CLIMATE AND CRYOSPHERE HAZARDS

Most high-latitude northern regions have undergone rapid and substantial warming over the last few decades. Alaska is particularly sensitive to the effects of climate warming as much of its social and economic activity is connected to the existence of snow, ice, and permafrost. Changes to the cryosphere can increase the magnitude and frequency of certain types of geologic hazards (such as flooding, erosion, slope instability, and thawing permafrost) and have a direct effect on Alaska communities and infrastructure, as well as on the livelihoods and lifestyles of Alaskans (fig. 1). The State can help preserve the integrity of its infrastructure and the health and safety of Alaska's people by being prepared for potential emergency situations resulting from cryospheric hazards that are caused or amplified by climate variability and change.

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

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

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

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

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

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

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CLIMATE AND CRYOSPHERE MONITORING

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

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

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

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

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

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

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

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

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INVESTIGATIONS OF COASTAL DYNAMICS

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

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

A partial list of new contributions includes:

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

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

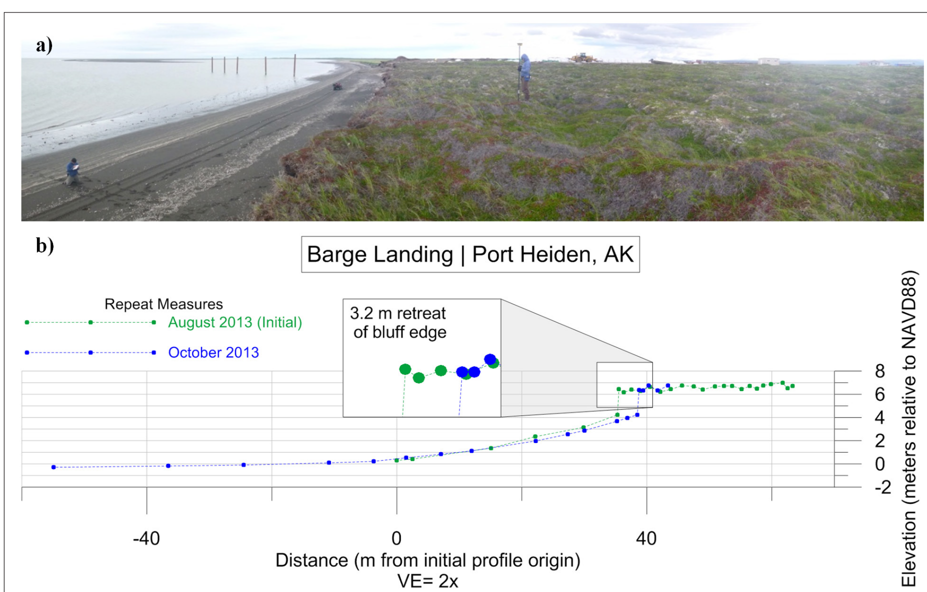

Figure 2. (a) DGGS geologists Alex Gould and Meagan DeRaps collect measurements of the upper shoreface in Port Heiden, Alaska, in August 2013. (b) Measurements were repeated in October 2013 following a high-energy wave event that caused the bluff to erode 3.2 meters inland.

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GEOHAZARD EVALUATION AND GEOLOGIC MAPPING FOR COASTAL COMMUNITIES

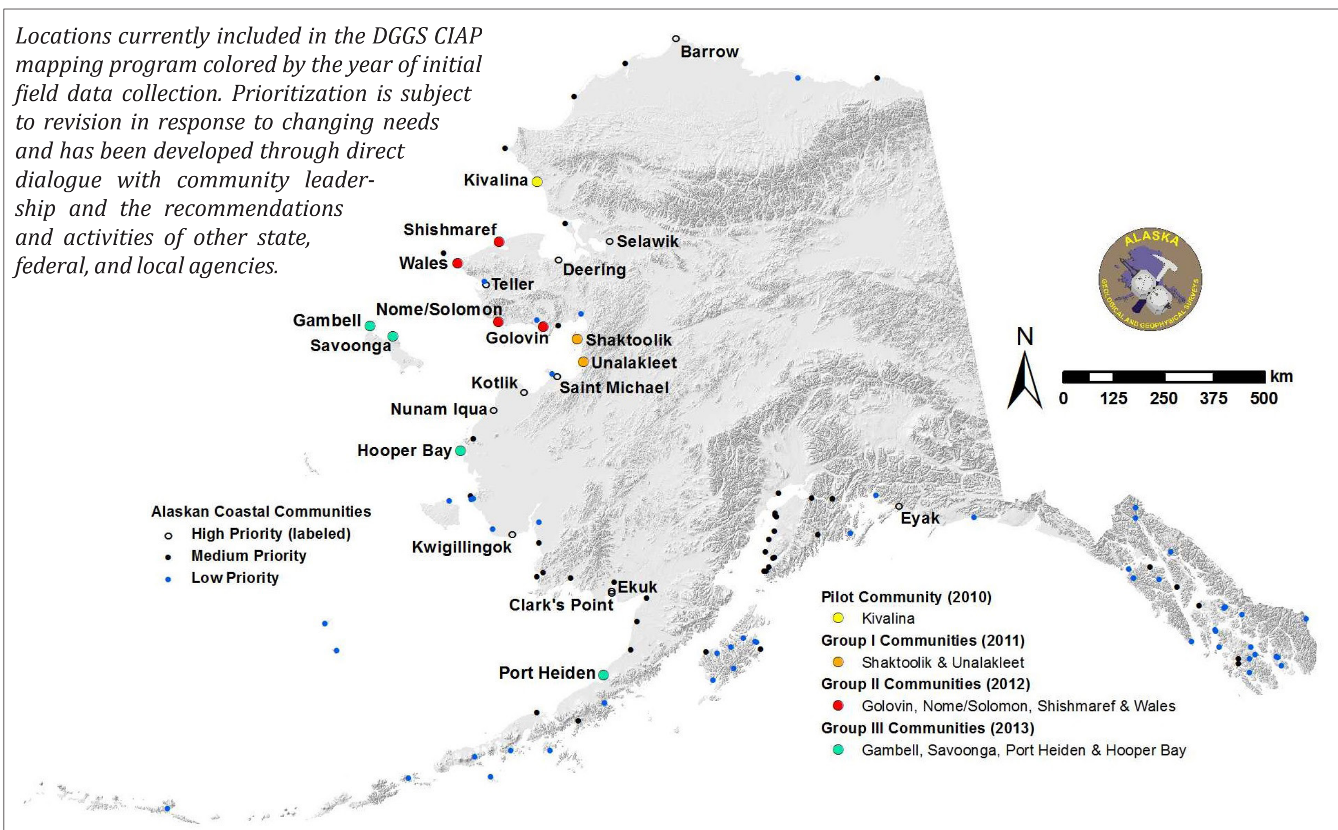
According to the 2010 United States census, more than 60 percent of Alaskans reside in coastal communities. These populations are inherently vulnerable to natural hazards such as erosion, storm surge flooding, and ivu (ice push). While these communities have been exposed to ongoing coastal processes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

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

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

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

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



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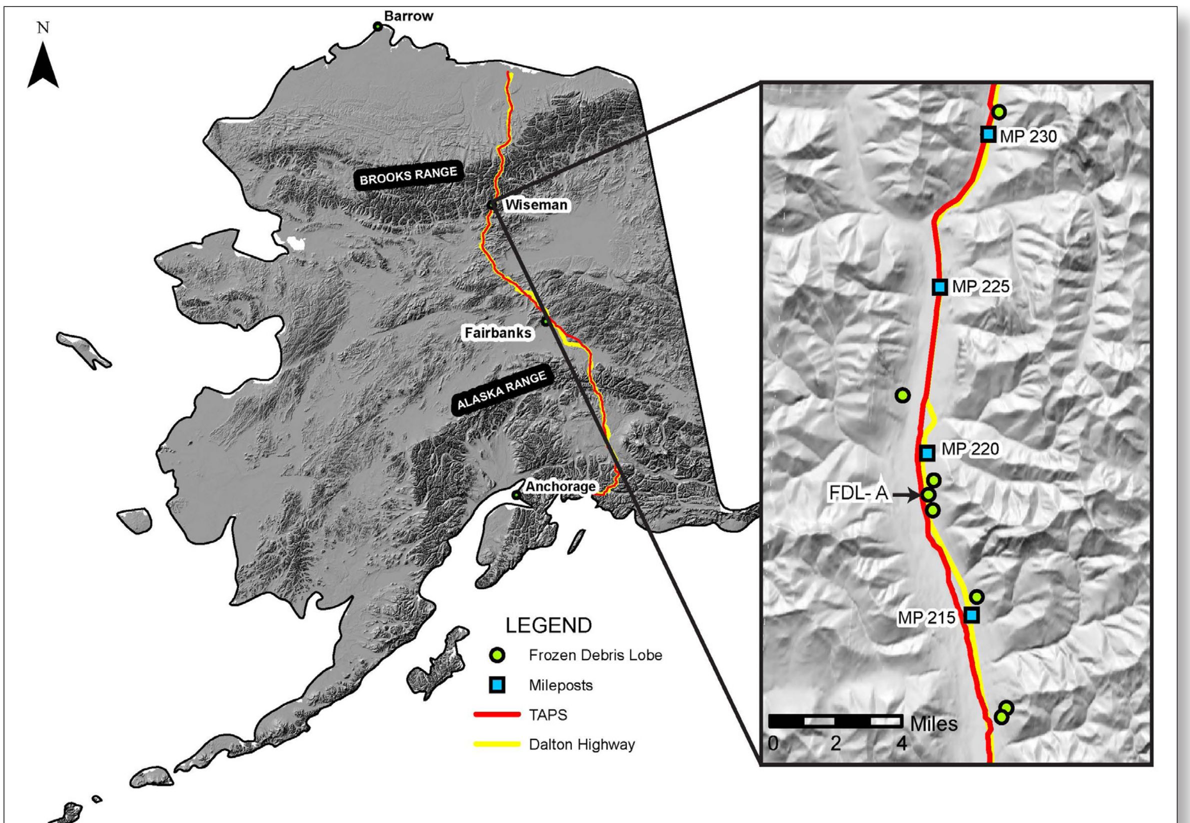
DALTON HIGHWAY FROZEN DEBRIS LOBES

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

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



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

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

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

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

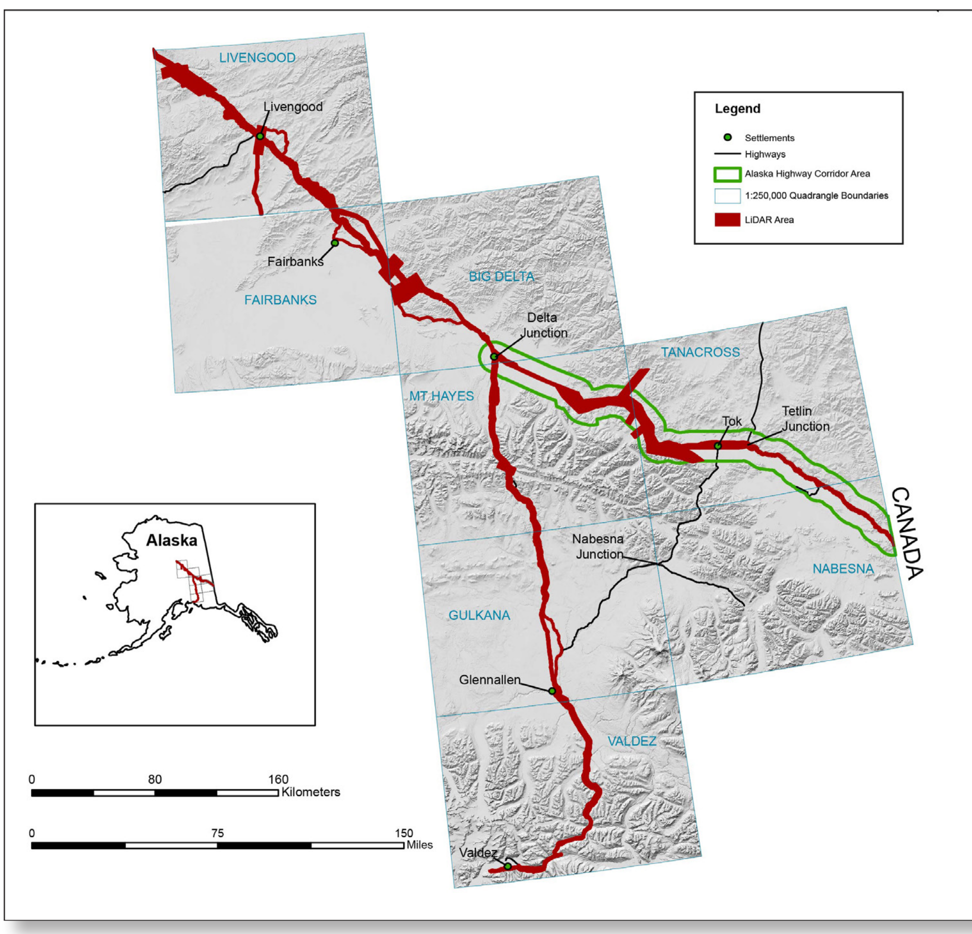
In preparation for construction of proposed natural gas pipelines, the Alaska Division of Geological & Geophysical Surveys (DGGS) has been evaluating the geology, geohazards, and material resources along a 12-mile-wide corridor centered on the Alaska Highway from Delta Junction to the Canada border,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

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

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

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

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



Map showing areas of geology and geohazards investigations.

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ALASKA STAND ALONE PIPELINE (ASAP) GEOHAZARDS STUDY

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

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

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

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

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APPLIED ENGINEERING GEOLOGY AND NEOTECTONICS RESEARCH PROGRAM

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

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

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

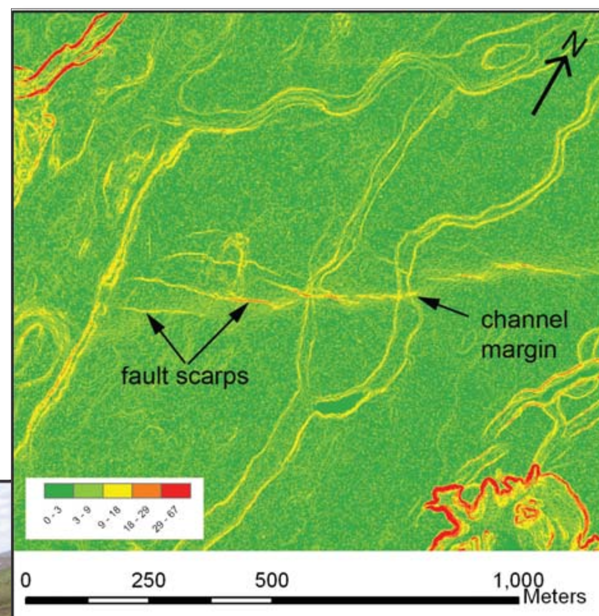

Figure 1. Slope map generated from LiDAR data showing abandoned stream channel margins that are continuous across the Castle Mountain fault and not laterally offset. The fault extends across the center of the image and is characterized by overlapping en echelon scarps.

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

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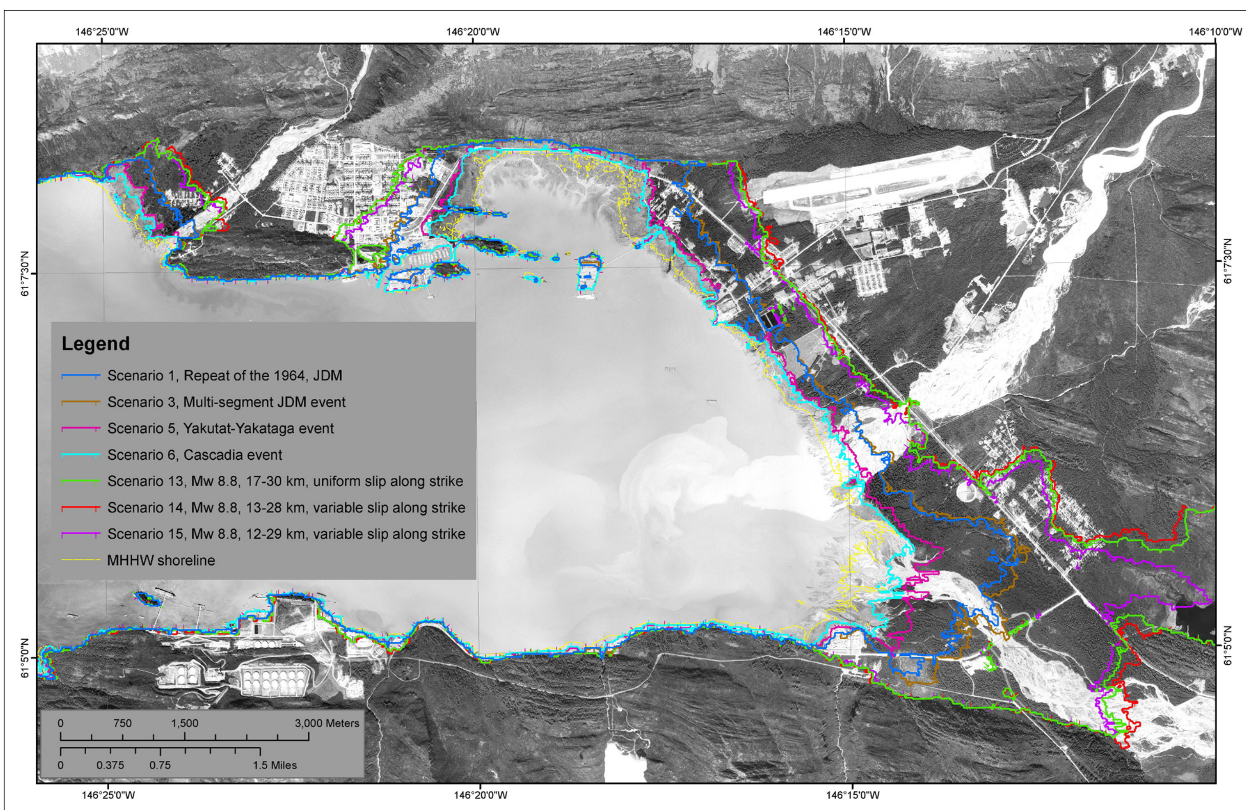
TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

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

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

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

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



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

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY14 Project Description

HYDROGEOLOGIC STUDIES

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

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

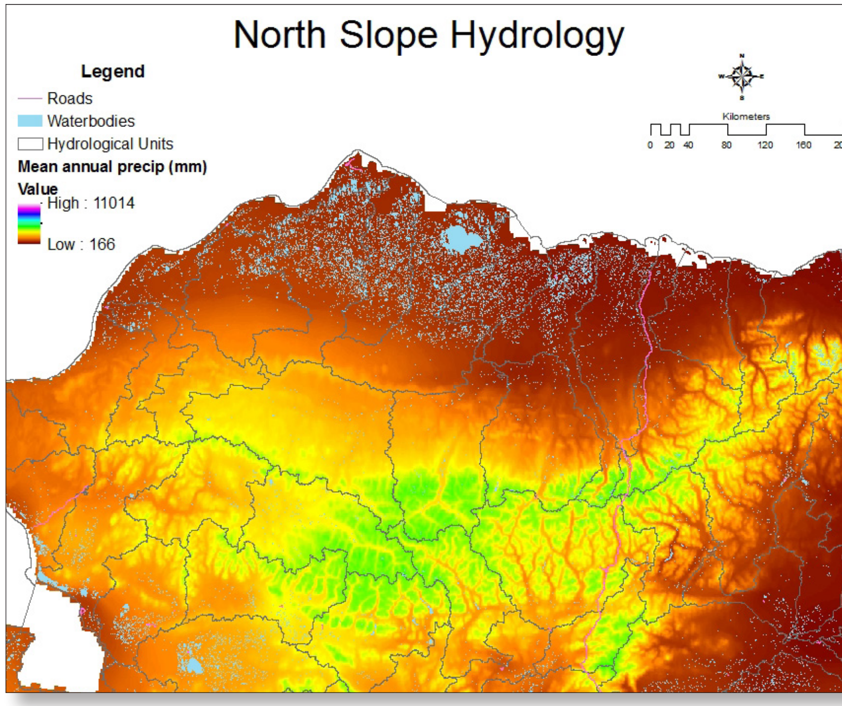

Figure 1. Map of mean annual precipitation on the North Slope and Brooks Range.

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

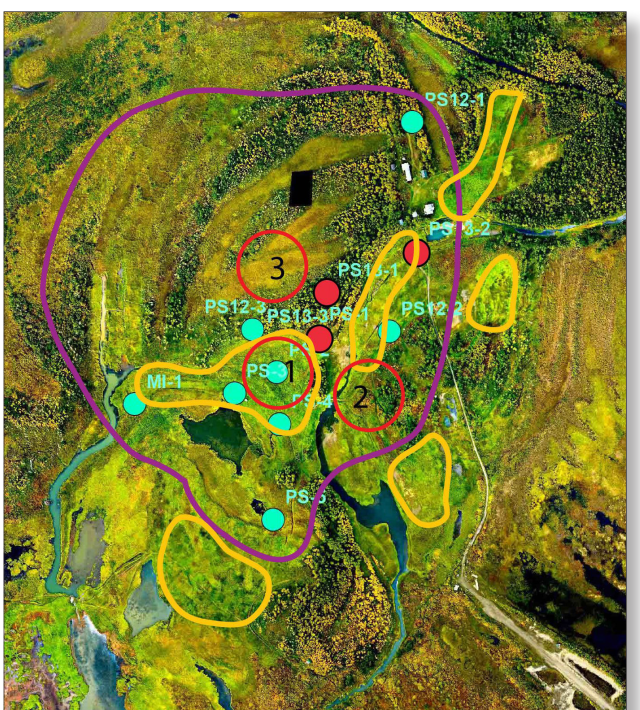

Figure 2. Map of Pilgrim Hot Springs geothermal anomaly, with deep well locations. Red dots indicate the 2013 wells, blue dots indicate older wells, and red circles numbered 1, 2, and 3 indicate current targets for upflow locations. Orange outlines are hot meadows that do not freeze in winter. Purple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

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GEOLOGIC CONTRIBUTIONS TO THE PROPOSED SUSITNA–WATANA HYDROELECTRIC PROJECT

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

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

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

This project is funded by the Alaska Energy Authority.

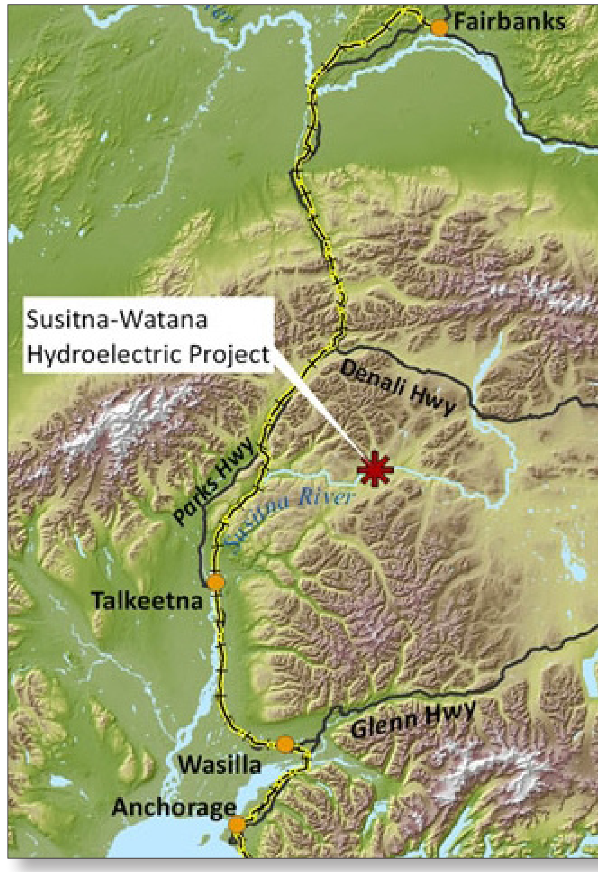

Figure 1. The Susitna–Watana Hydroelectric Project will provide power to meet the electrical needs of Alaska's Railbelt Region. Map by the Alaska Energy Authority, http://www.susitna-watanahydro.org.

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

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LEGACY SURFICIAL- AND ENGINEERING-GEOLOGIC STATEMAP PROJECTS

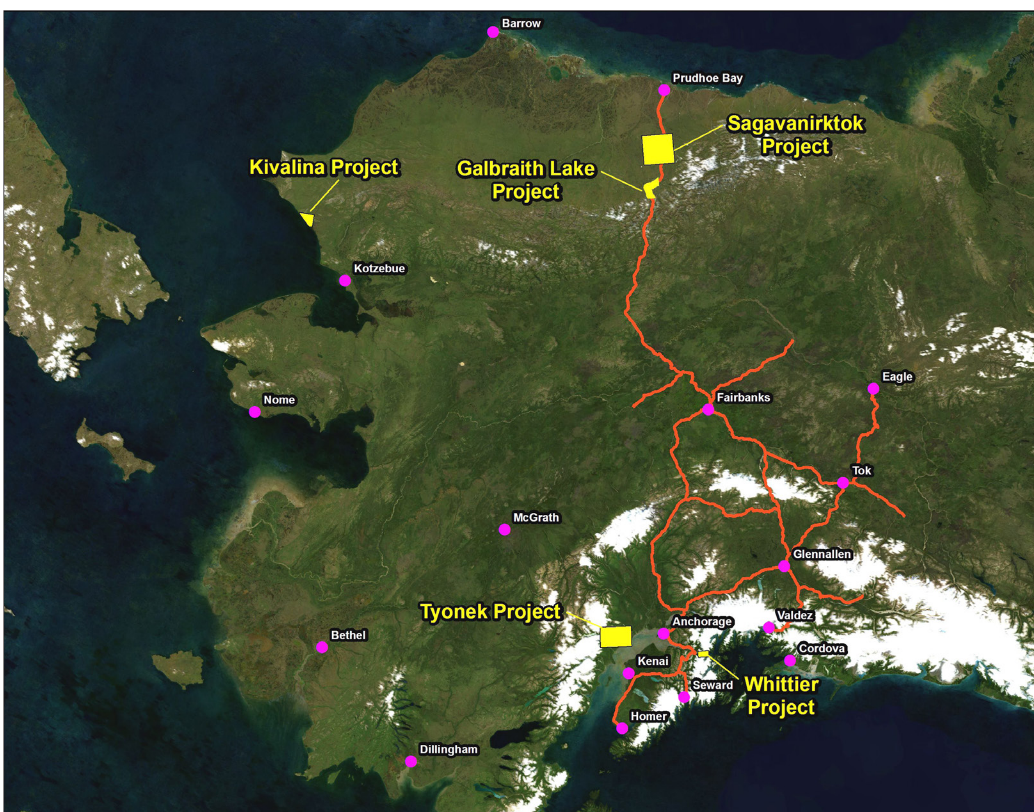
The DGGS Engineering Geology Section is finalizing and publishing maps for five legacy projects that were supported in part by the U.S. Geological Survey (USGS) STATEMAP program (see figure). The surficial- and engineering-geologic maps for these projects describe properties and extents of surficial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

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

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

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

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



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

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