ALASKA STAND-ALONE GAS PIPELINE GEOHAZARDS STUDY

In 2012, the Alaska Division of Geological & Geophysical Surveys (DGGS) continued investigating geologic hazards along the proposed Alaska Stand-Alone Pipeline (ASAP) from Anchorage to Prudhoe Bay (fig. 1). The ASAP project is a proposed in-state pipeline designed to bring long-term supplies of natural gas from the North Slope to the Fairbanks and Cook Inlet areas. The purpose of the DGGS investigation is to characterize a variety of potential geologic hazards including earthquakes, slope instability, and cryogenic processes that could potentially affect pipeline route feasibility, design, and construction. DGGS's approach is to perform reconnaissance geohazards evaluations along the proposed pipeline alignment on a quadrangle-by-quadrangle basis and to conduct more-detailed studies where warranted.

During the 2012 summer field season, DGGS geologists conducted detailed analyses aimed at better characterizing fault rupture parameters associated with the Castle Mountain and Denali faults (figs. 1 and 2). This effort utilized lidar data acquired by DGGS in 2010-2011 to refine helicopter-based preliminary field observations from the prior field season. The project's Geographic Information System (GIS) database was updated to reflect observations from summer 2012 and provides a permanent archive of field data, Quaternary geology and geologic hazards, including the locations of Quaternary-active fault traces.

DGGS geologists have completed geologic-hazard mapping along the segment of the proposed pipeline route between Anchorage and Livengood. These draft maps include data tables that describe hazard types and pertinent observations from each site. Important details related to pipeline design and construction such as location, distribution, and relative importance of specific geologic hazards are currently being described in a summary geologic-hazards report. The report and associated maps will serve as a template for planning our geologic-hazards assessment program for the Livengood to Prudhoe Bay segment, which will be assessed in 2013. The final published report for the entire route is anticipated to be completed in 2014 and will include a description of fault displacement parameters necessary for adequate pipeline design considerations.

Funding for this project is provided by the Alaska Gasline Development Corporation.

Figure 1. Geologists standing at the top and bottom of a fault scarp associated with the Castle Mountain fault. Photograph taken by Rich Koehler, June 2, 2012.

Figure 2. Complex left-stepping fissures along the Denali fault east of Cantwell. Rupture pattern possibly related to rupture of frozen fan gravels and rotation of intact blocks. Photograph taken by Rich Koehler, June 13, 2012.

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ASSESSMENT OF FLOOD HAZARDS IN THE VALDEZ GLACIER WATERSHED

Glaciers serve to regulate runoff events in alpine catchments throughout Alaska by acting as storage units for precipitation and meltwater and providing stream flow during dry periods. Recent mass balance studies on south-central and southeastern Alaska glaciers indicate that many glaciers in these regions have been decreasing in volume over the past 60 years in response to a warming climate. Alaska communities and infrastructure located in valleys downstream of these glaciers can be susceptible to flooding resulting from extended periods of glacier melting and glacial lake outbursts. These events have the potential for endangering life, disrupting the livelihoods of Alaskans, and impacting the state's economic activity.

In spring 2012, scientists from the Alaska Division of Geological & Geophysical Surveys (DGGS) and the University of Alaska Fairbanks began collecting detailed simultaneous measurements of glacier mass balance and basin hydrology in the Valdez Glacier catchment (figs. 1 and 2). The goal of this work is to develop more accurate predictions of glacier-related flood hazard potential for the community of Valdez. The results will be useful to community planners, the State of Alaska, and other stakeholders potentially impacted by flood events in this area. Methods developed in the Valdez study will serve as a template for future projects aimed at assessing potential hazards to communities downstream from glacier watersheds.

Work on the Valdez project will continue in 2013 and is supported through DGGS's Climate Change Hazards Program by a State of Alaska Capital Improvement Project (CIP). Preliminary data includes a bathymetric map of Valdez Glacier lake that will be published in spring 2013. The final report is expected to be released in 2014.

Figure 1. Jennifer Davis (DGGS/UAF) and Gabriel Wolken (DGGS) installing ablation stakes and temperature/relative humidity sensors on Valdez Glacier. (Photo credit: G. Wolken)

Figure 2. Alessio Gusmeroli (UAF/IARC) and Anthony Arendt (UAF/GI) collecting snow depth measurements using ground penetrating radar (GPR) and manual probing methods in the Valdez Glacier watershed. (Photo credit: G. Wolken)

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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. Many of these communities are vulnerable to a wide range of geologic hazards, including erosion, landslides, wave attack, storm surge/flooding, tsunami, and ivu (ice push). Since 2004, reports and recommendations from the U.S. General Accounting Office, the U.S. Army Corps of Engineers, and the Immediate Action Work Group of the Governor's Subcabinet on Climate Change have highlighted the imperiled or at-risk status of many Alaskan villages that are subject to severe flooding and erosion and have recommended baseline hazard evaluations. In response to both existing risks and to shifts in the frequency and/or magnitude of geohazard-triggering events influenced by a changing climate, communities throughout the state are becoming increasingly involved with mitigation or adaptation efforts. Baseline data pertaining to local geology, coastal and oceanic processes, and historic natural hazard events are necessary to facilitate these efforts (fig. 1).

In 2009, DGGS received federal funding through the Coastal Impact Assistance Program (CIAP) to establish a coastal community geohazards evaluation and geologic mapping program in support of local and regional planning. Following an extensive review of existing data and consultation with numerous agencies and affected coastal districts, a prioritized list of target communities was developed (fig. 2). The program was launched in 2010 with a pilot project in Kivalina, which leveraged State CIP funds and federal STATEMAP funds from the U.S. Geological Survey for an expanded project scope. Subsequent fieldwork has been conducted in six additional communities and includes field efforts to rapidly document the impacts of severe storms on Alaska's coast.

The DGGS Coastal Hazards Program is on track to assess the geologic context and dominant coastal processes near at least ten Alaskan communities by FY15. A coastal geohazard map series stemming from these field investigations is tailored to the specialized needs of Alaska and identifies local natural hazards that must be considered in the siting, design, construction, and operations of development projects to ensure protection of human life, property, and the coastal environment. Where necessary, surficial-geologic mapping (1:63,360 scale) is also being undertaken. These maps will be published in GIS format with standard metadata and will be available to the public approximately two years after initial field work at each location. For communities that are seeking to relocate or to establish evacuation shelters/routes, these products will be useful planning tools for informed decision making because they delineate areas where geologic hazards should be considered at a more detailed level to fully evaluate construction risk, identify potential sources of construction materials, and ensure that planned and proposed development will not exacerbate existing hazards.

In FY13, new partnerships with the Western Alaska Landscape Conservation Cooperative and the NOAA ShoreZone Imagery program have allowed the program to improve data collection efforts, such as through the addition of nearshore bathymetric measurement capability. Ongoing consultation and coordination with the Alaska Division of Community & Regional Affairs, U.S. Army Corps of Engineers, Alaska Department of Transportation & Public Facilities, U.S. Geological Survey, National Oceanic and Atmospheric Administration, affected coastal communities, and private-sector geotechnical consultants will continue to shape this program and avoid any duplication of efforts.

Figure 1. A DGGS field crew installs a temporary water level gauge in Shishmaref Inlet, August 2012. In addition to documenting water levels, extensive topographic and bathymetric measurements are collected from throughout the coastal zone in each field area. (Photo by Owen Mason)

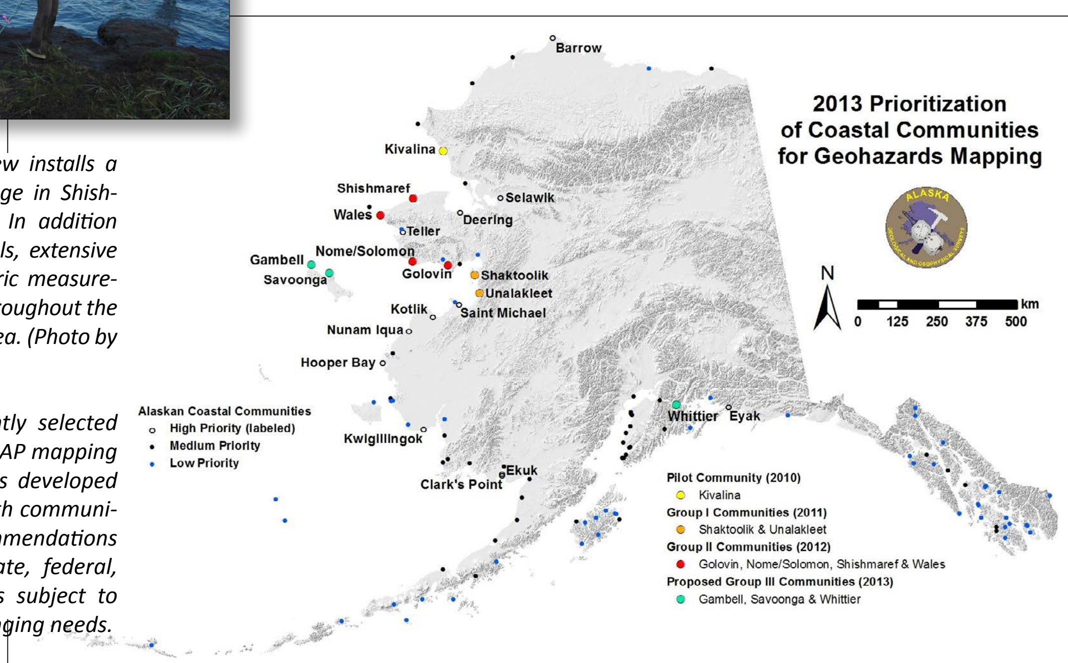

Figure 2. Locations currently selected for inclusion in the DGGS CIAP mapping program. Prioritization was developed through direct dialogue with community leadership and the recommendations and activities of other state, federal, and local agencies, and is subject to revision in response to changing needs.

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GEOLOGIC CONTRIBUTIONS TO THE PROPOSED SUSITNA–WATANA HYDROELECTRIC PROJECT, ALASKA

The Alaska Energy Authority (AEA) has been authorized by the State of Alaska to develop the Susitna–Watana Hydroelectric Project on the Susitna River, Alaska (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 39 miles long and up to 2 miles 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.

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.

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. Planned work in this AEA-funded study 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 have completed reviews of existing and new AEA-contractor-developed seismic hazards reports, and have gathered, reviewed, and compiled existing hardcopy geologic maps into a digital GIS database (fig. 2). The Phase 1 compilation maps and geodatabase are anticipated to be published in early 2013. Future work is dependent on additional funding but may include Phase 2 field-based verification to improve and expand the body of geologic and seismic-hazards data needed to fully meet the requirements of this major hydroelectric project, and a Phase 3 wrap-up of the geologic evaluation with final field checks, additional data analysis, and report writing.

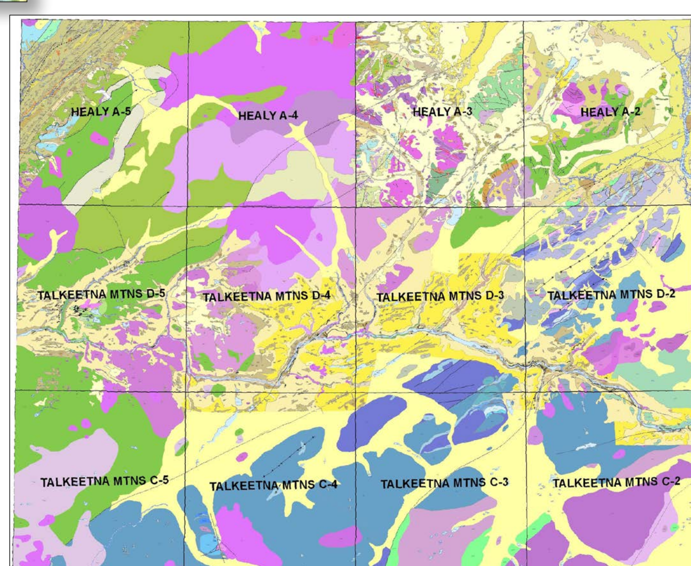

Figure 2. The most current and detailed geologic mapping for twelve inch-to-mile quadrangles has been compiled into a single geodatabase, along with georeferenced scans and digitized vector files of the original source maps. This will be a valuable geologic data resource for developers, planners and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

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ASSESSMENT OF GEOLOGIC HAZARDS ASSOCIATED WITH CLIMATE CHANGE

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 strongly influenced by the presence of snow, ice, and permafrost. Changes in climate can modify natural processes and increase the magnitude and frequency of certain types of geologic hazards (such as flooding, erosion, slope instability, and thawing permafrost) and, if not properly addressed, have a direct effect on Alaska communities and infrastructure as well as on the livelihoods and lifestyles of Alaskans. The State can help preserve the integrity of its infrastructure and the health and safety of its people by being prepared for potential emergency situations resulting from geologic hazards that are caused or amplified by climate change. A critical first step is to perform the necessary sound science to identify high-risk areas where proactive mitigation efforts will be needed and useful, and areas where design structure and informed planning can alleviate the need for future mitigation.

The Division of Geological & Geophysical Surveys' (DGGS) Climate Change Hazards Program has been developed to rigorously assess geologic hazards associated with climate change and publish information that can be used for proactive planning, hazard mitigation, and emergency response in high-risk communities and developing areas. DGGS is accomplishing this by collecting the necessary field data to assess geologic hazards and publish peer-reviewed geologic-hazards maps and reports of high-risk communities and infrastructure in Alaska. We are completing these assessments at local and/or regional scales as needed to address specific local problems and to understand and evaluate the larger geologic context. This effort is in collaboration with relevant organizations including local city officials, the Alaska Department of Transportation & Public Facilities (DOT&PF), the U.S. Geological Survey (USGS), and the University of Alaska Fairbanks, and will provide valuable information to allow planners and design engineers to minimize the economic impacts and public safety risks associated with geologic hazards.

In 2012 DGGS scientists conducted field-based geologic hazards assessments and mapping in and around the communities of Seward, Valdez, and Whittier (fig. 1). We anticipate publishing final products for Kivalina and completing draft products for Koyukuk, Seward, and Whittier in 2013. Geologic-hazards maps will delineate areas where potential natural hazards such as snow avalanches, flooding, erosion, slope instability, and thawing permafrost should be considered at a more detailed level to fully evaluate risk for any given use and will be published in digital GIS format in conformance with national standards. Reports describing the geology and hazards will accompany the maps.

The Climate Change Hazards Program is funded by the State of Alaska as a Capital Improvement Project (CIP), with additional support for the Kivalina work from the USGS STATEMAP program.

Figure 1. Matthew Balazs (DGGS/UAF) takes notes in his fieldbook during a Ground Based Interferometric Radar (GBIR) scan of the slope behind Begich Towers in Whittier, Alaska. (Photo credit: G. Wolken).

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GEOLOGY AND GEOLOGIC HAZARDS IN THE WHITTIER AREA, SOUTH-CENTRAL ALASKA

The town of Whittier, Alaska (pop. 225) is an all-weather, ice-free port crucial to the state, and one of only two serving the mainland via both railroad and road access. During the 1964 M9.2 great Alaska earthquake, Whittier suffered catastrophic tsunami damage, including loss of life. While not as widely known or as thoroughly studied as tsunamis caused by tectonic motions during earthquakes, landslide-generated tsunamis, such as those that devastated Whittier during the 1964 earthquake, can cause loss of life and significant damage to property and infrastructure with little or no warning. During summer 2011, DGGS geologists identified a large, fresh-looking bedrock fracture above the north shore of Passage Canal across from Whittier. The fracture is evidence of an unstable slope that, if mobilized, has the potential to generate a local tsunami capable of impacting the community of Whittier and damaging critical infrastructure along Passage Canal. Initial modeling of two hypothetical slides and resulting tsunamis suggests maximum wave heights of about 10 feet (see DGGS RI 2011-7, Appendix B). However, DGGS is undertaking collection of additional field-geologic and lidar data, as described below, to better evaluate the risks from this and other hazards in the Whittier area.

DGGS initiated a project in 2012 to map the geology and geohazards near Whittier (fig. 1) and collect high-resolution lidar data over key portions of the area (fig. 2). Given the high cost of mobilizing a helicopter-supported field program, DGGS expanded the size of the study area to include the heavily-visited Begich-Boggs Visitors' Center at Portage Lake and the Anton Anderson Memorial Tunnel to take advantage of the opportunity to assess the potential geologic hazards that could impact this significant infrastructure. Previous geologic mapping in the area has been of a reconnaissance nature and at a small scale. Detailed stratigraphic and structural information is sparse and geologic maps are too regional for assessment of specific geologic hazards. This project is allowing us to map surficial and bedrock geology at inch-to-mile scale and assess natural hazards in support of informed, proactive community planning, mitigation, and emergency response in and around this high-risk community and its associated critical infrastructure. The project is jointly funded by the U.S. Geological Survey STATEMAP program and by the State of Alaska as a Capital Improvement Project (CIP).

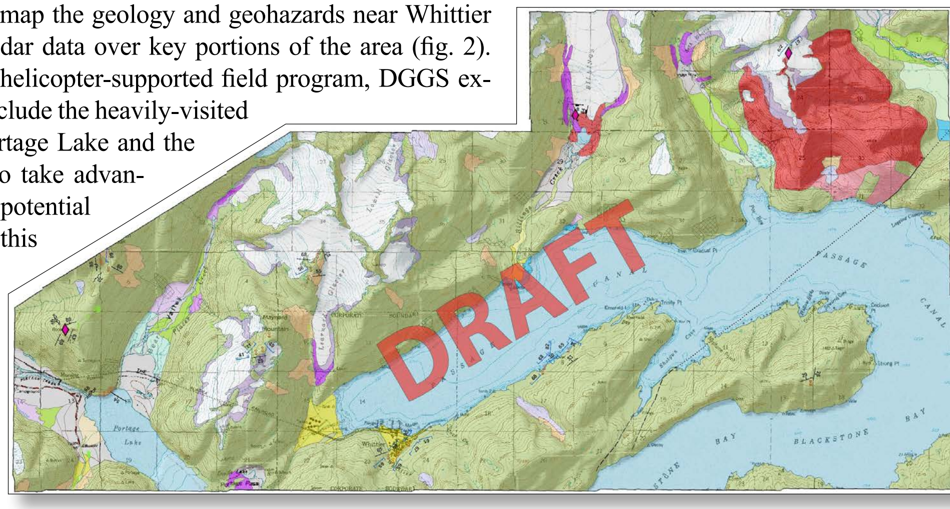

Figure 1. Preliminary geologic map of the Whittier area.

Products for this project include public release of the lidar data in spring 2013, a preliminary map of geology and geologic hazards that is due to the U.S. Geological Survey in May 2013, and a final, peer-reviewed map that is scheduled to be published in summer 2013. An additional detailed geologic hazards report will be published in conjunction with the DGGS Climate Change Hazards Program.

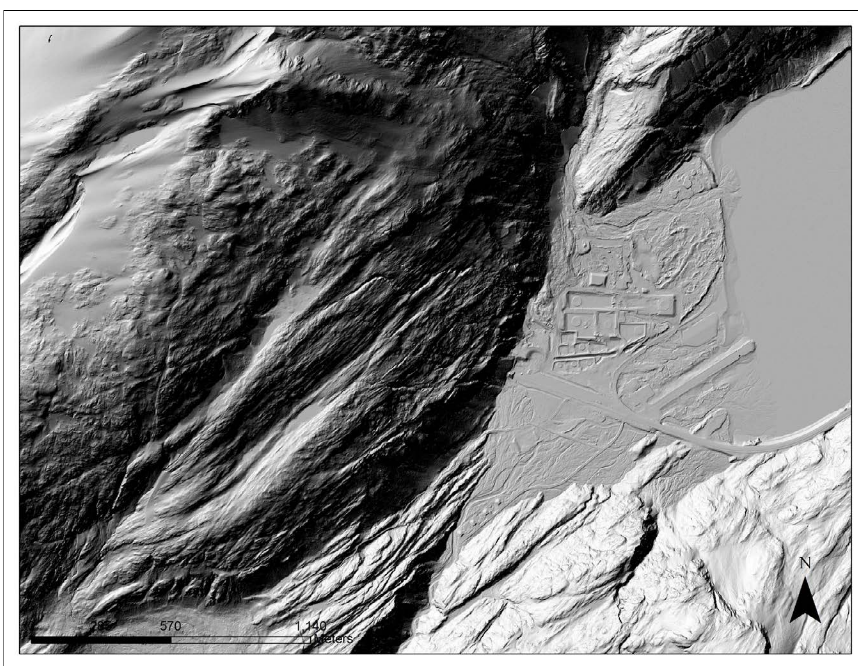

Figure 2. High-resolution lidar data such as this preliminary hillshade image will be used to refine the geologic mapping and to help identify and characterize potential geologic hazards that may not be as discernible in aerial photographs and satellite imagery due to thick vegetation cover. This image shows the area around the eastern entrance of the Anton Anderson Memorial Tunnel and Whittier air strip.

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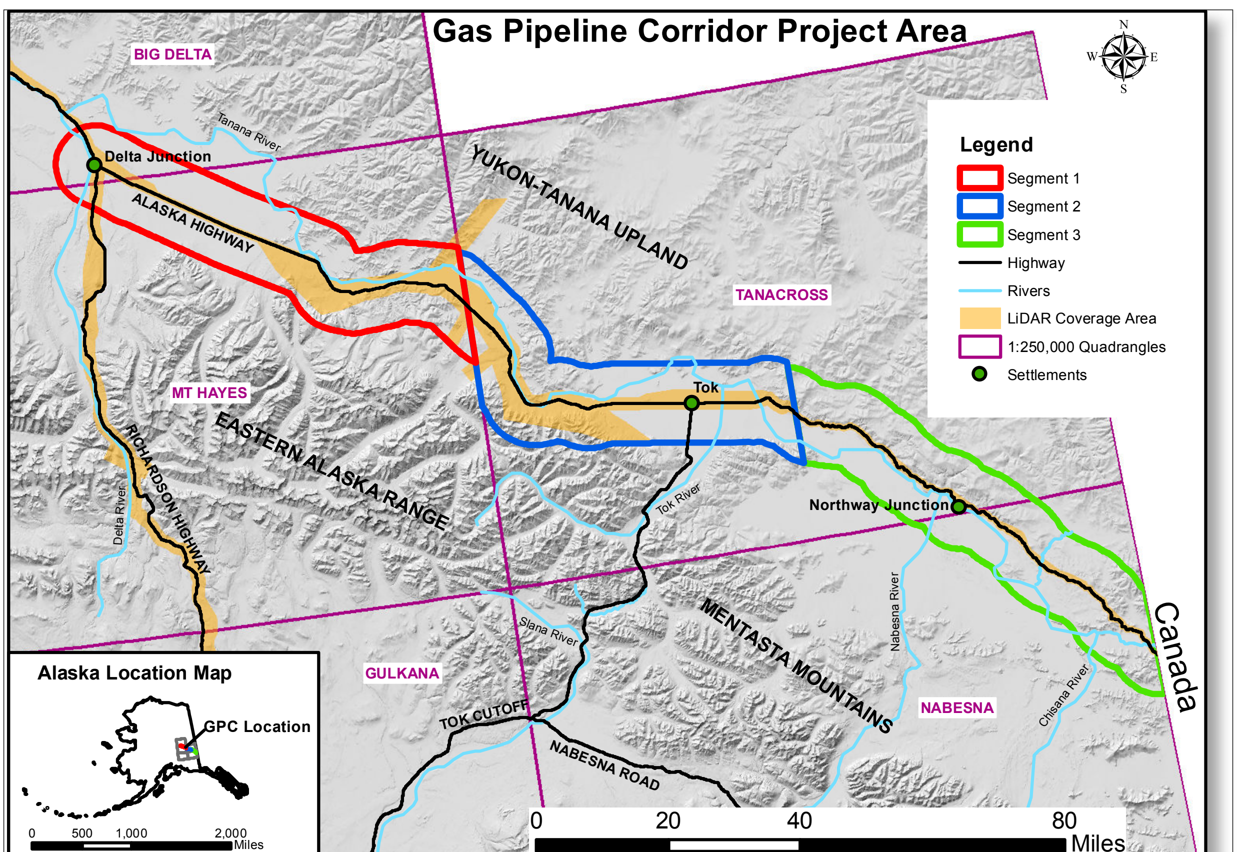
GEOLOGY, GEOHAZARDS, AND RESOURCES ALONG THE PROPOSED NATURAL GAS PIPELINE CORRIDOR, ALASKA HIGHWAY, FROM DELTA JUNCTION TO THE CANADA BORDER

In preparation for possible construction of a natural gas export pipeline, 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. Planned products for each of three segments along this route include preliminary maps and reports describing surficial geology, bedrock geology, permafrost, engineering geology, and potentially active faults. Surficial geology, bedrock geology, permafrost, and engineering reports include 1:63,360-scale reconnaissance maps and digital GIS data. These preliminary products will be followed by a final comprehensive report that compiles and synthesizes data for the entire project area.

DGGS is now completing work on the third and final segment of the corridor, between Tetlin Junction and the Canada border. The surficial geology and permafrost reports and accompanying maps were published in 2012 and the engineering-geologic maps for this segment are anticipated to be released in early 2013. In addition to the maps and reports described above, DGGS plans to publish bedrock maps and associated GIS data for all three segments of the corridor in 2013 (see separate briefing paper, page 41). This will complete the publication of materials for each of the 3 individual segments of the corridor.

During 2012, DGGS conducted desktop studies and field work to evaluate high-resolution lidar within the corridor to refine geologic mapping and interpretations for the final comprehensive report. This report will describe permafrost, surficial geology, and geologic hazards, including active faulting, for the entire project area. DGGS plans to complete a draft report and accompanying set of maps, with seamless GIS layers, which will be ready for review in 2013. In conjunction with this project, 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 2013.

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.



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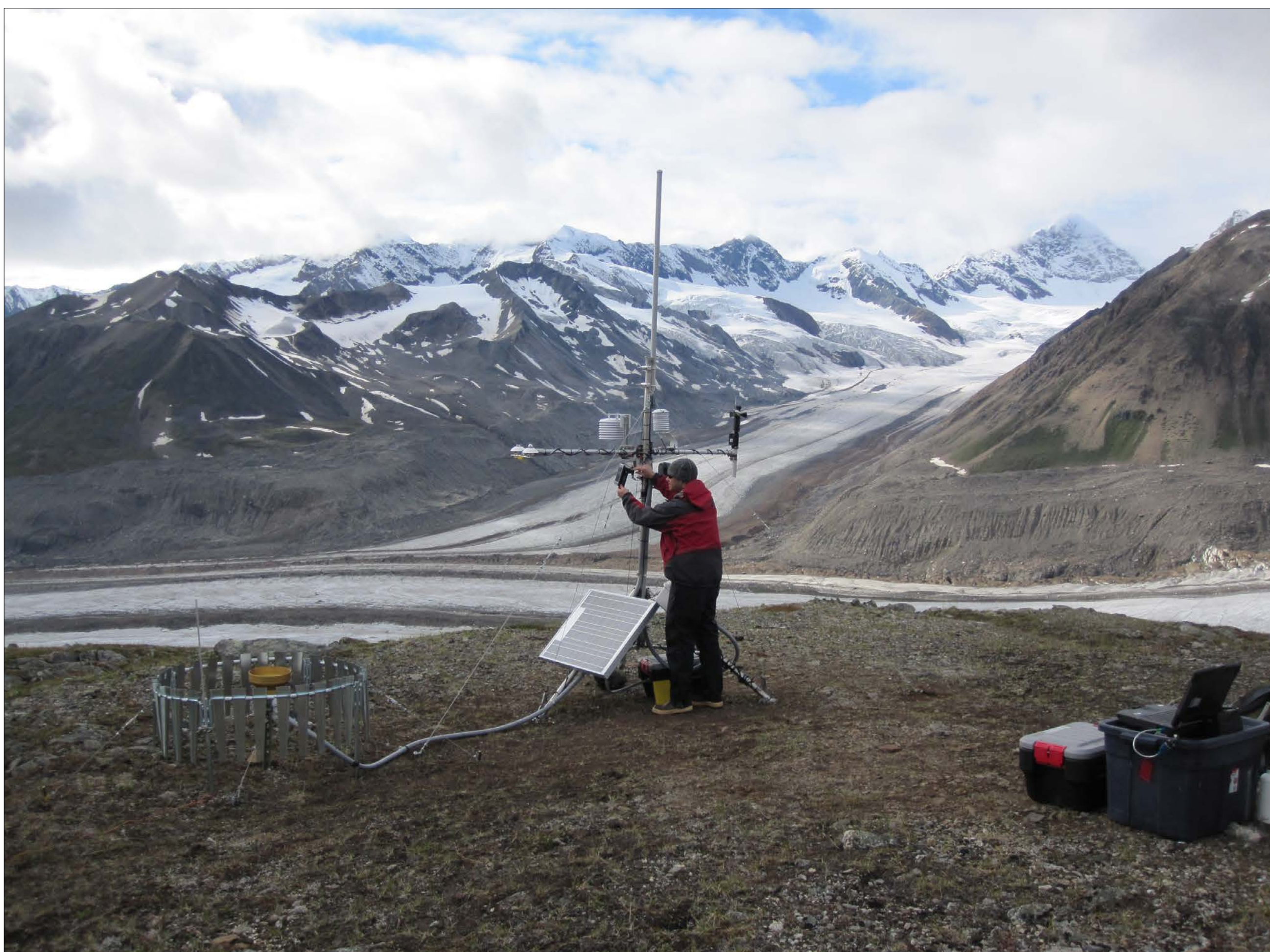
GLACIER AND RUNOFF CHANGES IN THE UPPER SUSITNA BASIN

The Alaska Energy Authority (AEA) has been authorized by the State of Alaska to develop the Susitna-Watana Hydroelectric Project on the Susitna River to serve the Railbelt's energy needs. Critical to any such development is a thorough 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. To accomplish this goal, the Alaska Division of Geological & Geophysical Surveys (DGGS), along with collaborators from the University of Alaska Fairbanks, began in 2012 a multi-year, AEA-funded study of the hydrology of the upper Susitna drainage basin, with a particular focus on modeling the effects of glacier wastage and retreat on streamflow. The study combines field measurements and computational modeling to improve estimates of runoff into the proposed 31 mi^2, 40-mi-long reservoir of the Susitna-Watana Hydroelectric Project.

Changes in glacier volume and extent and/or altered precipitation regimes in response to climate warming have the potential to substantially alter the magnitude and timing of runoff. Although only about 4 percent of the Susitna watershed area (5,127 mi^2) is glacierized, these glaciers provide a significant proportion of the total runoff within the upper Susitna drainage, and it is well documented that these glaciers are currently retreating. Given this trend, changes to the runoff represented by glacial melting may occur in the near future and may impact the hydroelectric project. Understanding of how changes to the upper Susitna basin hydrology due to glacier retreat can affect hydroelectric project operations is necessary for informed evaluation of potential protection, mitigation, and enhancement measures.

Preliminary results from this multi-year project will be provided to AEA by January 2014, with final reports published in 2015 and 2016 as the data collection and modeling efforts are completed.



DGGS geologist Gabriel Wolken installing a weather station in the upper Susitna basin, central Alaska Range. Tributaries to the Susitna Glacier are visible in the background. (Photo credit: G. Wolken)

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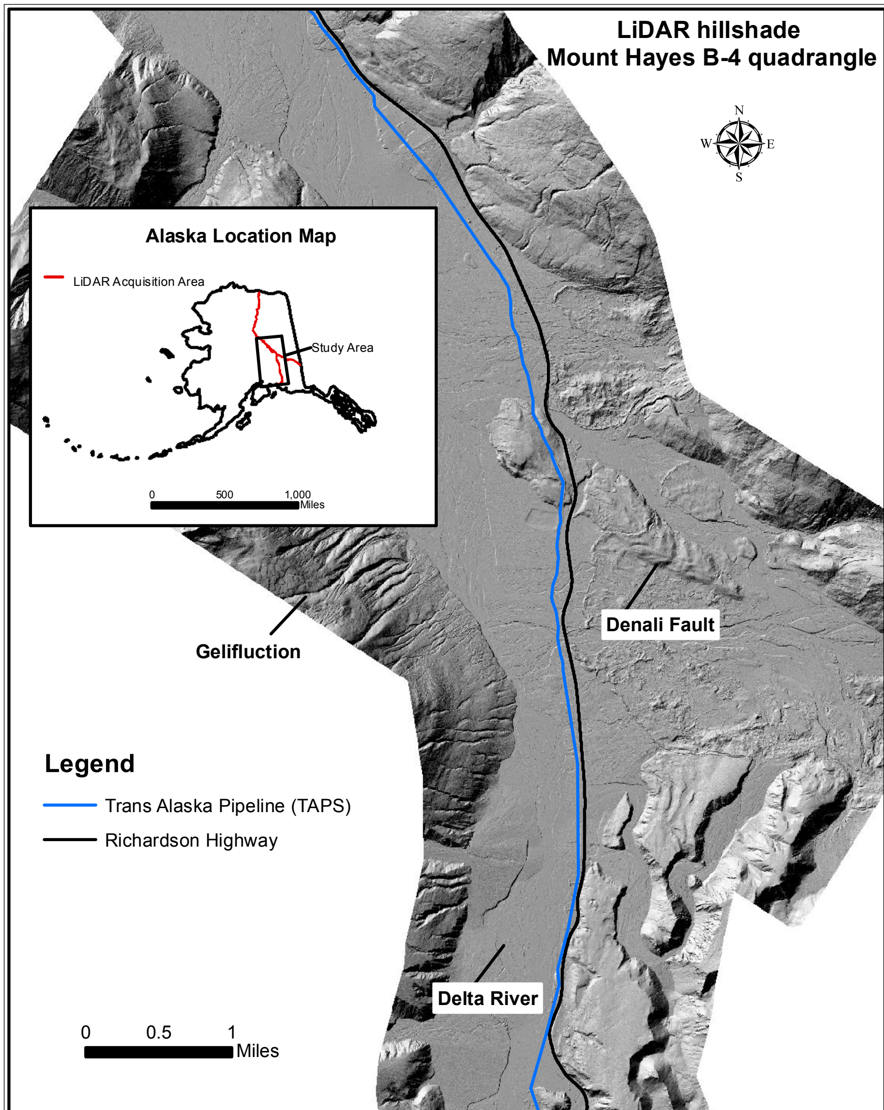
LIDAR-SUPPORTED ASSESSMENT OF GEOLOGY AND GEOHAZARDS IN THE LIVENGOOD-VALDEZ CORRIDOR

The Division of Geological & Geophysical Surveys (DGGS), with support from the Alaska Gas Pipeline Project Office, the Office of the Federal Coordinator, and the Alaska Gasline Development Corporation, completed in 2010-2011 acquisition and public release of approximately 3000 mi^2 of high-resolution lidar (light detection and ranging) data along major transportation and infrastructure corridors in the state. DGGS is using these data to identify and evaluate geologic hazards such as slope instability, thaw settlement, and erosion in a corridor from Livengood to Valdez. In other areas, such as along the Alaska Highway between Delta Junction and the Canada border, lidar has been extremely useful in identifying previously unrecognized geologic hazards, especially in areas of heavy vegetation.



Lidar hillshade image in the Mount Hayes B-4 Quadrangle showing the Denali fault and an area of gelifluction, both of which are potential geologic hazards that may impact human activities. Inset map shows the areas for which lidar was collected in red; box denotes area that is being evaluated for potential geologic hazards under the current project.

In 2012, DGGS researched background information, prepared lidar-derived imagery for analysis, conducted an initial desktop hazard evaluation, and began entering preliminary interpretations into GIS. Initial lidar-based evaluations and GIS data will be field-checked during the 2013 summer field season, and supporting data will be collected to describe and quantify the nature and extent of identifiable geologic hazards. Interpretations and GIS data will be updated in fall 2013.

DGGS plans to complete a draft report that will be ready for peer review in early 2014. The report will consist of a folio of page-size map figures showing the identified geologic hazards and related landscape features on a lidar hillshade background. Each figure will be accompanied on the facing page by descriptions and/or extended discussions of the features mapped in the area depicted in the figure. This report will be useful for planning, infrastructure maintenance, and future construction in this important corridor.

This lidar assessment work is funded by the State of Alaska as part of a Capital Improvement Project (CIP).

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY13 Project Description

MAPTEACH

Alaska's Division of Geological & Geophysical Surveys (DGGS) is participating in the last year of MapTEACH (Mapping Technology Experiences with Alaska's Community Heritage), an education–outreach program that targets geospatial technology skills for rural Alaska students. This program is a continuation of what was originally a multi-year National Science Foundation-funded collaborative project led by DGGS and is now a part of the University of Alaska School of Natural Resources and Agricultural Sciences. MapTEACH emphasizes hands-on experience with spatial technology (GPS, GIS, Google Earth, and remote-sensing imagery in a local landscape–landform context) in conjunction with traditional activities. Working directly with geologists and local landscape experts, participants are presented with a chance to authentically emulate scientific data collection and mapping activities at a novice level, using real data in a real-world setting (fig.1).

Figure 1. Metlakatla middle school students collecting geologic data during a MapTEACH site visit to Annette Island in May 2012.

MapTEACH is founded on the integration of three focus areas: Geoscience, geospatial technology, and local landscape knowledge. Program materials are built on a menu-based model in which users (teachers) can select those portions of the curriculum that are most useful for their classroom objectives. When implementing the full range of MapTEACH curriculum, students and teachers interact in field settings with Native Elders, traditions-based community leaders, and professional geologists from DGGS and the University of Alaska. Introducing students to geoscience and geospatial technology in culturally responsive and stimulating classroom and field settings will enhance community understanding of landscape processes and natural hazards in rural Alaska. It will also foster appreciation of state-of-the-art technology tools and datasets that can be applied to informed community planning and decision making.

The MapTEACH training model includes multiple workshops and on-site training and classroom visits with participating teachers, as well as an updated and improved website that allows online access to curriculum materials (fig. 2). MapTEACH is currently working with the Yukon–Koyukuk school district and individual teacher-participants in Sleetmute, Hoonah, and Metlakatla, training teachers with diverse subject matter expertise in the use of the curriculum and resources, and preparing them to continue using MapTEACH in their classrooms after the project sunsets in 2013, the end of the current grant period.

MapTEACH is funded by the Alaska Department of Education and Early Development (EED) through an Alaska Native Education Program (ANEP) grant to the University of Alaska Fairbanks. Additional EED support was provided through Alaska Title II-A SEP Competitive grants to the Yukon–Koyukuk and Yukon Flats school districts.

Figure 2. The updated MapTEACH website (http://ww.mapteach.org) offers curriculum resources and other helpful information about the program to teachers wishing to explore place-based education in Alaska.

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QUATERNARY FAULT AND FOLD DATABASE

In 2012, the Alaska Division of Geological & Geophysical Surveys (DGGS) published a Quaternary fault and fold database compilation for Alaska (fig. 1) based on guidelines designed by the U.S. Geological Survey for the National Quaternary Fault and Fold Database. The Alaska database (DGGS MP 141) provides a single-source, accurate, user-friendly, reference-based fault inventory to the public and includes the first comprehensive GIS shapefile of Quaternary fault traces digitized from original sources, with metadata. Individual fault parameters such as slip rate, age of most recent rupture, dip direction, and others are catalogued in the database attribute tables. The database provides a valuable resource for the earthquake engineering community, insurance industry, scientific researchers, policy planners, and the general public.

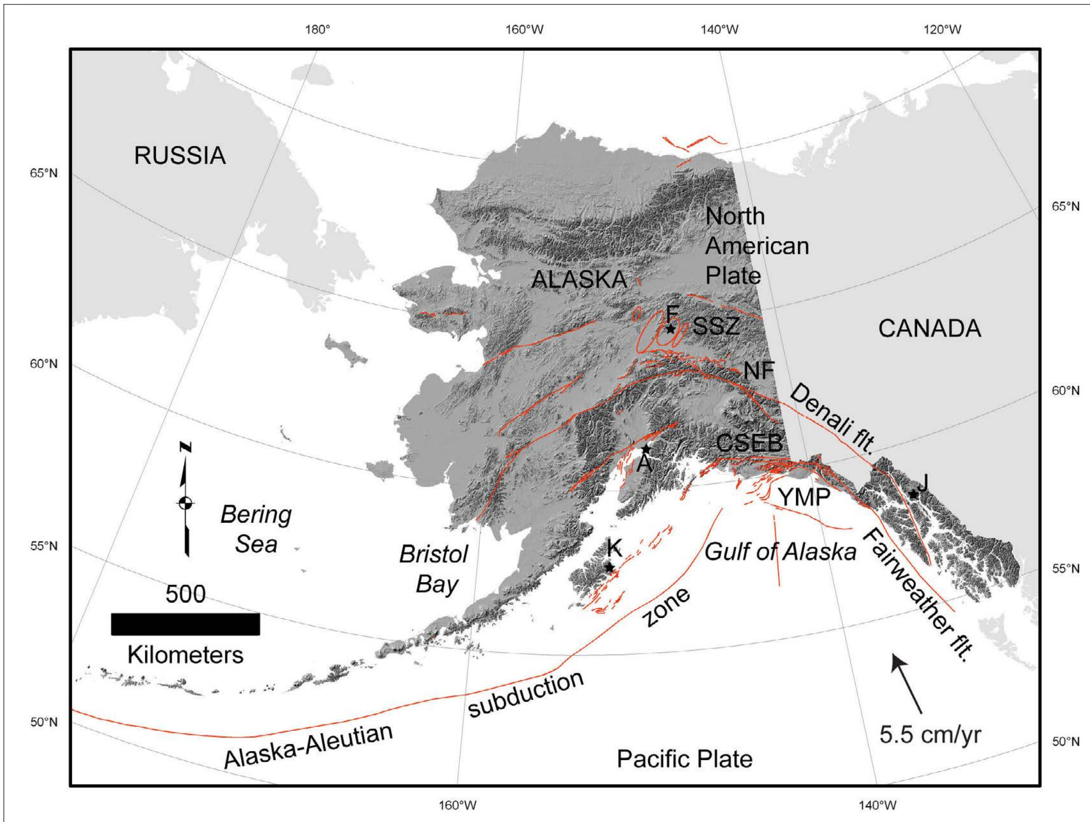

Figure 1. Quaternary faults and folds displayed on a shaded relief map of Alaska. Major cities shown by black stars. A, Anchorage; F, Fairbanks; J, Juneau; K, Kodiak; YMP, Yakutat microplate; CSEB, Chugach-Saint Elias fold and thrust belt; NF, Northern Foothills fold and thrust belt; SSZ, Salcha seismic zone.

DGGS is currently producing a printable map to accompany the database that will be publicly available for download for interested users. The map will depict Quaternary fault traces and crustal seismicity overlain on a hillshade map of the state. Faults will be color coded, based on the most recent age of activity, including historical (<150 yrs), post latest Wisconsin (<15,000 yrs), latest Quaternary (<130,000 yrs), mid-Quaternary (<750,000 yrs), and Quaternary (<1,800,000 yrs). The map will also include a table of significant historical earthquakes, selected photographs of surface ruptures, and an inset map depicting the distribution of pre-Quaternary faults. The inset map will communicate the concept that there are many unstudied faults in Alaska that may be Quaternary active. DGGS plans to release future updates of the database as new faults are discovered and existing faults become better characterized.

DGGS is currently seeking funding to produce text-based descriptions of individual structures. The text-based descriptions are an integral part of the U.S. Geological Survey's National Fault and Fold Database. Pertinent data to be summarized in these descriptions include geographic information, geomorphic expression, length, average strike, sense of movement, age of faulted surficial deposits, and summaries of paleoseismic studies. The ultimate goal is to link the text-based descriptions to individual faults in the database.

DGGS is also exploring options to display the database through an interactive web-map portal embedded on the DGGS website. The web-map application will present the database at the resolution of the original source maps and include basic map functions including identification and search tools, and multiple base map options such as topographic, satellite imagery, and hillshade maps.

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SURFICIAL-GEOLOGIC MAP OF THE SAGAVANIRKTOK AREA, NORTH SLOPE, ALASKA

The Alaska Division of Geological & Geophysical Surveys (DGGS) continues work on a project to map surficial geology at a scale of 1:63,360 for a 1,212-square-mile area that straddles 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 (fig. 1).

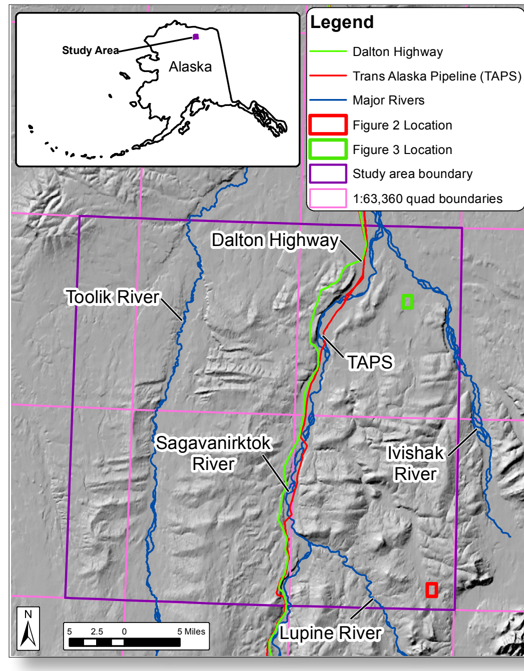

Figure 1. Location map of Sagavanirktok study area showing major drainages and infrastructure.

Many of the surficial deposits in the area are associated with latest Tertiary(?) to late Pleistocene glacial advances, with source areas in the Brooks Range. In southern and eastern portions of the map area younger glacial deposits with primary glacial morphology occupy lower elevations and valley bottoms (fig. 2a, Qgdi2/Qgfi2). Older glacial deposits (Qgdi1/Qgfi1) occupy higher elevations on valley walls and as a thin cover on bedrock hills. In contrast, northern and western portions of the map area are dominated by older glacial deposits with more subdued morphology. These areas are characterized by broad, low-relief surfaces extensively modified by gelifluction and thermokarst processes with a thick cover of ice-rich silt or loess (fig. 2b).

Completed maps will provide important information about geologic materials and potential geologic hazards such as thawing permafrost, slope instability, and flooding along the Trans-Alaska Pipeline System (TAPS) and Dalton Highway, the main artery for transportation to and from the North Slope. The maps will be a source of geologic information necessary for assessing landscape change and will be useful in evaluating the potential for future development such as resource exploration and a proposed natural gas pipeline. Draft maps are on schedule for peer review in early 2013, with final publication planned by the end of the year.

The 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. The project is funded by State of Alaska general funds.

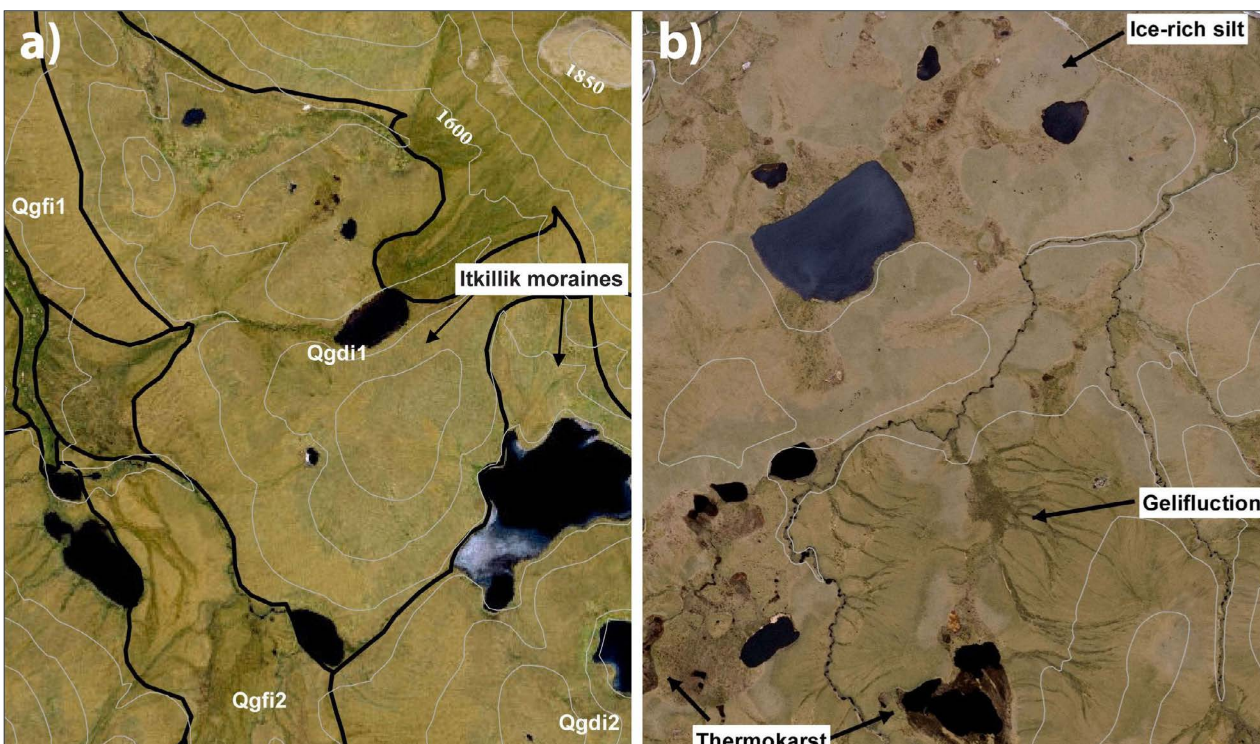

Figure 2. SPOT satellite images showing: (a) late Pleistocene age (Itkillik) moraines (Qgdi1, Qgdi2) and associated outwash (Qgfi1, Qgfi2) in the southern part of the map area, and (b) broad low-relief surfaces with extensive colluvial and periglacial deposits typical of northern portions of the map area.

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TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

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

As part of this program, the Division of Geological & Geophysical Surveys (DGGS) participates in a cooperative project with the Alaska Division of Homeland Security & Emergency Management (DHSEM) and the University of Alaska Geophysical Institute (UAGI) to prepare tsunami inundation maps of selected coastal communities. Communities are chosen and prioritized on the basis of tsunami risk, infrastructure, availability of bathymetric and topographic data, and willingness of a community to use results for emergency preparedness. For each community, DGGS and UAGI develop multiple hypothetical tsunami scenarios that are based on the parameters of potential underwater earthquakes and landslides. We have completed and published tsunami inundation maps and reports for the Kodiak area, Homer, Seldovia, Seward, and Whittier. A map and report for Valdez are in press as of this writing, and draft products for Chenega Bay have been submitted for publication. Modeling has been completed and maps and reports are in preparation for Sitka, Cordova, and Tatitlek.

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

Team members have presented results of this program at international tsunami symposia in Seattle; Honolulu; Istanbul; Vienna; Melbourne; Hania, Greece; and Perugia, Italy; and at American Geophysical Union annual meetings in San Francisco. Locally, we have given presentations in the affected communities, in Dutch Harbor, and at the Association of Environmental & Engineering Geologists 2011 national meeting in Anchorage. In addition, this project has been the subject of articles in *Geotimes* and *TsuInfo Alert Newsletter*.

The town of Whittier, Alaska, which sustained severe damage from local submarine-landslide-generated waves during the 1964 great Alaska earthquake (Mw 9.2), resulting in 13 fatalities. Photograph by Gabriel Wolken.

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