ALASKA COASTAL MANAGEMENT PROGRAM: NATURAL HAZARDS

DGGS provides support to Alaska Coastal Management Program (ACMP) personnel and coastal district planners regarding natural hazard issues. DGGS responsibilities include: reviewing natural hazard aspects of proposed coastal projects during the consistency review process; recommending state designation of hazard areas during consistency reviews when needed; providing support to coastal district planners in revising coastal management plans; par-ticipating in district teleconferences; and periodically reviewing regulatory and planning documents regarding natural hazards issues.

A lack of basic field data and baseline information on geologic hazards in Alaska makes it difficult for coastal districts and the State to implement the ACMP natural hazard standard (11 AAC 112.210). Coastal districts often do not have the scientific information needed to designate natural hazard areas in their district plans for the purpose of ensuring that coastal development adequately mitigates the risks of the hazards. During consistency review for a proposed project, the State can, under the standard, designate a natural hazard area so that hazards risks may be addressed in the review. DGGS assists DNR in development of the background information and formal designation of the hazard area.

The DGGS website provides access to the online "Guide to Geologic Hazards in Alaska," a bibliographic database with links to scanned maps and documents published by DGGS and the U.S. Geological Survey (USGS) that contain information relevant to hazard identification in Alaska: www.dggs.alaska.gov/geohazards . The guide is served from DGGS's publications database and is searchable by coastal district. In 2009, DGGS was awarded ACMP Enhancement Grant Program (EGP) funding to update the guide and make it more user-friendly to coastal district planners, ACMP, and project applicants. The revised online guide is facilitating delivery of new geologic hazard maps and reports planned by DGGS under the Coastal Impact Assistance Program (CIAP; described on p. 56) and recommended by the Climate Change Cabinet's Immediate Action Workgroup. DGGS has been awarded additional EGP funding in 2010 to expand this project. The upgraded Guide to Geologic Hazards in Alaska will act as a resiliency tool, providing districts centralized data that can support proposed natural hazards designations and policies, planning, and federal reporting on natural hazards. The upgrade plan includes incorporating the geographic extents of published hazards data (collected in part from the DGGS Map Index project [described on p. 52]), to develop a functional prototype of an interactive geologic-hazards bibliography map- and text-based search interface using a GoogleMaps-type application.

Figure 1. The DGGS online "Guide to Geologic Hazards in Alaska" has been updated to include relevant new published information and internet sites as well as to provide expanded information about the types of geologic hazards present in Alaska. The guide will also be enhanced by the addition of a searchable map interface that will allow users to more easily identify bibliographic resources available for their area of interest.

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ASSESSMENTS OF GEOLOGIC HAZARDS ASSOCIATED WITH CLIMATE CHANGE

Studies have shown clearly that high-latitude regions are experiencing the impacts of a sustained and amplified climate-warming trend. Alaska's high-latitude location makes it particularly sensitive to the effects of climate change, which can include the modification or enhancement of natural geomorphic processes. These modifications could increase the magnitude and frequency of some kinds of geologic hazards (such as erosion, flooding, 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 (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 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 proper, 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 will 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 surficial-geologic and 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 a collaboration with relevant outside organizations including the Immediate Action Work Group of the Governor's Subcabinet on Climate Change, University of Alaska, Federal Emergency Management Agency, Alaska Division of Homeland Security & Emergency Management, Alaska Division of Coastal & Ocean Management, Alaska Department of Commerce, Community and Economic Development, U.S. Geological Survey, and U.S. Army Corps of Engineers, and will provide valuable information to allow planners and design engineers to minimize the economic impacts and public safety risks associated with geologic hazards.

DGGS scientists conducted field-based geologic hazards assessments and mapping in and around the communities of Kivalina and Koyukuk during summer 2010, and expect to complete the first products of this project in FY2011. The geologic-hazards and surficial-geologic maps will be published in digital GIS format in conformance with national standards and will delineate areas where potential natural hazards such as erosion, slope instability, flooding, and thawing permafrost should be considered at a more detailed level to fully evaluate risk for any given use. The maps will also help evaluate proposed relocation sites for communities that must move to avoid irreparable damage, and identify potential sources for construction materials. 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).

Figure 1. Permafrost cellar near the Wulik River, northwestern Alaska. Warming temperatures and thawing permafrost can flood permafrost cellars and threaten food supplies in some villages in rural Alaska. Natural processes, such as thawing permafrost, are likely to be modified by climate change.

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GEOHAZARD EVALUATION AND GEOLOGIC MAPPING FOR COASTAL COMMUNITIES

Approximately 6,600 miles of Alaska's coastline and many low-lying areas along the state's rivers are subject to severe flooding and erosion. The United States General Accounting Office (GAO; now the U.S. Government Accountability Office) reported in 2004 that flooding and erosion affects 184 out of 213 (86 percent) Alaska Native villages, and most of these are coastal communities (fig. 1). Many of the problems are long-standing, although some studies indicate that increased flooding and erosion are being caused in part by changing climate. These findings were reinforced in 2006, when the U.S. Army Corps of Engineers determined that the coastal villages of Kivalina, Newtok, and Shishmaref have only 10–15 years left in their current locations before being irretrievably lost to erosion if countermeasures are not implemented. The Immediate Action Work Group (IAWG) of the Governor's Subcabinet on Climate Change made a series of recommendations in 2009 that represent an intensive collaborative effort undertaken in an open public forum to address the immediate needs of the state, with a specific focus on six communities in peril: Newtok, Shishmaref, Kivalina, Koyukuk, Unalakleet, and Shaktoolik (fig. 2). Four of the top six at-risk villages are located on the coast.

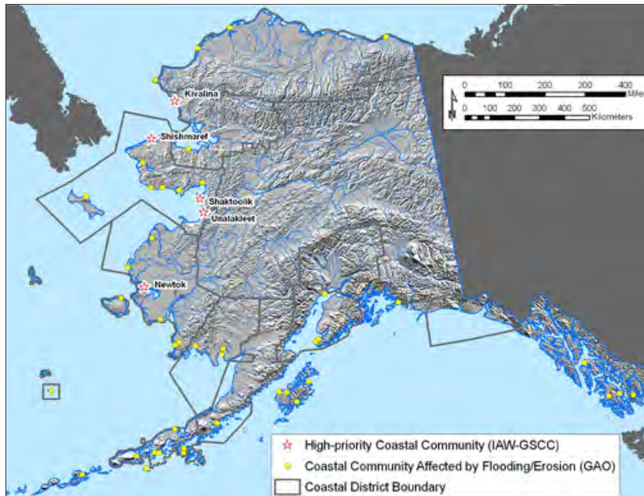

Figure 1. Map showing the distribution of Alaskan communities at risk for coastal flooding and erosion.

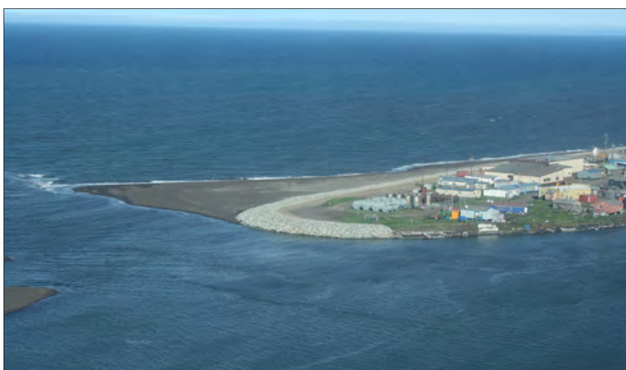

Figure 2. The village of Kivalina, northwestern Alaska. The engineered rock barrier is designed to help protect the town against coastal erosion.

In response to these issues, the Division of Geological & Geophysical Surveys (DGGS) has initiated a program of coastal community geohazards evaluation and geologic mapping in support of community and district planning. External support for this effort comes from the federal Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE; formerly the U.S. Minerals Management Service, MMS) as part of the Coastal Impact Assistance Program (CIAP). In 2010, DGGS hired a new staff geologist specializing in coastal hazards and began to collect the necessary field data to produce and publish surficial and engineering-geologic/hazards maps of Alaska coastal communities, prioritized in consultation with the IAWG, Alaska Division of Community and Regional Affairs, Alaska Coastal Management Program staff, U.S. Army Corps of Engineers (COE), and affected coastal districts. Kivalina was selected as the pilot community for DGGS's first mapping efforts, leveraging federal STATEMAP and state CIP funds to enhance the scope of the project. The maps produced by this program will identify local natural hazards and other geologic factors 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. Maps may include proposed relocation sites in response to the severe coastal erosion problems now facing various Alaskan communities. Mapping will be completed at local and/or regional scales as needed to address specific local problems and to understand and evaluate the larger geologic context of the area. The engineering-geologic/hazards maps will be published in GIS format with standard metadata and will delineate areas where natural hazards such as erosion, slope instability, active faults, flooding, and earthquake effects should be considered at a more detailed level to fully evaluate construction risk and to ensure that the coastal areas are not damaged by planned and proposed development. Project work will be coordinated with current U.S. Geological Survey coastal studies to ensure there is no duplication of effort. DGGS expects to complete the geohazard evaluation and hazard mapping for Kivalina in FY2011 and two or more communities in each of the following three years. Target communities for FY2011 mapping are likely to include Shaktoolik and Unalakleet.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

GEOLOGIC MAPPING AND HAZARDS EVALUATION IN AND NEAR KIVALINA, NORTHWEST ALASKA

Approximately 10,600 kilometers of Alaska's coastline and many low-lying areas along the state's rivers are subject to severe flooding and erosion. The United States General Accounting Office (GAO; now the U.S. Government Accountability Office) reported in 2004 that flooding and erosion affects 184 out of 213 (86 percent of) Alaska Native villages. These findings were reinforced by subsequent studies, conducted by the U.S Army Corps of Engineers (2006) and the Immediate Action Workgroup of the Alaska Governor's Subcabinet on Climate Change (2008), that identified Kivalina as among the most imperiled communities in Alaska due to climate-change phenomena and therefore in most need of immediate actions to prevent loss of life and property.

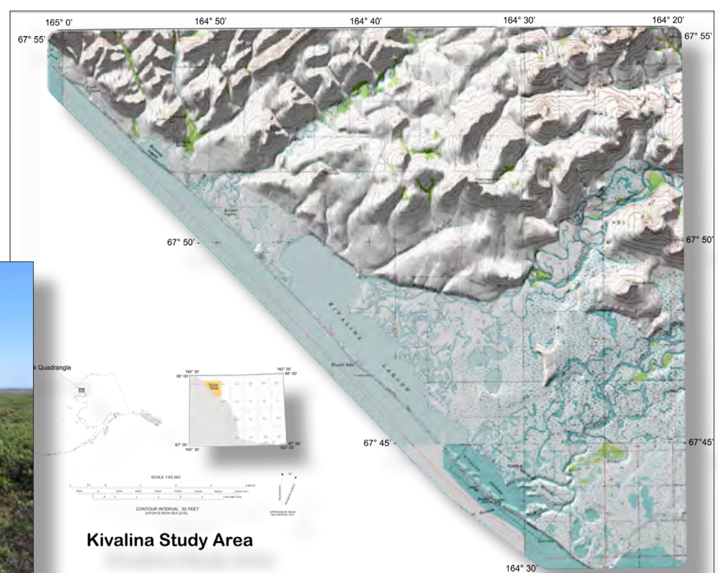
The Alaska Division of Geological & Geophysical Surveys (DGGS) has statutory responsibility to perform the necessary sound science to identify high-risk areas where proactive mitigation efforts will be needed and useful. Alaska's Geologic Mapping Advisory Board (GMAB) endorsed DGGS's choice of Kivalina (fig. 1) as a project to be funded by the U.S. Geological Survey's STATEMAP program in order to map surficial geology and assess geologic materials and natural hazards in support of informed community planning.

The objectives of the 2010 Kivalina STATEMAP project are: (1) Map the surficial geology in sufficient detail to develop comprehensive lithologic unit descriptions and a geomorphic framework that can be used to understand the active earth processes affecting the village of Kivalina and the surrounding area, and map the bedrock geology at a reconnaissance level sufficient to evaluate the lithologies for general engineering and materials characteristics; (2) Develop information matrices and derive maps that describe the general engineering properties of bedrock and unconsolidated geologic units in the map area; and (3) Identify and map potential geologic hazards, including the coastal zone and areas of flooding, erosion, thawing permafrost, and slope instability (fig. 2).

DGGS scientists completed fieldwork in the Kivalina STATEMAP area in July 2010 and are analyzing data and generating map products. Final products will be published in 2011 and include a report and maps describing the geologic setting and natural hazards of the study area. These new data will be critical to community planners as they develop and administer their plans in the context of major undertakings ranging from construction of engineered protective structures to possible relocation of the entire village.

Federal STATEMAP funding for this project is matched by state Capital Improvement Project (CIP) funds through DGGS's Climate Change Hazards program. Supplementary funds are from the U.S. Minerals Management Service (MMS) as part of the Coastal Impact Assistance Program (CIAP).

Figure 1. Map showing location of the Kivalina study area.



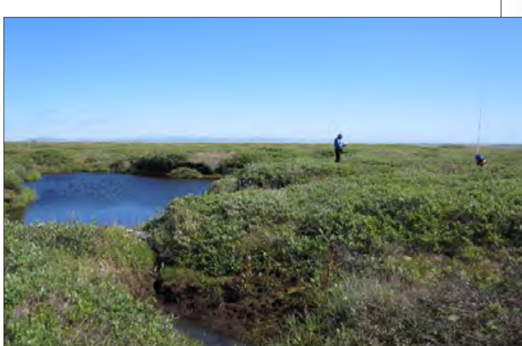


Figure 2. Thermokarst and drainage system development near Kivalina, Alaska.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

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

In preparation for the proposed Alaska natural gas pipeline, the Alaska Division of Geological & Geophysical Surveys (DGGS) is continuing work on a multi-year project to evaluate the geology, geohazards, and material resources between Delta Junction and the Canada border along a 12-mile-wide corridor centered along the Alaska Highway (fig. 1). Information obtained as a result of this study has been utilized for time-critical alignment, engineering, design and permitting decisions. Published materials from each of three segments along this route will include reports describing surficial geology, permafrost, bedrock geology, and potentially active faults. Each report, with the exception of the one describing potentially active faults, will be accompanied by 1:63,360-scale geologic maps. An engineering-geologic map and associated descriptive table will also be published as a derivative product from each surficial-geologic map. The bedrock mapping portion of this project is described separately (see p. 50). All maps are being made available as digital GIS files with accompanying metadata.

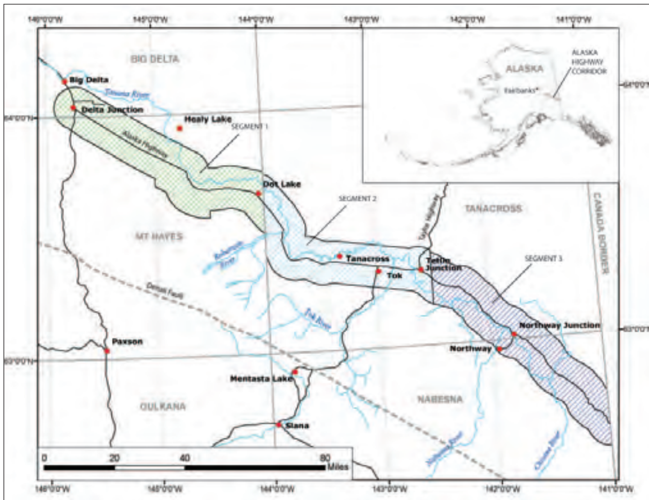

Figure 1. Location of the three segments of the study area.

For corridor Segment 2, between Dot Lake and Tetlin Junction, products in 2010 include a report on potentially active faults, a report and associated maps describing permafrost, and engineering-geologic maps with descriptive tables. DGGS is also currently engaged in report writing and map preparation for the third segment of the corridor between Tetlin Junction and the Canada border. We anticipate publication of the surficial-geologic map and report for Segment 2 in the fall of 2010 and all Segment 3 maps and reports by the fall of 2011.

DGGS personnel and contractors conducted field work during the summer and fall of 2010 to address additional questions arising from evaluation of previous years' results and to collect more data for completing a final compilation report that will include revised GIS maps for the entire corridor. Fieldwork included refining the permafrost, surficial- and engineering-geologic mapping and assessing areas along the Alaska Highway that are undergoing active slope failures (fig. 2). Additionally, we evaluated a paleoseismic trench along a lineament south of Alaska Highway milepost 1338 for evidence of recent fault activity. Information from field investigations was used in posters presented in fall 2010 at meetings of the Geological Society of America and the American Geophysical Union. During 2011, we will perform minor final fieldwork to resolve remaining geologic issues and to inspect any significant newly identified features that become apparent from high-resolution LiDAR (Light Detection and Ranging) data being collected in the entire proposed pipeline corridor (described separately; see p. xx). We anticipate completing the final compilation maps and report by winter 2012.

The Gas Pipeline Corridor Project is funded by the State of Alaska as a Capital Improvement Project (CIP).

Figure 2. Cracking of road surface resulting from active slope movement along the Alaska Highway near milepost 1272.

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LIDAR ACQUISITION FOR GEOLOGIC HAZARD EVALUATION

LiDAR (Light Detection and Ranging) has proven to be a highly useful form of remotely sensed data for identification and characterization of potentially active faults and many other surficial-geologic landforms and hazards, especially in areas of heavy vegetative cover where access may be difficult and other forms of remotely sensed data are ineffective. Because of its documented effectiveness as a tool for evaluating geology and geologic hazards, the Alaska Division of Geological & Geophysical Surveys (DGGS), with support from the Alaska Gas Pipeline Office and the Office of the Federal Coordinator, contracted Watershed Sciences, Inc. to acquire high-resolution LiDAR data (8 pulses per square meter) for an area of 1,578,504 acres beginning in the fall of 2010.

LiDAR acquisition areas (fig. 1) consist of: (1) contiguous 1-mile-width coverage over existing infrastructure along the entire length of the proposed natural gas pipeline corridor from Prudhoe Bay to the Canada border (following the Alaska Highway) and from Delta Junction to Valdez; (2) half-mile-wide coverage of existing primary pipeline-support roads where outside the main corridor; and (3) expanded areas of coverage along these corridors where data are needed for evaluation of active faults, slope instability, and other hazards.

The LiDAR data will serve multiple purposes, but will be primarily used to evaluate active faulting, slope instability, thaw settlement, erosion, and other engineering constraints along the proposed pipeline routes, and to provide a base layer for the state–federal GIS database that will be used to evaluate permit applications and construction plans.

Watershed Sciences, Inc., began work in mid September and was able to collect data for 128,221 acres, or about 22 percent of the total survey area, before the onset of snow prevented further acquisition. Data were collected for most of the targeted area between Delta Junction and the Canada border as well as between Delta Junction and Paxson. Remaining data collection will take place in the spring and summer of 2011, with anticipated completion by August 2011. Data delivery to DGGS will be staged beginning in early 2011. After quality control and analysis, data, including bare earth Digital Elevation Models (DEM's), will be made available to the public via the DGGS web page.

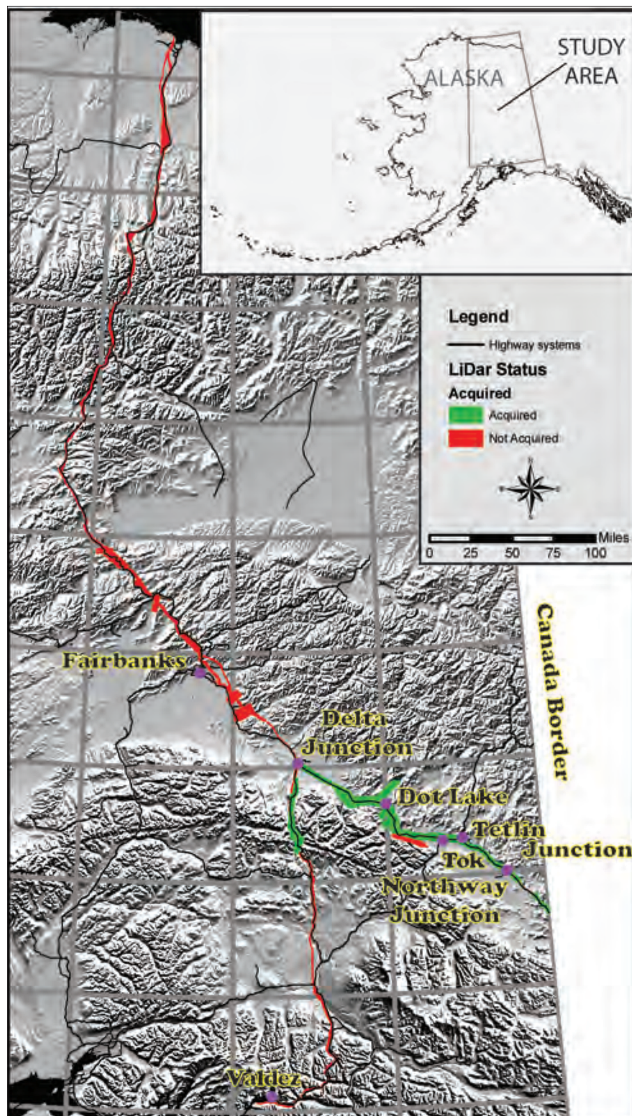

Figure 1. Map showing LiDAR acquisition areas.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

MapTEACH

The Alaska Division of Geological & Geophysical Surveys (DGGS) continues to participate in MapTEACH (Mapping Technology Experiences with Alaska's Community Heritage), an education-outreach program that targets geospatial technology skills for rural Alaska students (fig. 1). This program is a continuation of what was originally a multi-year NSF-funded collaborative project by DGGS and is now an important part of the University of Alaska Integrated Geography Program, which has embraced it as their "flagship K–12 outreach program." MapTEACH emphasizes hands-on experience with spatial technology (GPS, GIS, 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.

Figure 1. The MapTEACH website offers curriculum resources and other helpful information about the program to teachers wishing to explore place-based education in Alaska. The program was originally named "Mapping Technology Experiences with Alaska's Cultural Heritage," but "Cultural" has been replaced by "Community" to reflect the broader context into which MapTEACH has grown.

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 data sets that can be applied to informed community planning and decision making.

MapTEACH is currently working with the Yukon–Koyukuk and Yukon Flats school districts to train science and geography teachers in the use of the MapTEACH curriculum (fig. 2). Class implementation projects to date have included an erosion study in Huslia, re-clearing and mapping an abandoned nature trail in Ruby, mapping Native place names in Koyukuk and Nulato, and mapping a road trip from Manley Hot Springs to Seward.

Figure 2. A Fort Yukon teacher prepares to core a tree on a MapTEACH field trip. Teacher training workshops were held in Fairbanks for teachers from the Yukon–Koyukuk and Yukon Flats school districts in which they learned about permafrost effects on landscape and vegetation , and gained experience in digital mapping using GPS units, GIS and GoogleEarth.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

QUATERNARY FAULT AND FOLD DATABASE

The Division of Geological & Geophysical Surveys (DGGS) is continuing collaborative efforts with the U.S. Geological Survey (USGS) to develop a Quaternary fault and fold database for the State of Alaska (fig. 1). Partial funding for GIS support has been provided by the Federal Office of Emergency Management (FEMA) in a grant to DGGS. The on-line resource will be of great utility to the earthquake engineering community, the insurance industry, scientific researchers, and the general public, and will contribute to the established database of active faults for the nation. Although Alaska is one of the most seismically active states, information on Quaternary tectonics is sparse. The November 3, 2002, magnitude 7.9 Denali fault earthquake and a large scarp in the vicinity of Anchorage along the Castle Mountain fault attest to the importance of information related to the location of past and future earthquakes. When completed, the database will also help identify gaps and problems in the existing information as a means of prioritizing future field investigations to identify, map, and describe Quaternary faults and folds.

DGGS is digitizing a GIS database of fault traces and fold axes (with associated attributes and in compliance with national guidelines) from 1:250,000-scale published data . In some cases, where more detailed maps are available, faults are digitized at a scale of 1:63,360. In support of the database, DGGS has completed a comprehensive literature search for published materials on Quaternary faults and folds and is in the process of creating text-based descriptions for individual structures. The descriptions summarize pertinent data such as geographic information, geomorphic expression, length, average strike, sense of movement, age of faulted surficial deposits, existing paleoseismological studies, and a list of references. The database will be incorporated into the existing USGS Quaternary fault and fold database, which provides users with a powerful user-friendly map interface linked to the available data.

We have completed digital mapping of eight major structures, including the Denali, Castle Mountain, Queen Charlotte–Fairweather, Iditarod–Nixon, Kaltag, Bendeleben, Patton Bay, and Hanning Bay faults. Fault digitizing will next concentrate on the Northern Alaska Range Foothills Fold and Thrust Belt and the southern Yakutat collision zone. Given the number of faults and lack of information on many structures, the complete dataset will take years to complete. Therefore, DGGS is concentrating efforts along structures that pose the greatest seismic hazards and/or have potential to impact planned and likely future development in the state. Our initial effort will serve as a platform up which to add additional information as new faults are discovered and future detailed studies are performed. Ultimately, the database will provide a comprehensive resource for seismic hazard assessment and regional policy planning.

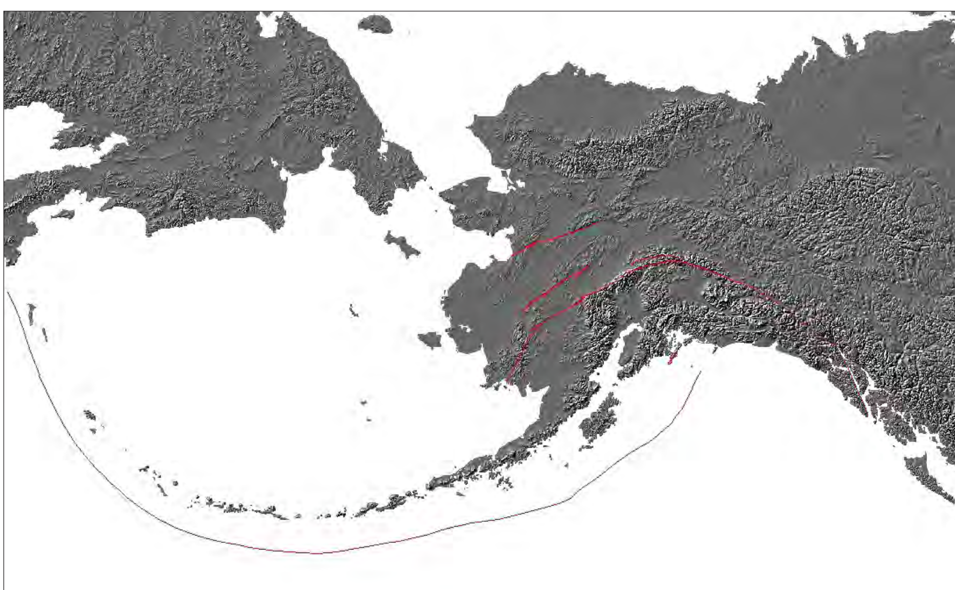

Figure 1. Digital shaded relief map of Alaska showing faults already digitized as part of the DGGS/USGS Quaternary fault and fold database project.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

SURFICIAL-GEOLOGIC AND NEOTECTONIC MAPPING OF THE SLATE CREEK AREA, MT. HAYES QUADRANGLE, SOUTH-CENTRAL ALASKA

The Alaska Division of Geological & Geophysical Surveys (DGGS) conducted surficial-geologic and neotectonic mapping of about 113 square miles of the Chistochina geophysical survey tract during July 2009. This mapping project was primarily funded by State capital project funds, with supplementary Federal STATEMAP funding from the U.S. Geological Survey (USGS). The Slate Creek study area is located in the southern foothills of the Alaska Range about 140 miles southeast of Fairbanks and 20 miles east of Paxson (fig. 1). The 1,240-mile-long (2,000-kilometer-long) right-lateral Denali fault bounds the northern margin of the map area and was the source of the Mw 7.9 Denali fault earthquake on November 3, 2002, that caused significant damage to transportation corridors and many communities, as well as impacting the Trans-Alaska Pipeline. To identify and study evidence for past earthquakes along the Denali fault in this area, DGGS, in conjunction with the USGS, initiated a paleoseismic trench study as part of this project.

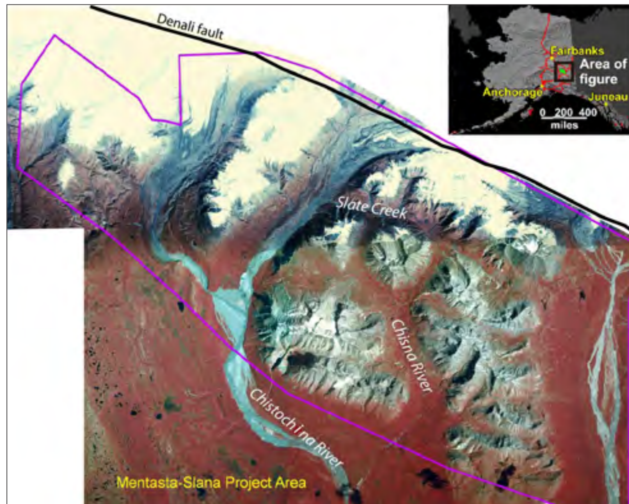

Figure 1. Location map of Slate Creek area, showing approximate trace of the Denali fault.

During Pleistocene time, the map area was inundated by ice that was part of an extensive system of alpine glaciers and ice caps of the Alaska Range that coalesced with the Cordilleran Ice Sheet and reached all the way to the Gulf of Alaska. The map area was also extensively glaciated during late Wisconsin time, with ice reaching up to 30 miles (50 kilometers) from the rangefront at its maximum extent 25,000–20,000 years ago. Glacially-oversteepened slopes and comparatively recent loss of ice buttresses, possibly combined with proximity to the Denali fault and its attendant seismicity, have resulted in numerous landslides. Three trenches were hand dug on the 2002 rupture trace of the Denali fault. Six faults were identified on one trench, all of which break the entire stratigraphic section to the surface and thus indicate rupture during the 2002 event. The other two trenches suggest the occurrence of at least two paleoearthquakes.

Figure 2. Draft surficial-geologic map of the Mentasta–Slate Creek area. Green = Pleistocene glacial deposits; purple = Holocene glacial deposits; orange = colluvial deposits; yellow = alluvial deposits; gray = bedrock.

New surficial-geologic mapping (fig. 2) will lead to a better understanding of the region's Quaternary geologic framework and provide geologic-resource and -hazards data critical to land-use decisions. Paleoearthquake chronology data developed in collaboration with our USGS colleagues are being compared to paleoseismic histories determined at other sites along the central and eastern Denali fault, and will ultimately be used to develop earthquake recurrence models for south-central Alaska. This information will also contribute to Alaska's Quaternary Fault and Fold Database (QFF project, described separately). Products of the Slate Creek project anticipated by late 2011 include a report and a geologic map (1:50,000 scale) describing surficial-geologic deposits. A Report of Investigations (RI) summarizing the results of the paleoseismic investigation has been reviewed internally by the USGS and will be finalized in Spring 2011. Bedrock mapping performed in conjunction with this project is described separately.

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SURFICIAL-GEOLOGIC AND NEOTECTONIC MAPPING OF THE TYONEK AREA, WESTERN COOK INLET, ALASKA

In conjunction with the 2010 Tyonek STATEMAP project (described separately), the Division of Geological & Geophysical Surveys (DGGS) is undertaking surficial-geologic mapping and neotectonic investigation on the western side of Cook Inlet (fig. 1). The map area straddles the northwestern margin of Cook Inlet basin and encompasses about 875 square miles (2,266 square kilometers) of State and Native corporation land. The Lake Clark fault is a right oblique reverse fault that extends ~105 miles (~170 kilometers) northeast from Lake Clark in the western Alaska Range to the northern Cook Inlet forearc basin. Post Eocene right lateral and north-side-up vertical displacements of 16 miles (26 kilometers) and 1,640–3,280 feet (500–1,000 meters), respectively, are well documented. Details about the fault's Quaternary history are limited to only a few observations.

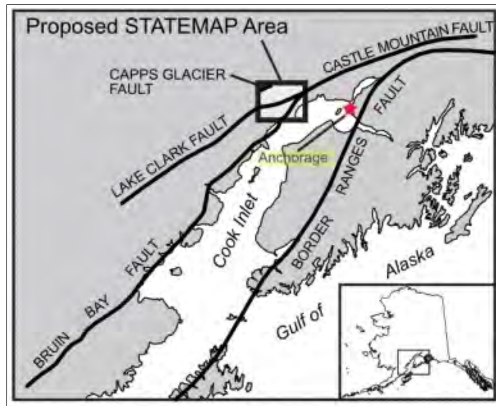

Figure 1. Location map of Tyonek area.

Glacial, volcanic, and mass-movement deposits dominate the Tyonek landscape (fig. 2). During the last major glaciation, the map area was invaded by the massive Cordilleran Ice Sheet, which spread eastward into the Cook Inlet trough from sources in the southern Alaska Range to the west and north. Following the maximum ice extent about 23,000 years ago, the glacier complex thinned and ice from individual lobes fluctuated as it deposited glacial and glacioestuarine material that is now preserved in the coastal lowland area of northwestern Cook Inlet. Volcanism centered on the Mt. Spurr complex temporarily dammed the valley of Chakachatna River, producing massive flooding in the southwestern part of the map area. Massive landslides displace bedrock and Quaternary sediments in the uplands and valley walls of incised streams, and the volcanic plateau in the northwestern map area is being dismantled by complex landslides along the eastern and western margins. Our neotectonic investigation places broad constraints on the recency of activity along the Lake Clark fault. The results indicate that the eastern part of the fault is characterized by a relatively low rate of activity and has been tectonically quiescent since at least 21,000 years ago.

New geologic mapping will lead to a better understanding of the region's geologic framework and provide geologic-resource and -hazards data critical to land-use decisions. The neotectonic data are important for seismic hazards assessments related to petroleum production infrastructure and potential future coal resource and hydroelectric power development, as well as seismic safety of the greater Anchorage metropolitan area. The results of the neotectonic study will ultimately be incorporated into the Alaska Quaternary Fault and Fold database (see p. 61). Final products of the Tyonek project will include two reports and a geologic map at 1:63,360 scale. The neotectonics report is presently in review and expected to be completed in Spring 2011. A map and report describing the surficial geology will be completed by late 2011. Bedrock geologic mapping performed in conjunction with this project is described separately.

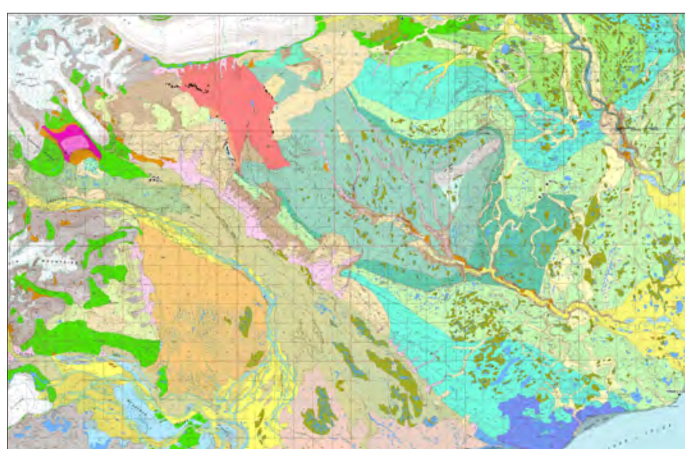

Figure 2. Draft surficial-geologic map of the Tyonek area. Green = glacial deposits; yellow = alluvial deposits; blue = glacioestuarine deposits; tan = landslides; and dark pink = volcanic deposits.

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ALASKA DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
FY11 Project Description

SURFICIAL GEOLOGY IN THE SAGAVANIRKTOK QUADRANGLE, NORTH SLOPE ALASKA

In 2010 the Alaska Division of Geological & Geophysical Surveys (DGGS) continued compiling surficial-geologic maps of a 1,212-square-mile area straddling the Dalton Highway in the northern Brooks Range foothills in the Sagavanirktok B-3, B-4, B-5, A-3, A-4 and A-5 quadrangles at a scale of 1:50,000 (fig. 1). Mapping in this area will provide crucial baseline geologic data for assessing potential geologic hazards such as permafrost thawing, slope creep, and flooding, which could impact existing infrastructure in the area, including the Trans Alaska Pipeline (TAPS) and Dalton Highway, both of which are vitally important to Alaska's economy. Information from these mapping efforts can also be useful for assessing the rate and severity of landscape change, an important consideration in infrastructure development in arctic regions where such information is limited. Future development such as resource exploration and construction of a natural gas pipeline will depend on having good quality geologic and hazards data upon which to base decisions.

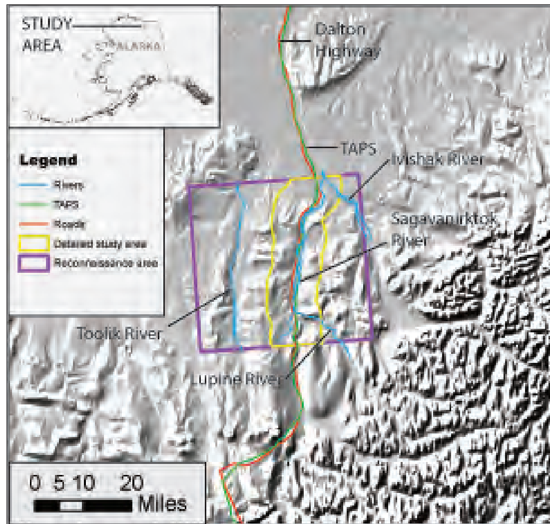

Figure 1. Area of mapping.

Many of the surficial deposits in the area are related to Itkillik (late Pleistocene), Sagavanirktok (middle Pleistocene), and Anaktuvik (early Pleistocene) glacial advances moving northward out of the Brooks Range along major drainages. Deposits from the Anaktuvuk advance have been extensively modified by colluvial and periglacial processes (fig. 2) and are characterized by broad, gently sloping surfaces. The younger Itkillik and Sagavanirktok deposits, although somewhat modified by slope processes, retain more primary glacial morphology and tend to have steeper slopes (fig. 2). In general, the northern and western portions of the study area are characterized by thermokarst and other features associated with extensive permafrost development (fig. 3).

Figure 2. Oblique, south-facing photo of Sagavanirktok River and Anaktuvuk River drifts. Sagavanirktok River drift retains some primary glacial morphology, and Anaktuvuk River drift is characterized by broad, gently sloping surfaces extensively modified by colluvial and periglacial processes.

We anticipate that a reconnaissance map of the entire area and a more detailed map of 377 square miles in the central portion of the area along TAPS will be completed in 2011. This project has been conducted in conjunction with the DGGS Energy Section as part of their continuing work along the northern foothills of the Brooks Range. Preliminary results were part of a combined bedrock–surficial geologic map presented at the Alaska Geological Society Conference in 2009 and a map submitted to the U.S. Geological Survey in fulfillment of STATEMAP reporting requirements that same year.

Figure 3. Oblique photo showing polygonal ground associated with extensive permafrost development.

The Sagavanirktok mapping project is funded by State of Alaska General Funds and the Federal STATEMAP program.

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SURFICIAL GEOLOGY OF THE NORTHERN FAIRBANKS MINING DISTRICT, CIRCLE QUADRANGLE, NORTHEAST FAIRBANKS GEOPHYSICAL SURVEY TRACT

In summer 2007, the Division of Geological & Geophysical Surveys (DGGS) conducted about 189 square miles of geologic mapping straddling the Steese Highway, about 50 miles northeast of Fairbanks, covering the central portion of DGGS's 404-square-mile Northeast Fairbanks airborne magnetic and electromagnetic geophysical survey area. The mapping project was funded primarily by DGGS's Airborne Geophysical/Geological Mineral Inventory program, a special multi-year capital-project investment by the State of Alaska to expand Alaska's geologic and mineral resources knowledge base, catalyze future private-sector mineral exploration and development, and guide state planning. Other funding sources included the U.S. Geological Survey's STATEMAP program and the State's General Fund.

The Engineering Geology Section of DGGS mapped the surficial geology of the area to understand the genesis of the landscape in which placer gold deposits have accumulated (fig. 1). Glacial deposits are prominent in the northwestern portion of the field area, where large granite erratics can be traced many kilometers downvalley from sources in the high peaks of the Mt. Prindle area. Extensive gravel-capped high-level terraces are preserved along the Chatanika River, and extend upvalley into the lower reaches of major tributary streams in the western portion of the field area. Thin lags of rounded fluvial cobbles are draped on discontinuous remnants of these high-level terraces as far as 10 kilometers upstream in Faith Creek. Silt-dominated deposits characterized by numerous pingos predominate in the southern part of the study area.

The products of this project are geologic-framework maps at 1:50,000 scale, one of which describes the surficial geology of the area. The map is being revised after technical review and will be released in spring of 2011. We are using the DGGS Geographic Information System (GIS) to generate these maps, and all data for the project will ultimately be stored and made available in a geographically referenced relational database. DGGS will serve these data from its website (www.dggs.alaska.gov) upon completion of the project. Past experience has shown that a thorough understanding of the geologic framework of an area acts as a catalyst for resource development, paves the way for future exploration, and fosters improved resource management and land-use planning. We anticipate a similar result for the Northeast Fairbanks geophysical tract.

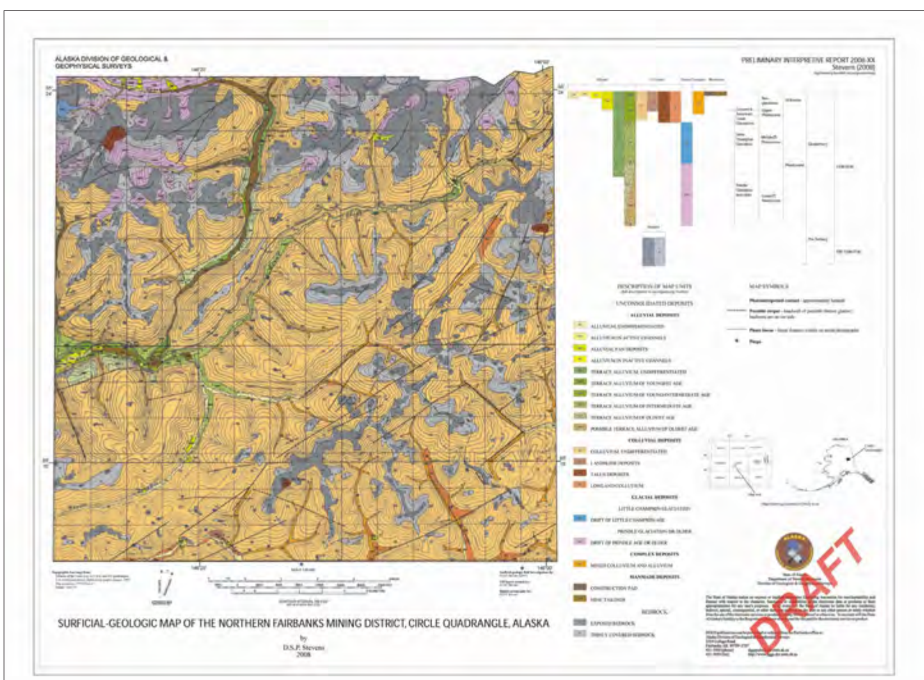

Figure 1. Draft surficial-geologic map of the northern Fairbanks mining district.

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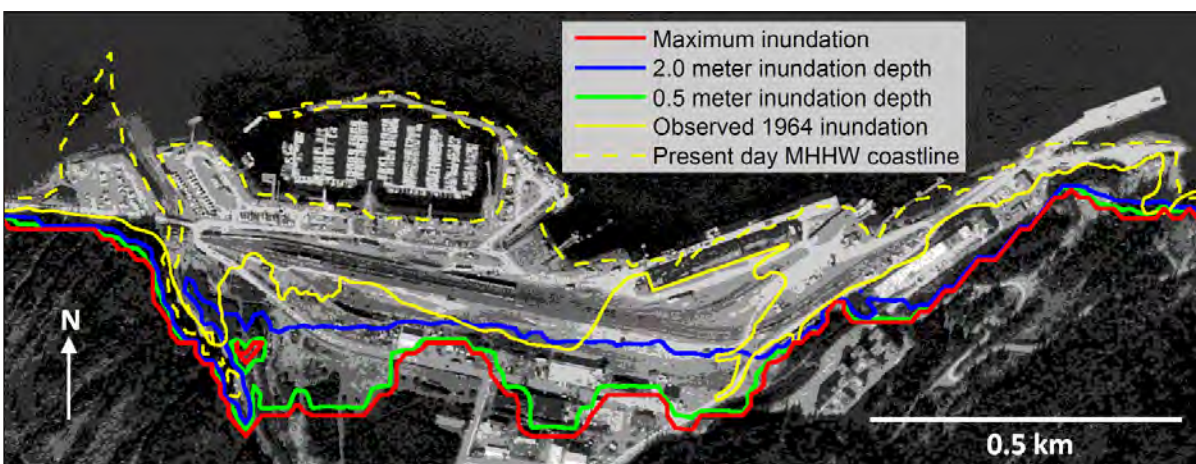
TSUNAMI INUNDATION MAPPING FOR ALASKA COASTAL COMMUNITIES

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 use 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 selected based on tsunami risk, infrastructure, availability of bathymetric and topographic data, and willingness of the 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 for the Kodiak area, Homer, Seldovia, and Seward. A draft report and maps for Whittier are currently under review for publication in early 2010 (fig. 1). Data compilation and inundation modeling for the next community, Sitka, are underway.

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.

We have presented results of this project at international tsunami symposia in Istanbul, Turkey, Seattle, Washington, and Hania, Greece; at the Tsunami Society symposium in Honolulu, Hawaii; at the International Union of Geodesy and Geophysics Symposium in Perugia, Italy; and at the American Geophysical Union annual meetings, 2003–2007. In addition, this project has been the subject of articles in *Geotimes* and *TsuInfo Alert Newsletter*.



Draft tsunami inundation map of Whittier, Alaska, showing observed 1964 inundation, maximum estimated future inundation resulting from all considered tectonic and landslide sources, and resulting water depths.

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