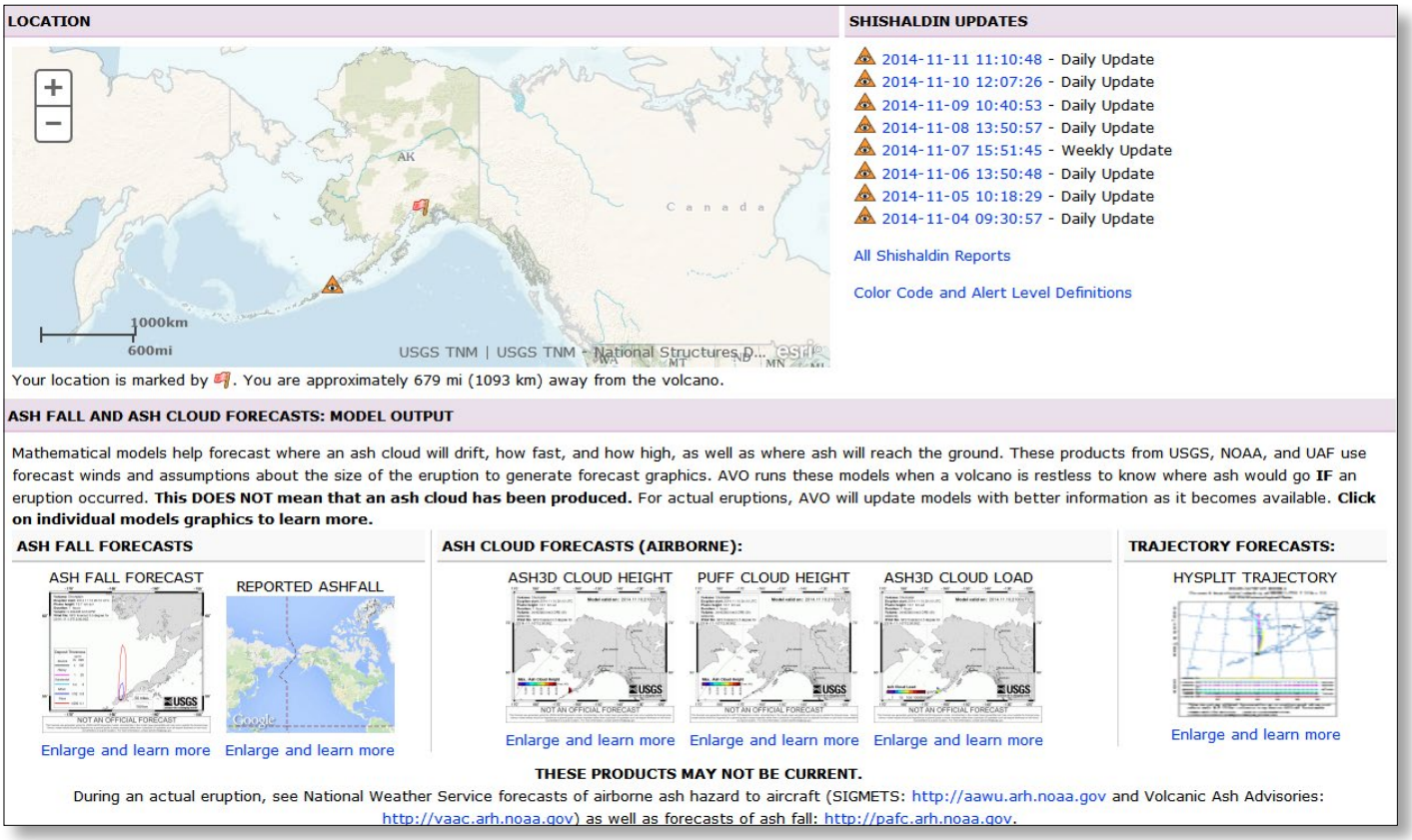
The AVO public website (http://www.avo.alaska.edu) serves about 2,800,000 pages to more than 80,000 unique visitors per month, and is among the top ten most-visited USGS and USGS-affiliated websites in the country. It continues to be the most complete single resource on Quaternary volcanism in Alaska. The Alaska Division of Geological & Geophysical Surveys (DGGS) was the original creator of the AVO website in 1994, and the Volcanology Section continues to design, build, and manage the site. The website is dynamically driven by the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA).

This year saw the first graphical change to the website in several years. While the layout of items on the pages remained relatively stable, the colors and section borders have become less bold, making the pages appear more open and uncluttered.

Pages showing current activity at an individual volcano have received some important updates, including improved ashfall information and the ability for users to determine how far away they are from an active volcano. Images displaying modeled ash cloud and ashfall information are generated twice a day by the USGS Ash3d tephra modeling system. These images are then copied to the AVO webserver for public use. Also, users can now click a button that (with permission) retrieves their approximate location, plots that location on a map, and returns a distance measurement to the volcano of interest.

In addition to housing thousands of Alaska volcano references contained in the online library (https://www.avo.alaska.edu/downloads/index.php), the website is also home to AVO's recently published geochemical database (https://www.avo.alaska.edu/geochem/index.php) and serves as the primary portal to access that information. All searches and data displays or downloads reside within this portal on the AVO website.

DGGS–AVO is on the leading edge of web and database development for volcano observatories nationwide, and portions of DGGS-written database software have been installed at other U.S. volcano observatories. DGGS is monitoring new and emerging technologies that will allow us to further improve AVO's web presence and data dissemination methods. We continually refine and enhance the applications that AVO and other observatories use regularly. We will maintain our focus on continued improvements to the site, and serving new database modules as they become available (see briefing paper on the Geologic Database of Information on Volcanoes of Alaska for additional information on the database modules).



Shishaldin volcano's activity page, showing Ash3d model images and a map displaying the user's approximate location and distance from the volcano.

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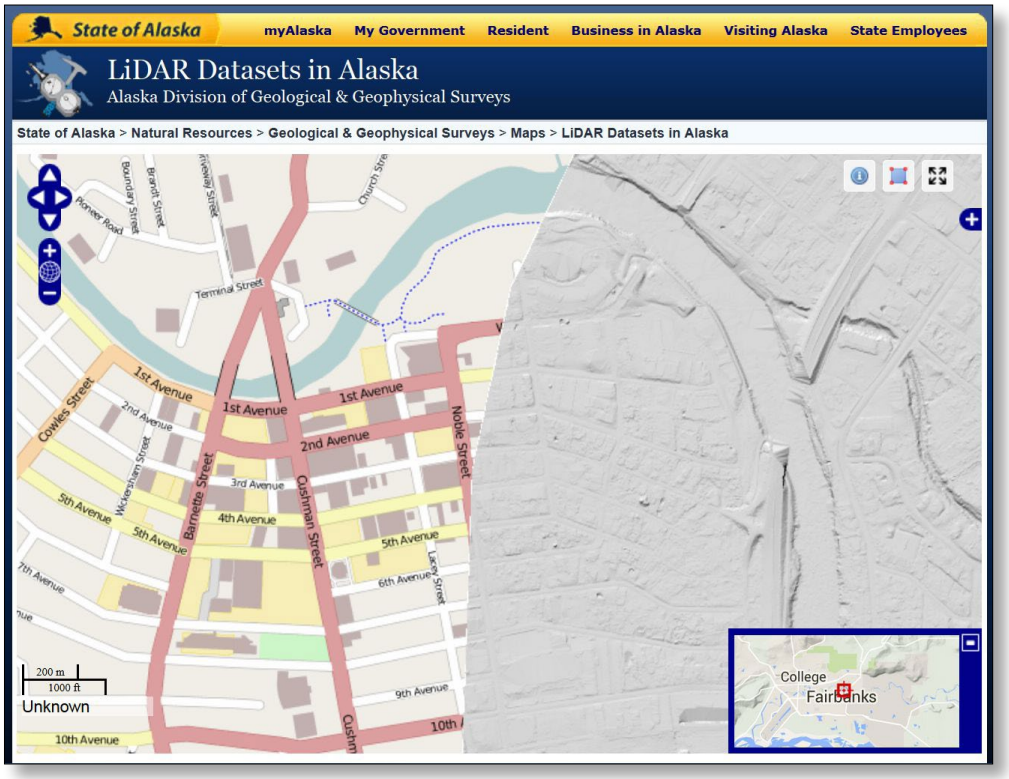
INTERACTIVE MAPS: HIGHLIGHTING LIDAR, AIRBORNE GEOPHYSICS, AND GEOLOGIC MAPS

The Alaska Division of Geological & Geophysical Surveys (DGGS) is committed to providing easy access to geology-related datasets. Technological advances and in-house expertise have allowed us to significantly advance online data delivery of important geologic information through easy-to-use, web-based, searchable interfaces. Most importantly, these online applications include spatial functionality so that users can select their area of interest and search for or download only the data they want. Maintenance of the applications is supported by State of Alaska General Funds. All of the Division's web mapping applications are available at http://maps.dggs.alaska.gov/; below, we highlight several applications of interest.

LiDAR Datasets of Alaska is the only single-source map interface to lidar point-cloud data in Alaska (http://dx.doi.org/10.14509/lidar) (see figure). Currently, the online application provides free access to more than 8,395 square miles of public-domain point-cloud data, covering Eklutna Glacier, Golovin, Unalakleet, Whittier, and proposed and existing pipeline corridors. The interface displays lidar hillshades, which are grayscale images portraying the relief of the landscape. Once an area of interest has been selected, the raw point-cloud downloads are compressed for delivery to the user. Users may uncompress the files using the open-source "LASzip" tool and add them to their own Geographic Information System software. Additional publicly available datasets from a variety of agencies, including the National Oceanic and Atmospheric Administration and the Alaska Department of Transportation and Public Facilities, will be available from this interface in the future.



DGGS interactive map, LiDAR Datasets of Alaska. Users can select from multiple options for base map and overlays.

Airborne GeophysWeb facilitates public access to published Alaska airborne geophysical data from DGGS, the U.S. Geological Survey (USGS), and the Bureau of Land Management since 1993 (http://dx.doi.org/10.14509/gp). The application displays a representative image for each survey area and type of survey so users can get an idea of what the processed dataset looks like before they download the geophysical data for free from DGGS's online publications database. The DGGS Airborne Geophysical/Geological Mineral Inventory program provided the original funding for this application.

Geologic Map Index of Alaska provides the locations and outlines of most DGGS and USGS geological and geophysical maps of Alaska in the only existing online geographic index for the state (http://dx.doi.org/10.14509/mapindex). Search results link to DGGS's comprehensive, multi-agency publications database, where users may view and download publications for free. Users can save search results by highlighting individual publication or map selections and exporting them to an Adobe PDF document. Reports without maps can be accessed through DGGS's comprehensive publications database, www.dggs.alaska.gov/pubs/advanced-search.

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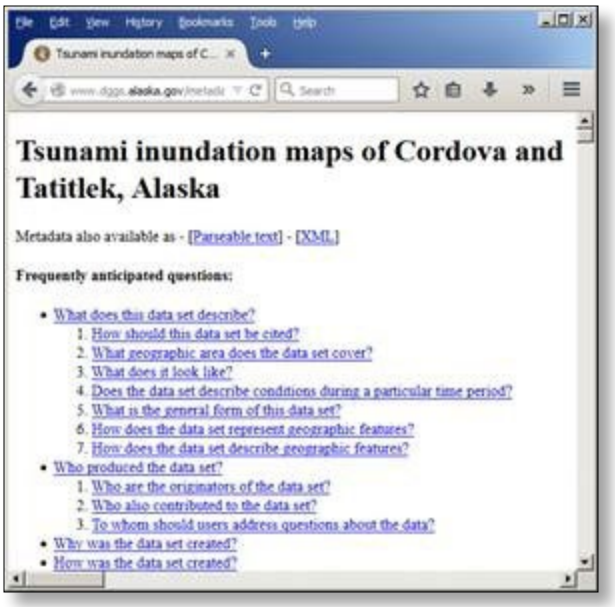
DIGITAL DATA DISTRIBUTION

Geospatial datasets published by the Alaska Division of Geological & Geophysical Surveys (DGGS) are designed to be compatible with a broad variety of digital mapping software, to present DGGS's geospatial data in multiple ways, and to provide the State with a comprehensive repository of geoscientific data that the Division collects and distributes. While we continue to provide conventional maps and reports (available in both paper and PDF formats), we are rapidly expanding our publication products to include spreadsheets of analytical data, map data in shapefile and geodatabase format, geospatially-referenced image collections, web map services, and online map- and text-based search interfaces.

Although the Division provides a variety of GIS (Geographic Information System) products, the bulk of our collection consists of spreadsheets, shapefiles, and georeferenced raster files. These files are typically paired with an accompanying report or printable map that provides scientific observations, interpretations, and data acquisition parameters. Additional information about the data acquisition parameters as well as a succinct description of the positional accuracy, precision, scale, resolution, completeness, and scope is also provided to users in a metadata file.

DGGS metadata files conform to the FDGC–CSDGM (Federal Geographic Data Committee–Content Standard for Digital Geospatial Metadata) standard. This national metadata standard was developed to ensure that geospatial data distributors provide sufficient documentation to allow users to make informed decisions about appropriate use of geospatial data. Due to the importance of providing substantive supporting documentation, DGGS scientists work collaboratively with database managers and GIS staff to ensure that our agency consistently and efficiently generates comprehensive geospatial data files and metadata.

Our methods for generating geospatial data and metadata records have evolved to accommodate the Division's growing geospatial data collection. Ten years ago we typically published fewer than five geospatial datasets per year. Between 2008 and 2010 the average number of new geospatial data releases doubled to ten per year. Beginning in 2011, the annual average number of DGGS geospatial data releases more than doubled again (to about 22 per year). This exponential growth rate is fueled by both an ever-increasing customer preference for geospatial data and by workflow modifications that reduce redundant tasks.



Sustaining the growth of our geospatial data collection is an ongoing challenge. Practices that worked well when our products were mostly print files resulted in unsustainable duplication of tasks as our emphasis shifted from paper to data. Development and implementation of division-wide data standards have been key to accommodating the growth of our geospatial data inventory. A commitment to providing standardized data has enabled us to develop an efficient and rigorous process for validating data and generating metadata. These improvements provide a solid organizational foundation from which we can cost-effectively manage our repository of legacy geospatial data while supporting ongoing development and publication of new science.

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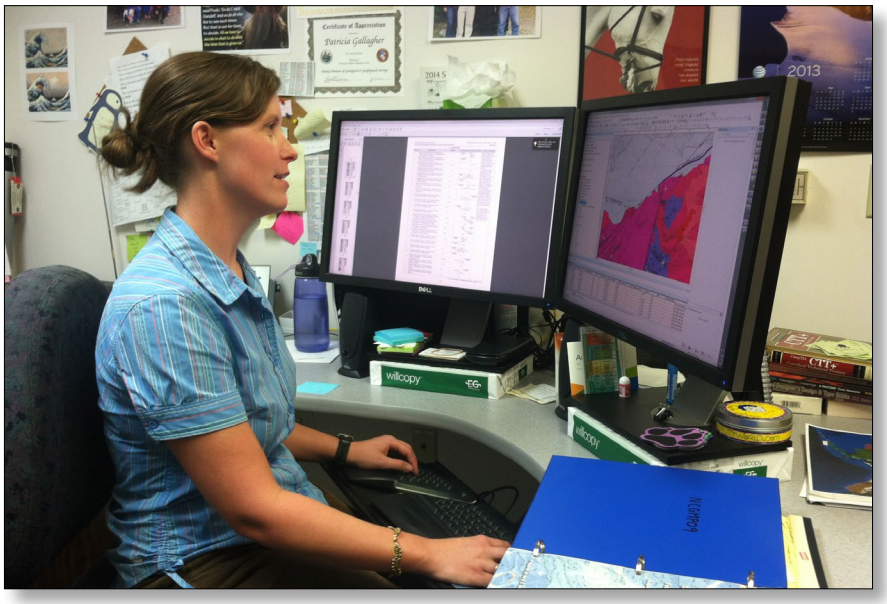
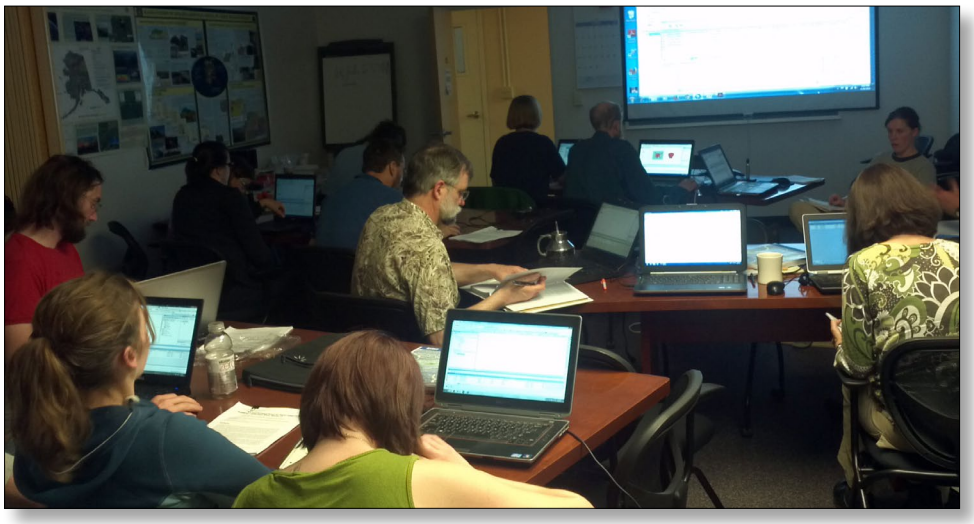
GEOGRAPHIC INFORMATION SYSTEM (GIS) NETWORK

To effectively understand and manage Alaska's vast geologic resources requires powerful support systems designed to gather, store, analyze, and communicate complex geospatial data. Geographic Information Systems (GIS) are specifically designed to meet this requirement. The Alaska Division of Geological & Geophysical Surveys' (DGGS) scientists and geospatial analysts employ GIS daily to visualize, explore, and analyze complex geologic information and relationships. In addition, GIS is critical for the efficient storage and distribution of the Division's valuable geologic analyses, which are critical to many public and private entities as they work to develop Alaska's natural resources.



Standard design for DGGS digital data: DGGS continues implementation of a Division-wide standardized geodatabase model based on the U.S. Geological Survey's (USGS) National Cooperative Geologic Mapping Program (NCGMP) format (http://ncgmp.usgs.gov/). This national model standardizes data content, attributes, naming conventions, and other pertinent information required for archiving and disseminating geologic map data. The standardized data design is instrumental in streamlining cartographic production and metadata creation. DGGS is one of the leading states to adopt and implement the NCGMP standard, and is currently developing procedures and best practices for the first release of a large, fully NCGMP-compliant geodatabase directly to the public.

GIS training and education: In FY2014, the Division continued its commitment to GIS education for geologic staff. A series of custom GIS training workshops were designed based on the skills and knowledge needed to create digital geologic data. The training material covered the NCGMP data standard, national digital cartographic standards, suggested workflows and best practices, and provided basic to advanced GIS tips. With improved GIS skills and knowledge, DGGS scientists can better visualize, analyze, interpret, and manipulate geologic data.



Interagency GIS support: The GIS team at DGGS continues to provide GIS and cartographic support to other state agencies. In FY2014, DGGS converted the Mesozoic Subcrop Map of Cook Inlet Basin for the Division of Oil and Gas (DOG) to the NCGMP data standard and is in the final stages of producing the cartographic product. We also compiled USGS geologic data and created a series of Naturally Occurring Asbestos maps for the Alaska Department of Transportation and Public Facilities (DOT&PF). Providing GIS and cartographic support to other state agencies facilitates cooperation and communication between agencies and allows scientists to focus on data collection and interpretation rather than cartography.

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BEDROCK POTENTIAL FOR NATURALLY OCCURING ASBESTOS IN ALASKA

Asbestos has come under close scrutiny in recent decades due to its link to lung diseases such as asbestosis, lung cancer, and malignant mesothelioma. Health hazard concerns have concentrated on man-made hazards such as mining, manufacturing, and products in which asbestos was used or disturbed. More recently, studies have looked at environmental exposure to asbestos occurring in natural rock outcrops and derived gravel and soils, but it is not yet clear how low-level environmental exposure affects health.

The Alaska Department of Transportation & Public Facilities (DOT&PF) has been impacted by the occurrence of naturally occurring asbestos (NOA) during the course of several projects. In 2000, the Department established a NOA task group, which has gathered information and posted it on the DOT&PF website, http://www.dot.alaska.gov/stwddes/desmaterials/noa.shtml. DOT&PF contracted the Alaska Division of Geological & Geophysical Surveys (DGGS) in 2014 to evaluate the bedrock geology of the state for naturally occurring asbestos potential.

For this project, DGGS uses the term 'asbestos' in the geologic sense, in which asbestos is the subset of a group of minerals that sometimes has an asbestiform (fibrous) shape that is strong, can bend under force, and will split lengthwise into thinner fibers. Based on known geologic settings where naturally occurring asbestos is most likely to be found, DGGS and a consulting geologist formulated a set of criteria to rate NOA potential according to rock type. Using existing geologic map compilations of the state, the consultant then assigned a rating of NOA potential to each bedrock map unit. Reported asbestos localities in Alaska were compiled from Alaska Resource Data File (ARDF) and Mineral Resource Data System (MRDS) data, although this list is by no means exhaustive. There are undoubtedly numerous additional occurrences of asbestos in Alaska that are not listed in ARDF and MRDS data tables.

This statewide study includes a report, data tables, and a series of maps of NOA potential in bedrock, and is anticipated to be published by DGGS in 2015. The products will be available digitally or printed on demand. Evaluation of surficial-geologic units for NOA potential has not been addressed in this product.

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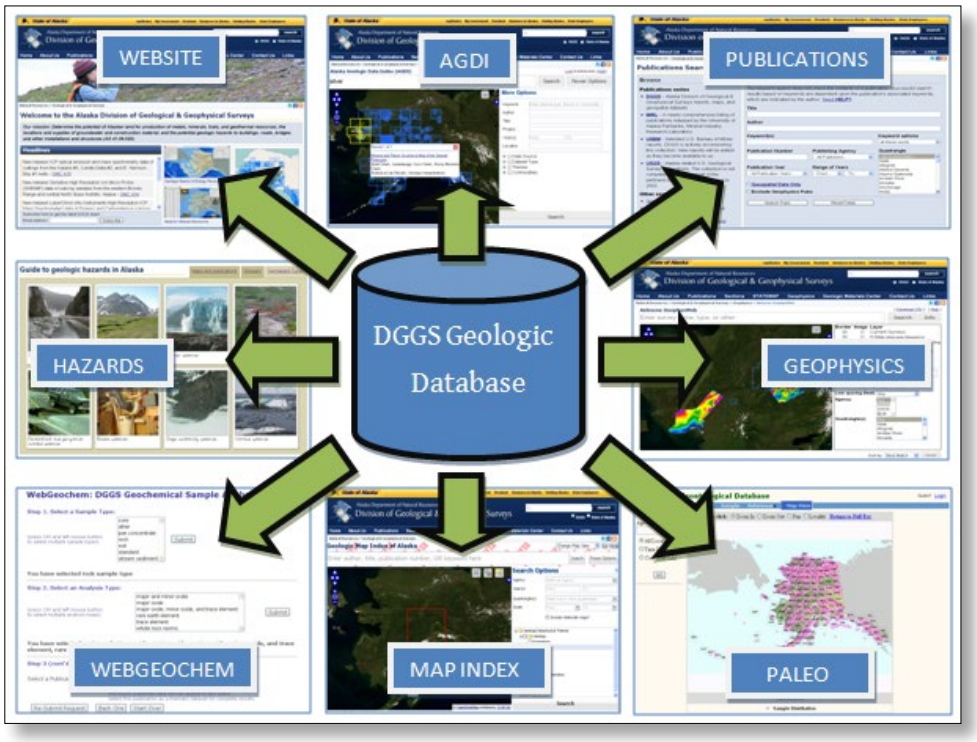
WEBSITE DEVELOPMENT AND DIGITAL GEOLOGIC DATABASE

Over the past decade, the Alaska 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 state agency for Alaska geology-related databases 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 Geographic Information System datasets produced by DGGS and other geoscience agencies, including the U.S. Geological Survey, University of Alaska Fairbanks Mineral Industry Research Lab, and U.S. Bureau of Mines. The volume of files and information available through the DGGS website has grown exponentially. The catalog recently expanded to include bibliographic references for all Alaska-related geology and geophysics Master's theses and Ph.D. dissertations. It also provides web users easy access to geophysical data, geochemical data, information about the DGGS Geologic Materials Center, the Alaska Geologic Data Index, descriptions of the Division's projects and special studies, Alaska's mineral industry reports, and other topics of interest.

The Division's database system dynamically generates the majority of the website content and serves as the backbone of many of its web applications. Development of this geologic database was initiated as part of the federally funded Minerals Data and Information Rescue in Alaska 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 development team has established a secure and stable enterprise database structure, loaded data into the database, and created multiple web user interfaces. During 2014, the team's achievements included joining the DOI (digital object identifier) system that creates permanent links to online documents, a system widely used by the academic and scientific communities. This step created DOIs for all DGGS publications, linking to each citation web page and improving the discoverability of DGGS maps and reports and the permanence of their location on the internet. The team also secured funding from the National Geological and Geophysical Data Preservation Program to develop an interface for indexing and annotating staff field photos and begin the inventory process for our extensive field photo collection. The team continued support and maintenance of various projects and applications: Geologic Map Index of Alaska, Airborne GeophysWeb, Alaska Geologic Data Index, LiDAR Datasets of Alaska, Geologic Materials Center Inventory, Alaska Paleontology Database, and other web mapping applications in our Digital Data Series. Also, the backlog of geochemistry data from 2009 through 2014 has been loaded into Webgeochem, the DGGS geochemical data application.

In the coming year, the team's major projects include the development of an interactive Geothermal Map of Alaska and a complete redesign of Webgeochem. DGGS will also 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.

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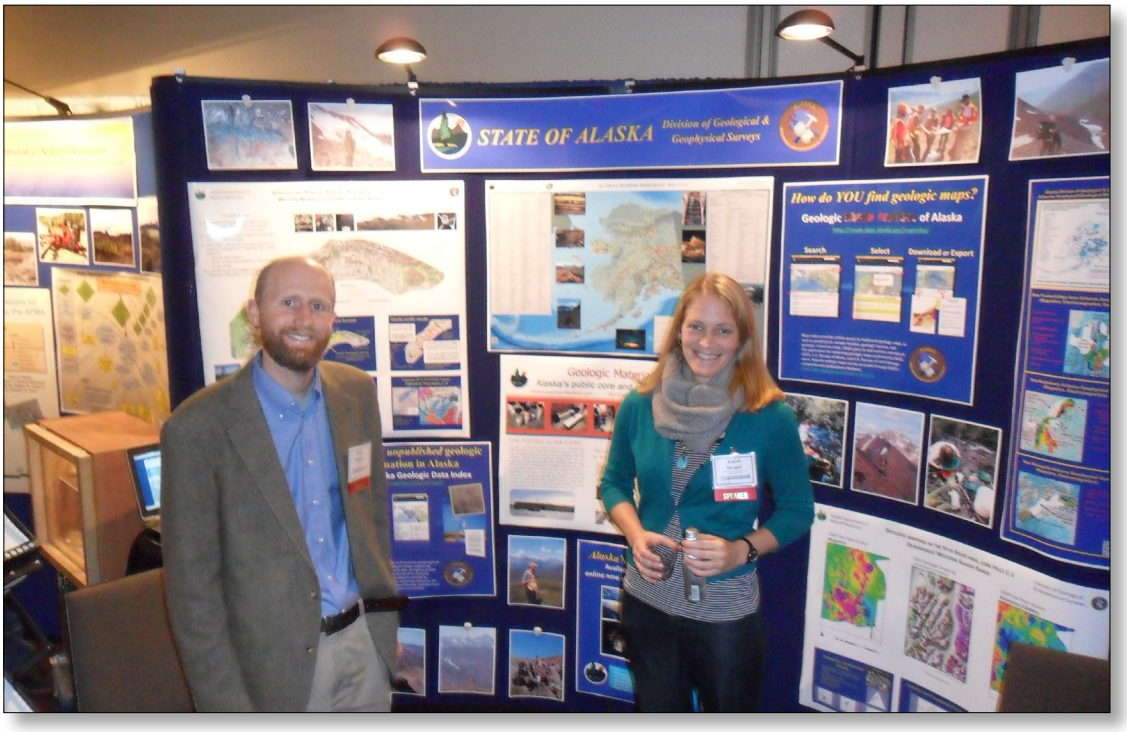
PUBLICATIONS AND OUTREACH

The Alaska Division of Geological & Geophysical Surveys (DGGS) publishes and distributes, in many different formats, geologic data that has been collected, analyzed, and assembled by DGGS geologists. Below are some of the functions associated with publications and outreach:

- 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 goals and challenges.
- Prepare displays; 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 scientists 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 features. Some of DGGS's recent publications include: • Airborne GeophysWeb, an online map compilation of geophysical data, • Geologic Map Index of Alaska, an online geospatially-searchable database of geologic maps of Alaska, • Yukon River bridge landslide evaluation, • Passage Canal–Portage Valley area assessment of geologic hazards, • Lidar data for Whittier, Passage Canal, and Portage Lake areas, and • Tsunami hazard reports for Valdez and Sitka.

Publications are available in paper format (plotted as needed and sold for cost of printing) and as digital PDF documents and scanned, compressed maps on the DGGS website (available for free download). More than 180 digital geospatial datasets are now available on the DGGS website; that number continues to grow. 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 informed management and exploration of Alaska's natural resources, and provides critical scientific information to help mitigate risks from the state's geologic hazards.

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GEOLOGIC MATERIALS CENTER (GMC)

The Alaska Geologic Materials Center (GMC) in Eagle River holds nonproprietary rock core and cuttings that represent nearly 14 million feet of exploration and production drilling (77,500 linear feet of core) on Federal, State, and private lands in Alaska, including the Alaska outer continental shelf. Additionally, the collection holds more than 280,000 linear feet of diamond-drilled hard-rock mineral core, representing more than 1,800 exploratory boreholes; rock samples from more than 1,700 oil and gas exploratory or production wells; samples from 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 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, 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. Chief users of the GMC are the oil and gas industry, with substantial visits by the minerals industry, government agencies, engineering firms, academic institutions, and the general public.

It has been more than a year since the Alaska Department of Administration officially acquired the Debarr Sam's Club warehouse to house the new GMC. The well-attended ribbon-cutting ceremony on October 29, 2014, at the new facility in Anchorage included a keynote address by Governor Parnell and marked the successful completion of renovation upgrades to the new Alaska GMC (fig. 1). Although the Center's geologic sample collection will not be transferred to the new site until spring 2015, a great deal of progress was made at the Eagle River site in preparing for the relocation.

Figure 1. Former Governor Sean Parnell has some help cutting the ribbon at the new Alaska GMC.

GMC staff successfully completed all necessary preparations prior to the originally planned August 4, 2014, relocation date, which included (1) curating damaged samples and reboxing thousands of others, (2) entering tens of thousands of new items into the inventory database, (3) performing a shelf-by-shelf inventory audit for more than 100,000 sample boxes, (4) packing all office supplies, lab equipment, maps, reports, and tools, and (5) establishing logistical plans and relocation protocols with the moving contractor.

In preparation for the move, GMC staff members have been working to improve the quality of the sample inventory. The year 2014 saw the successful completion of a major, year-long project with DGGS programmers and IT staff to completely redesign and repopulate the GMC inventory database and sample-tracking system. The new database system will (1) give clients the ability to view and query the inventory in near real-time via a web-map interface and save their results in a variety of useful formats, (2) enable real-time inventory tracking, redundancy, and backup capabilities, and (3) provide 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 facility. Additional computer code has been written to quickly import new sample data from the AOGCC, and inventory templates are being refined to better assist those who wish to donate samples to the GMC.

The successful completion of renovation upgrades to the new facility has opened the door for many potential new donations from the oil & gas and mining industries, federal agencies, engineering firms, and academia. The USGS will be donating its

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entire Anchorage collection, turning over an impressive 260 pallets of samples and related data to the state. In October and November of 2014, Linc Energy and Goldrich Mining Corp. donated six pallets of core from their Umiat #18 oil and gas well and 22 pallets of core from their prospect in the Chandalar Quadrangle (~180 miles north of Fairbanks), respectively. We are excitedly anticipating additional potential large donations from Calista Corp./Nyac Gold LLC, the Alaska Volcano Observatory, Alaska Earth Sciences, Inc., ConocoPhillips, BPXA, and Great Bear Petroleum LLC. By investing in a much larger, modern building, the State has now made these donated samples more accessible, dramatically helping the GMC accomplish its mission.

Work is underway to improve the quality and accessibility of the GMC's Bureau of Mines core and BLM pulp collections. Both sets of samples are the focus of recent reanalysis projects, where new data is collected using the latest laboratory techniques. More than 40 drawers, containing more than13,000 sample envelopes of powdered rock, represent tens of thousands of samples collected throughout the state over a period of many years. The Bureau of Mines core, representing 31 mining prospects and more than 20,000 linear feet of rock drilled in some of Alaska's most remote locations, is stored in 800+ wooden boxes in which the dividers have become compromised by exposure to moisture. As a result, much of the core has become jumbled and moved out of place inside the boxes (fig. 2). Rescuing these irreplaceable geologic samples is critical because of their role in identifying potential new mineral resources and helping to meet the long-term goals of the State's critical and strategic minerals assessment in Alaska. This project is currently ongoing with funding in part by the USGS-led National Geological and Geophysical Data Preservation Program.

Figure 2. As a result of the Congressional closure of the Bureau of Mines in 1995, the GMC received a large sample donation of core from their facility in Juneau. The core is now being restored (left) and made more accessible (right).

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DGGS REPORTS

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DDS 2. Airborne GeophysWeb: A compilation of geophysical data from DGGS and cooperating agencies, by DGGS Staff, 2014. http://dx.doi.org/10.14509/27222

DDS 6. Historically active volcanoes of Alaska, by Schaefer, J.R., Cameron, C.E., and Nye, C.J., 2014. http://dx.doi.org/10.14509/27061

DDS 7. Alaska Coastal Profile Tool (ACPT), by DGGS Staff, 2014. http://dx.doi.org/10.14509/27359

DDS 8. Alaska Volcano Observatory geochemical database, by Cameron, C.E., Snedigar, S.F., and Nye, C.J., 2014. http://dx.doi.org/10.14509/29120

GMC 422. Apatite fission track, magnetic susceptibility, and vitrinite reflectance analyses on cuttings from the Nunivak #1 and Nenana #1 wells, by Dixit, N., and Tomsich, C.S., 2014, 1 p. http://dx.doi.org/10.14509/27042

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GMC 424. Porosity and permeability, mercury injection capillary pressure, grain density, and petrologic analyses of core from the E. Simpson Test Well #2 well, by Nordaq Energy, Inc., 2014, 1 p. http://dx.doi.org/10.14509/27044

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