ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

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).

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

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.

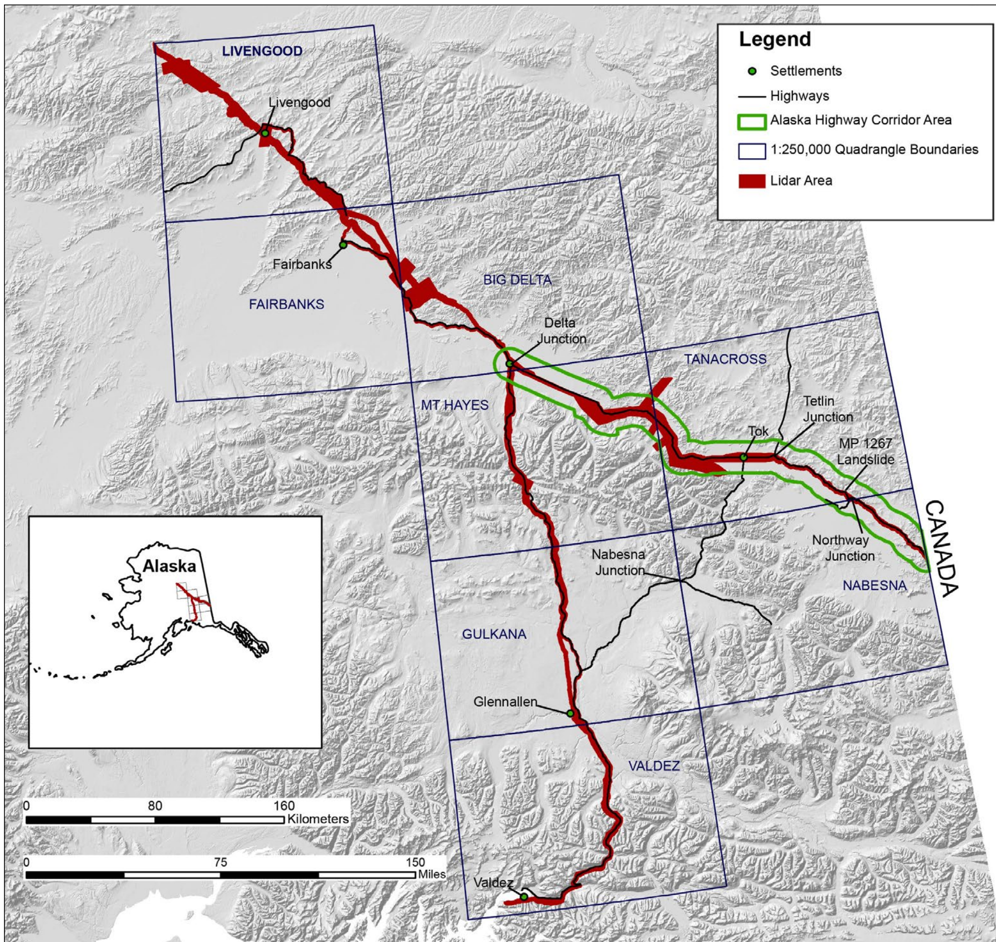
The observations from our 2014 efforts indicate that the Castle Mountain, Denali, and Park Road faults and the Northern Foothills thrust present the most significant surface fault rupture hazards to the proposed pipeline. Several other faults were determined to be characterized by low slip rates and/or 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.

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

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.

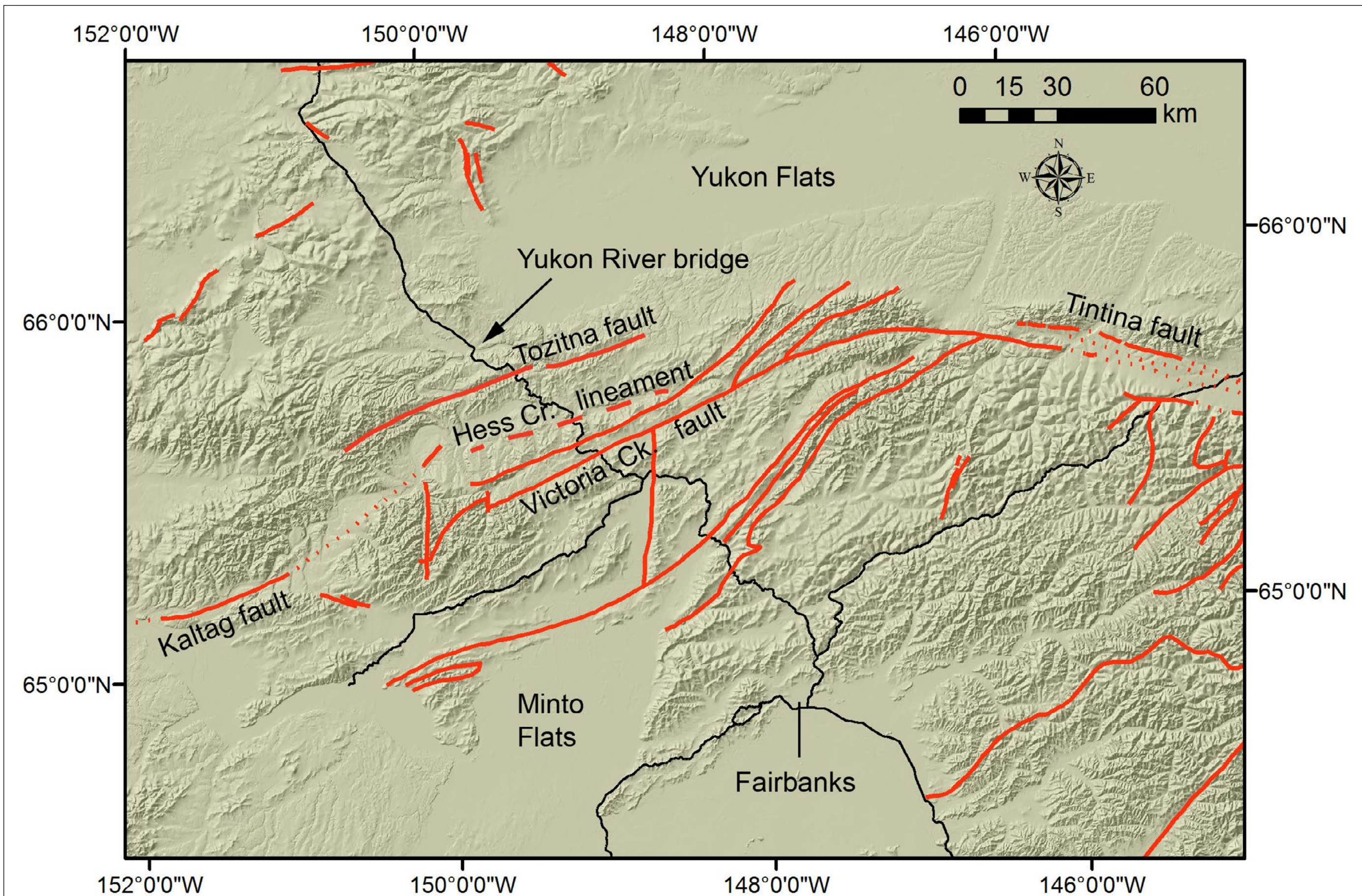
The Gas Pipeline Corridor project was funded by the State of Alaska as a Capital Improvement Project (CIP), with additional funding provided by the U.S. Geological Survey STATEMAP program.

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

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.

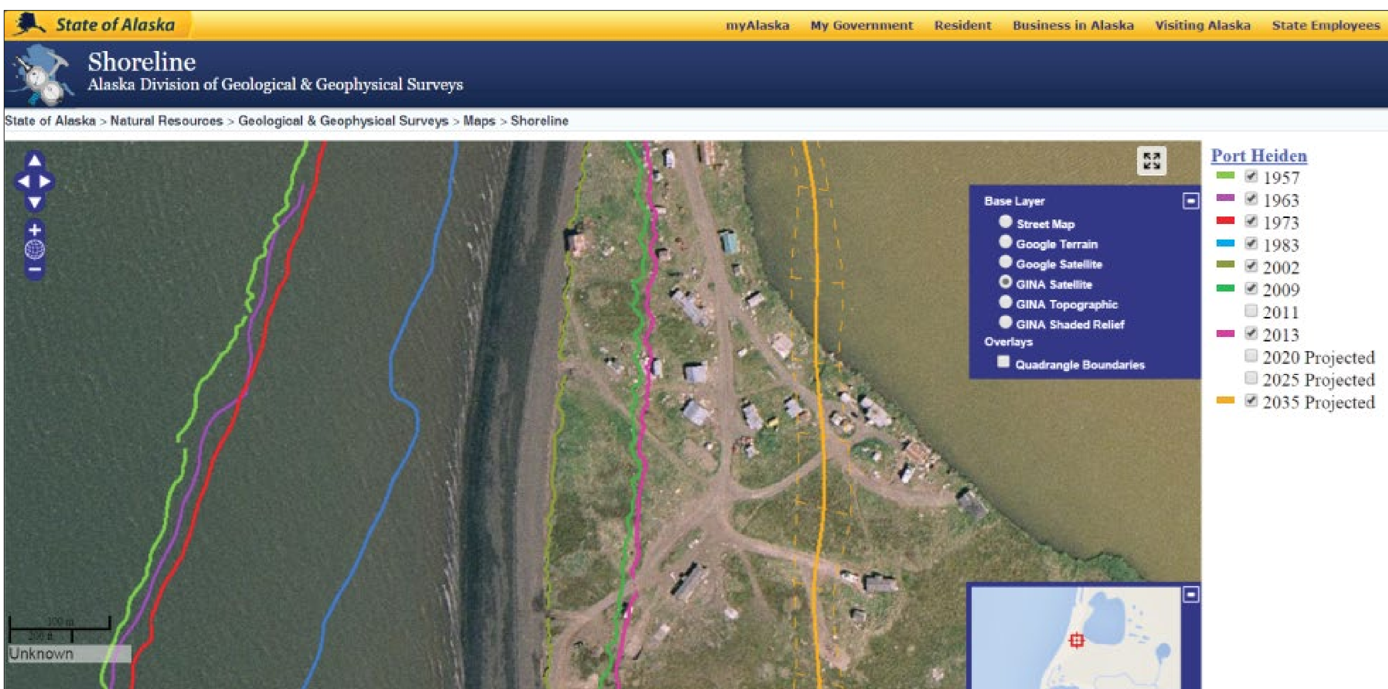
Contact: Richard Koehler, 907-451-5006, richard.koehler@alaska.gov

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.

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

ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

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).

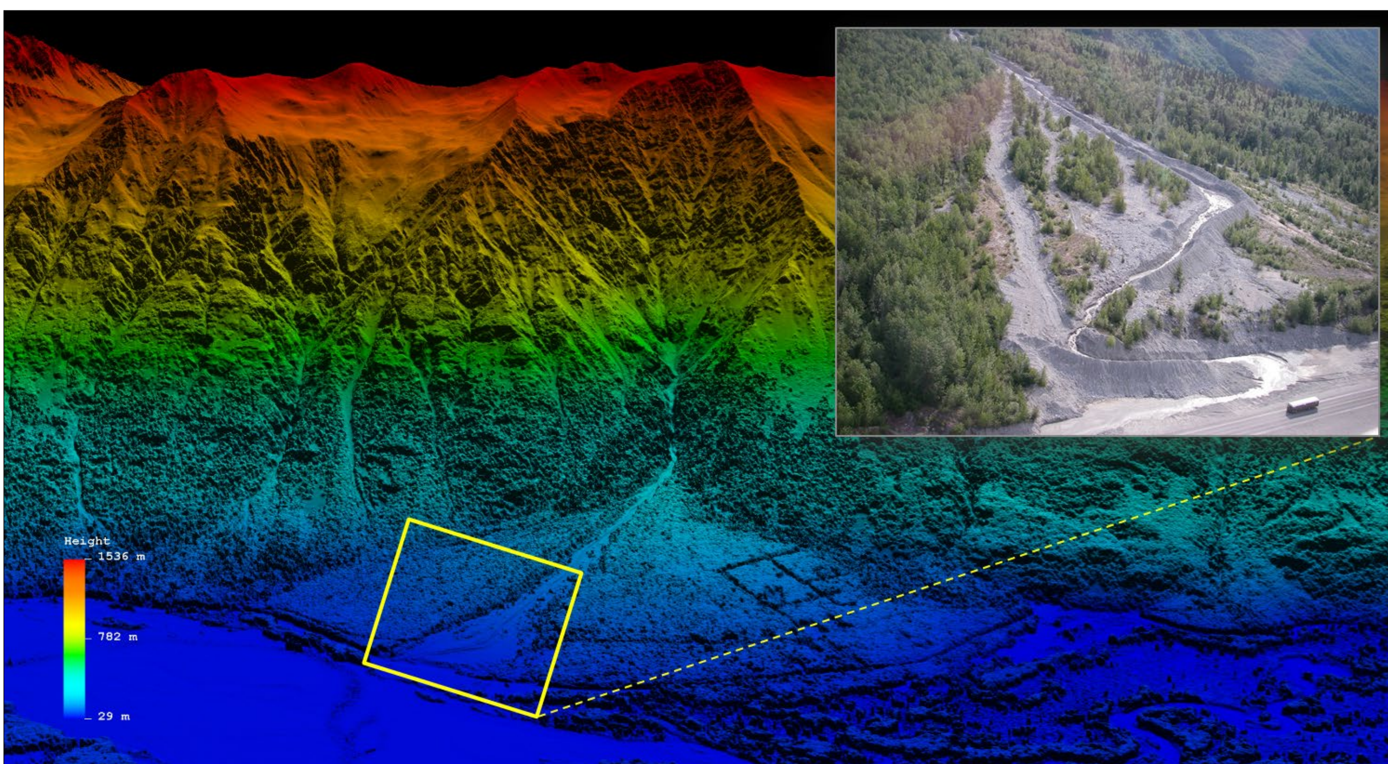


Figure 2. May 2014 photogrammetrically-derived digital surface model (DSM), produced by DGGS scientists, of the Haines Highway milepost 19 catchment.

Contact: Gabriel Wolken, 907-451-5018, gabriel.wolken@alaska.gov,
or Ronald Daanen, 907-451-5956, ronald.daanen@alaska.gov

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.

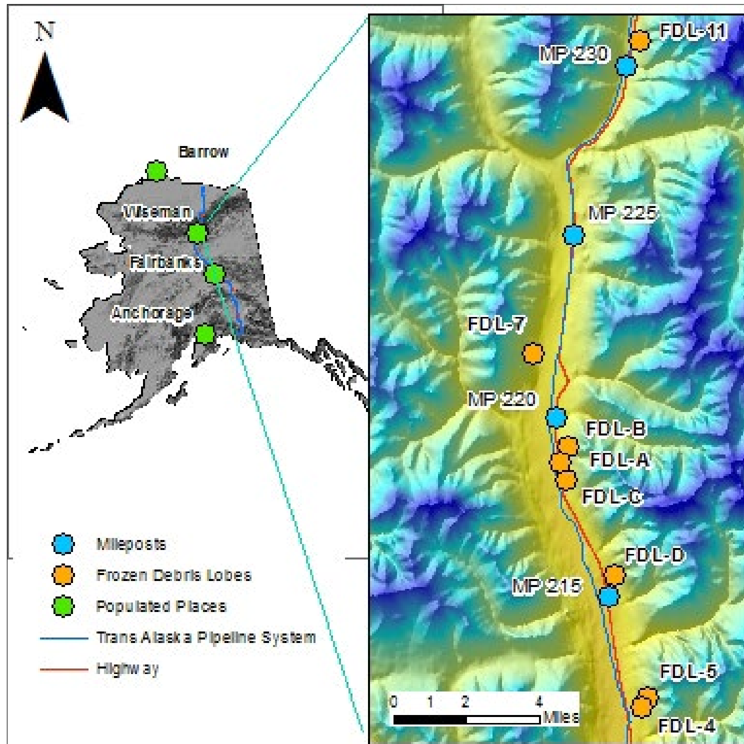


Figure 1. Locations of FDLs under evaluation along the Dalton Highway and TAPS in the southern Brooks Range. FDL-A currently poses the greatest threat to the Dalton Highway.

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.

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

CLIMATE AND CRYOSPHERE HAZARDS

Most high-latitude northern regions have undergone rapid and substantial warming over the last few decades. Alaska is particularly sensitive to the effects of climate warming, as much of its social and economic activity is connected to the existence of snow, ice, and permafrost (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).

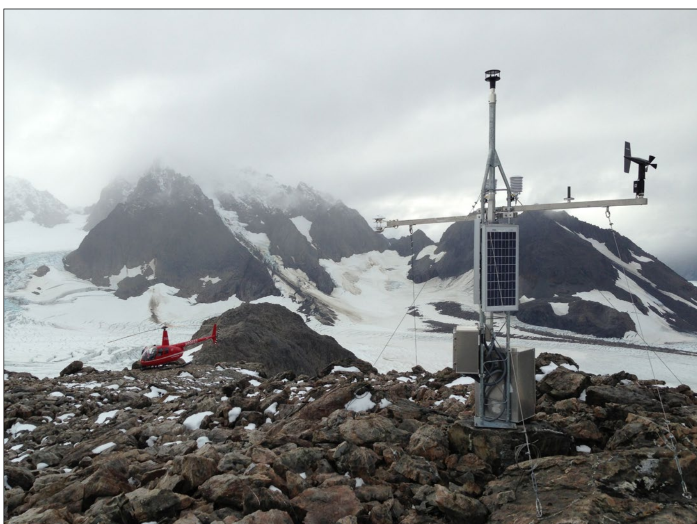


Figure 1. (above) Servicing a high-elevation weather station in the Scott Glacier watershed near Cordova, Alaska.

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

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

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.

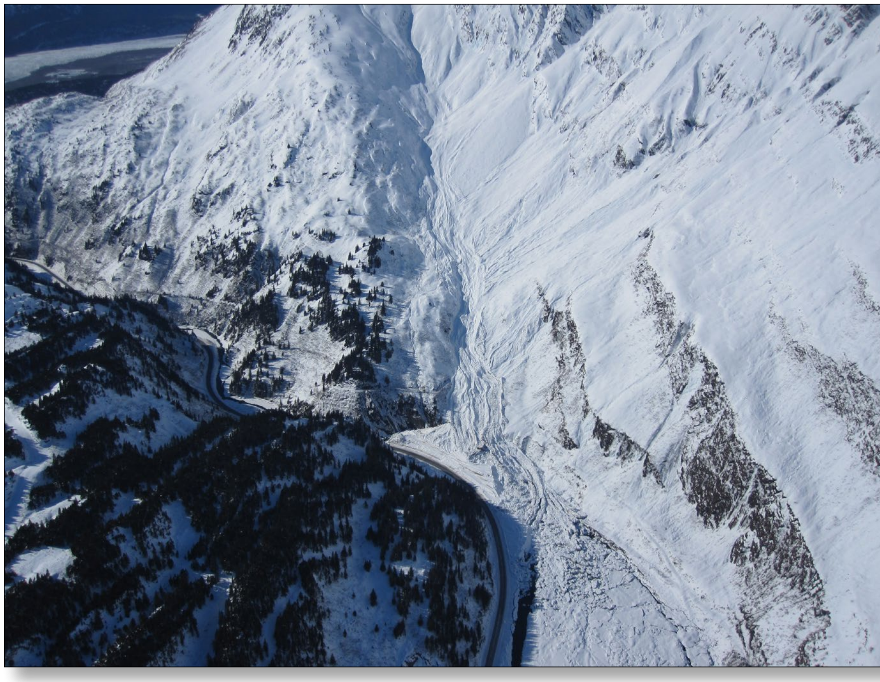


Figure 1. Oblique air photo of the Richardson Highway at Keystone Canyon two months after the large avalanche ("damalanche") that occurred in January 2014 and cut off the community of Valdez from the road system for several days. An enormous deposit of avalanche debris is visible along the side of the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

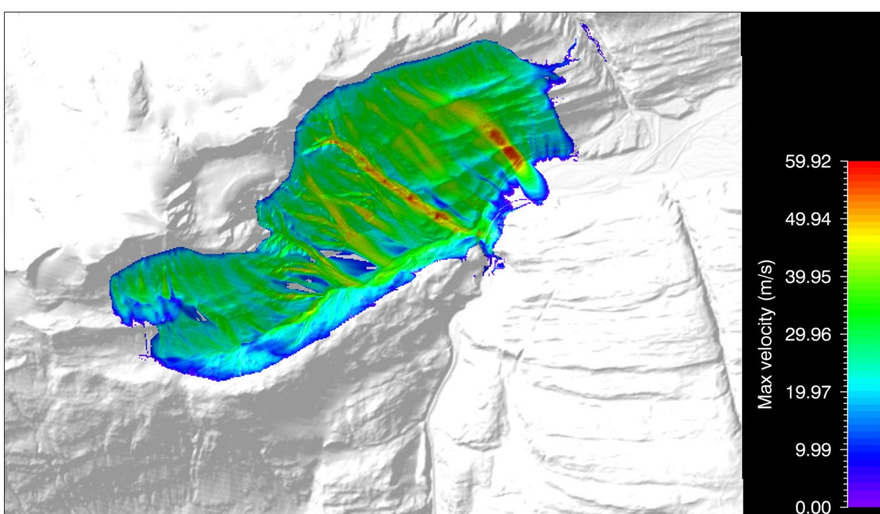


Figure 2. Preliminary snow avalanche model calibration results for Keystone Canyon, Richardson Highway, Alaska.

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

GLACIER AND RUNOFF CHANGES IN THE UPPER SUSITNA BASIN

The Alaska Energy Authority (AEA) has been authorized by the State of Alaska to perform studies required for the licensing process of the 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.

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

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).

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

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.

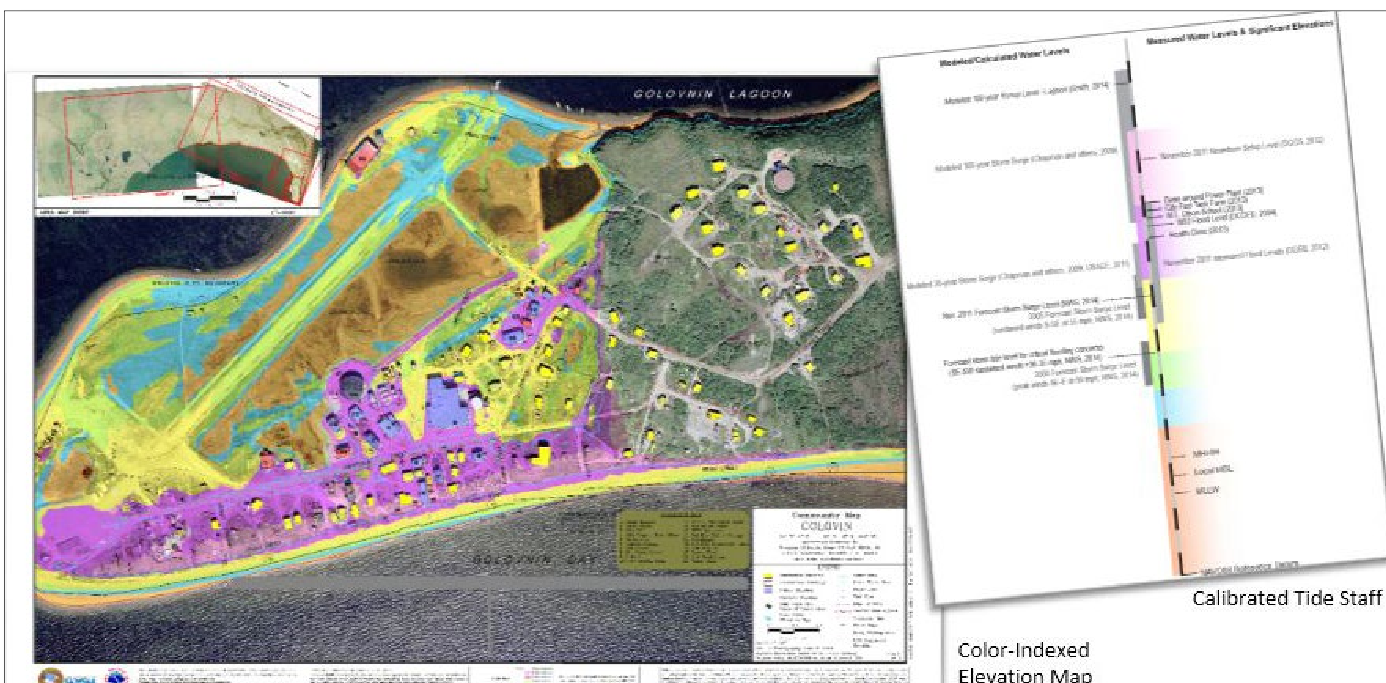


Figure 2. Color-indexed elevation map of Golovin, Alaska, and associated elevation key, in the form of a calibrated tide staff with documented and modeled water levels, displayed in a combined format to facilitate communication about water levels in an emergency situation.

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

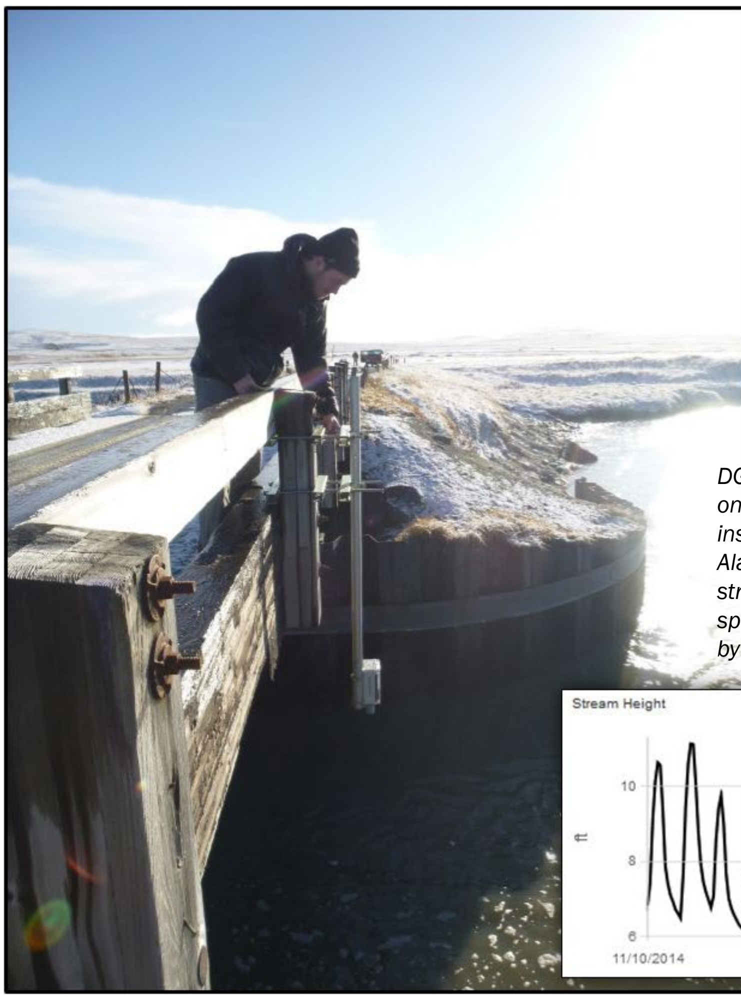
WATER LEVEL DOCUMENTATION AND VERTICAL DATUM RESOURCES

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.

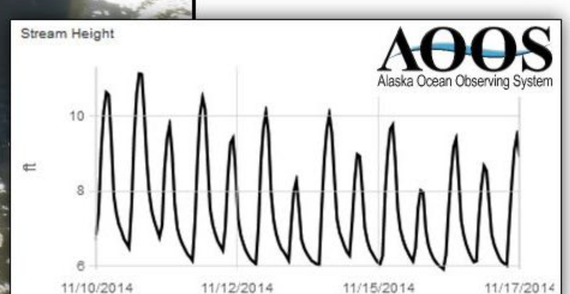
In partnership with the Alaska Ocean Observing System (AOOS) and the National Weather Service (NWS) Alaska Region, the Alaska Division of Geological & Geophysical Surveys' (DGGS) Coastal Program is seeking effective ways to fill gaps in Alaska's water-level network through a combination of traditional, 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.



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

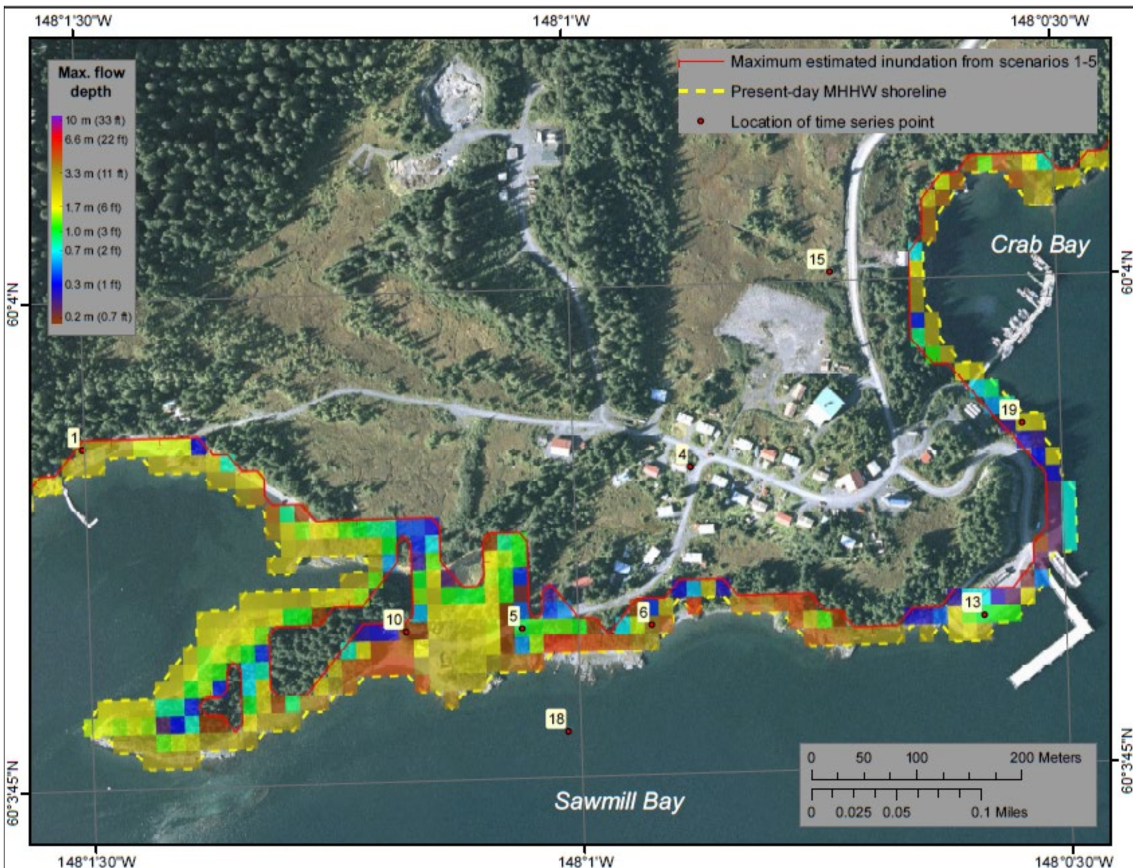
ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY2015 Project Description

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.

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

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.

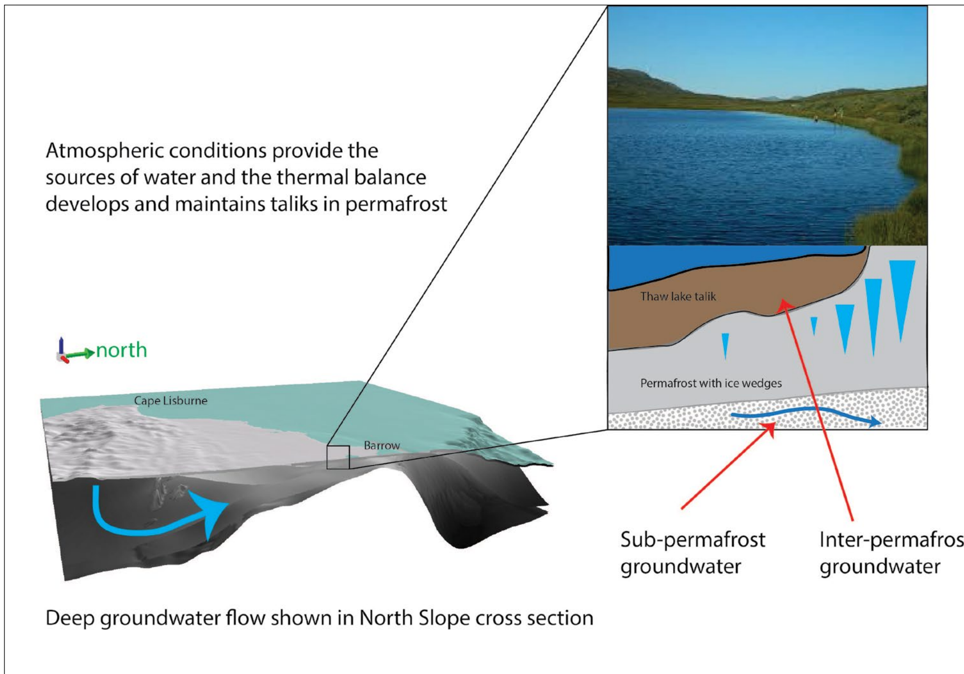


Figure 1. Key water sources of the North Slope and Brooks Range.

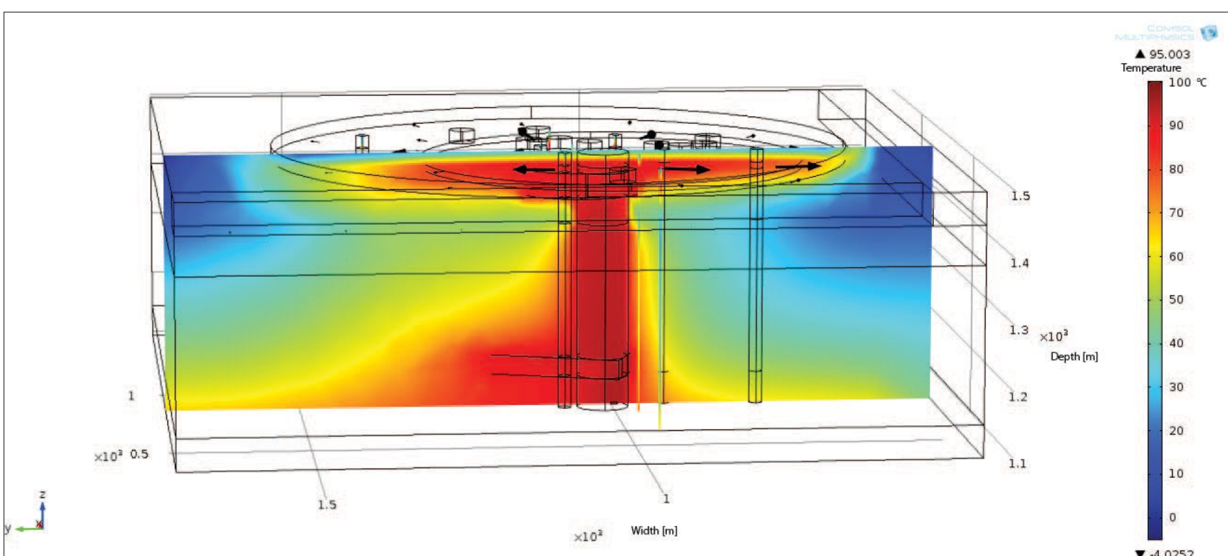


Figure 2. Results of groundwater flow simulation for Pilgrim Hot Springs geothermal anomaly.

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

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.

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.

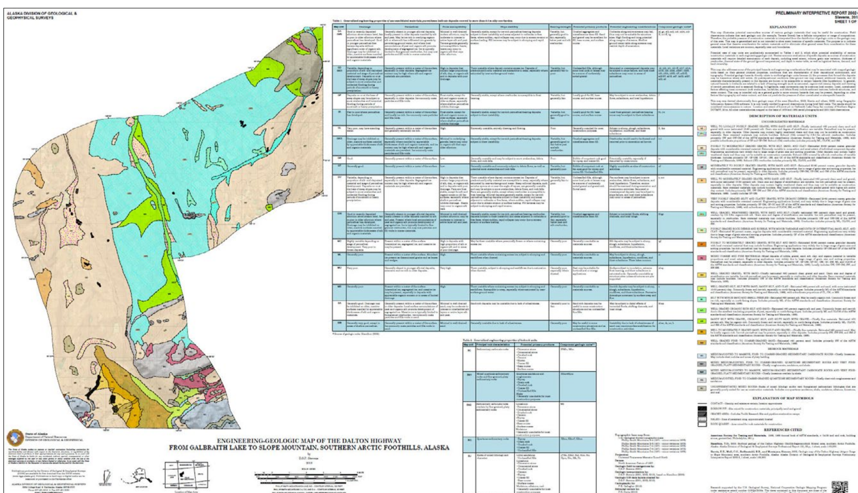


Figure 1. Engineering-geologic map of the Galbraith Lake area, published in 2014.

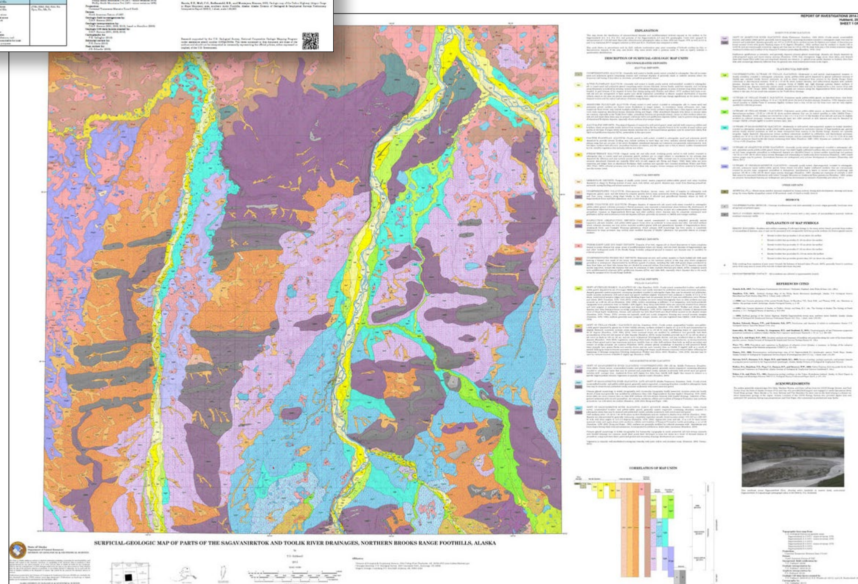


Figure 2. Final pre-publication draft of the DGGS surficial-geologic map of the Sagavanirktok area.

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