Alaska Division of Geological & Geophysical Surveys

# Annual Report 2018

State of Alaska
Department of Natural Resources
Alaska Division of Geological & Geophysical Surveys

STATE OF ALASKA
Michael J. Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
Corri A. Feige, Commissioner

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

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# Message from the Director

Steve Masterman
State Geologist, Director

Greetings! I continue to be amazed by the quality and quantity of work completed by the staff at Alaska's geological survey, or DGGS as we like to call it. Whether it's core workshops on oil and gas plays, mapping coastal flooding and erosion, issuing volcano eruption alerts to communities and aviators, responding to earthquakes, mapping Alaska's geology, or producing maps and reports, the work done by DGGS touches the lives of all Alaskans.

DGGS provides geologic information to assist industry discover and develop Alaska's oil, gas, and mineral resources. DGGS also provides information about geologic hazards, construction materials and groundwater resources, which are critical to sustaining our communities, and developing our natural resources. Public geologic information is the key to unlock our natural resources, drive state revenue generation, and help grow Alaska's economy. Alaska is a natural resources state. Investing in geologic information is a strategic investment in developing those resources.

This annual report is a brief summary of the many achievements of these energetic, resourceful, and committed staff:

DGGS petroleum geologists conducted fieldwork in the North Slope Foothills, and the 1002 area of ANWR. Results were shared during a two-day industry tour of relevant Brookian exposures.

DGGS petroleum geologists led multiple core workshops for industry, which focused on the oil and gas reservoir potential of the North Slope Nanushuk and Torok Formations.

DGGS minerals geologists completed the geologic mapping and geochemical sampling for mineral assessments of parts of the Tanacross and Big Delta quadrangles, which are prospective for lode gold and porphyry gold-copper-molybdenum systems. Industry responded by staking large areas of mining claims on state land in the Tanacross mapping area.

DGGS began collecting lidar data with an in-house instrument, greatly reducing collection costs.

DGGS developed and implemented a field data support system that facilitated a transition to digital field data collection. This will speed map production while easing database management.

The DGGS Coastal Program established new flooding/erosion monitoring stations to measure the impacts of storms on Alaska's western coast, and collaborated with local tribal and city governments to establish erosion and flood monitoring sites throughout Alaska, and train local residents to conduct regular monitoring activities.

Began a project to assess the construction material resources for the western North Slope.

DGGS website received 25.1 million page-views and recorded more than 2 million downloads of available reports and datasets.

The number of visitors to the Geologic Materials Center was 1,226 in 2018, a 25 percent increase over 2017.

These snapshots are just a few of the notable DGGS achievements during the last year. I encourage you to read this report and learn more about Alaska's geological survey and its projects, activities, products, and impacts. Investing in geologic information is necessary for the discovery and commercialization of the state's undiscovered oil, gas, coal and mineral resources, and for protecting Alaskans from geologic hazards. It is an investment in future mines, oil and gas production, state revenue, jobs, and a sound economy.

Respectfully,

S. Masterman

Steven S. Masterman
State Geologist & Director

# Contents

# Key Issues

DGGS faces numerous critical issues and has to manage the strategic allocation of available resources to balance the needs of the broader state economy with those of local communities, all while ensuring that we fulfill our statutory mission.

## Rates of Progress

One of the principal challenges DGGS faces is being too small an organization relative to Alaska's size. This translates into a limited capacity to fulfill our mission in a functional amount of time. As an example, the last 20 years of geological mapping indicate it will take DGGS at least another 400 years to complete a geologic map of the state at a 1-inch to 1–mile scale. This slow rate of progress inhibits development of Alaska's resources, and places communities and residents at risk. Our mapping rate needs to accelerate for the state to achieve the potential inherent in its energy and mineral resources, and to assist communities with hazard planning in a meaningful timeframe.

## Oil and Gas Development

As oil companies have transitioned to smaller exploration departments, and more independent oil and gas companies participate in Alaska oil and gas fields, there is an increasing need for publically available geological information on the petroleum geology of Alaska's oil and gas basins. Maintaining access to existing, and providing new data on emerging plays is crucial for future oil and gas discoveries. DGGS is challenged to provide sufficient geologic information on emerging plays to attract exploration companies.

The USGS recently revised their NPR-A oil and gas assessment, and concluded that there are billions of barrels of oil yet to discover. However, the North Slope is a mature hydrocarbon basin and, like all mature hydrocarbon basins, the "easy" prospects were drilled and tested early. The untested, remaining plays require new geologic research and investment to maintain discovery and production rates. This new geologic information is the key to advancing understanding of the petroleum systems and ensuring new resource discoveries. DGGS will continue to be challenged to provide timely information in sufficient volume to support exploration of these new plays.

## Mineral Development

Many other political jurisdictions are investing aggressively in publically available geological, geophysical, and geochemical data. These data reduce the cost of entry into new areas, a critical factor considered by industry when allocating exploration resources, and are crucial in attracting new exploration spending. Alaska competes head-to-head with these jurisdictions for industry exploration dollars. A lack of similar surveys in Alaska is reducing the states attractiveness for mineral exploration dollars, and impacts Alaska's competitiveness.

Rapidly changing technology results in rapid changes in commodity needs. This situation creates a fluid and evolving commodities market with rapid price adjustments to changing metal needs. DGGS will be challenged to provide sufficient new data and interpretations related to the occurrence of emerging commodities in a timely manner for industry to respond to these new demands. DGGS will also be challenged to be forward-looking, anticipating the demands for geoscience data and quickly responding to surges in

demand for commodity-specific geoscience data during commodity price fluctuations.

Construction materials are in critically short supply in numerous areas of the state and the lack of affordable basic construction materials can dramatically affect project economics. Meeting this need for information will continue to be a challenge for DGGS.

## Public Safety and Community Resilience

Despite Alaska's abundance of geologic hazards, such as earthquakes, tsunamis, volcanoes, landslides, avalanches, erosion, and others, there is a grave lack of systematic, statewide data to allow quick assessment of natural hazards risks. Communities, residents, project proponents, and managers alike suffer from this lack of basic data. Providing basic statewide geologic hazards data will remain a key challenge for DGGS.

Geologic information is needed in a large number of communities for resiliency efforts. These data are essential for coastal and river communities, which can be impacted by thawing permafrost, erosion, storm surges, landslides, sea-level change, and changes in the hydrologic system. DGGS will be challenged to continue its efforts to provide basic information to guide community and regional resiliency efforts.

The state has historically relied on site-specific hazard analyses related to ongoing development or permit approval. There is a growing need for up-to-date, regional or statewide baseline data. DGGS will be challenged to provide these data before they are required to manage crisis situations.

## Climate

As geologists, we know that Alaska has been warming since the last glacial maximum, roughly 25,000 years ago, when mammoths roamed Alaska, and glaciers covered much more of our state. Data tell us that Alaska's glaciers are still shrinking, and permafrost is warming. Mapping areas prone to ground failure from past, and predicted changes is necessary to mitigate impacts. Impacts will be most extreme in coastal, low-lying areas, and areas that will be destabilized by thawing of permafrost. The need for basic data at a community level is greater than our capacity to provide the information, which challenges DGGS, state maintenance efforts, and affected communities. DGGS will be challenged to continue developing and applying innovative methods and technologies for data acquisition and analysis.

The expansion of Arctic shipping lanes from Asia to Europe highlight the paucity of basic coastal and maritime data along Alaska's western and northern coasts. As the nation's only Arctic state geological survey, DGGS will be challenged to provide the necessary data on coastal and nearshore areas, and identify other areas of critical need for the state.

## Accessing Geologic Materials

Our ability to provide geologic data to exploration and development industries will be tested as users demand comprehensive information to be delivered more quickly. The Geologic Materials Center (GMC) is a key component of these efforts and is the "first stop" for oil and gas and mineral exploration companies.

The state's archive of geologic materials represents billions of dollars of acquisition and preservation costs. Providing efficient and comprehensive access to this collection is critically important for viable exploration programs, for both seasoned and new Alaska exploration companies. Any one piece of core from this archive has the potential to identify a resource prospect that could bring billions of dollars of revenue to the state. DGGS will be challenged

Roberta Glenn measures water levels in Kotzebue, Alaska.

to secure funding to ensure the facility continues to operate, grow, generate revenue, and serve its users long into the future.

Digital mapping techniques, changes in database design, vast volumes of data, and ever-changing computer software and hardware are a challenge to DGGS' ability to meet an increasingly diverse customer base. Paper maps and reports are no longer sufficient; digital maps, databases, social media, and interactive online maps are among our growing list of distribution methods that are all crucial in an increasingly electronic world. DGGS must continue developing and optimizing its data acquisition, storage, and distribution programs to discover and provide new and more efficient ways to disseminate the information to the groups who use it.

## Personnel Retention and Recruitment

Cyclical commodity prices create spikes in the exploration cycle, which creates challenges for DGGS. However, low commodity prices will not persist indefinitely. During boom times, high-paying, private-sector jobs become abundant, and opportunities for experienced geoscientists become commonplace. The state must remain competitive in workforce recruitment and keep our best and brightest employees.

DGGS is a strategic investment in future state revenue generation and the maintenance of Alaska's economy. Our agency provides objective geologic information to assist industry discover and develop Alaska's oil, gas, and mineral resources. DGGS also provides information about construction materials and groundwater resources, which are critical to developing natural resources, and evaluates geologic hazards that may adversely impact the state's economy and public safety. DGGS will continue to be the central repository of information on Alaska's resources and will play a pivotal role in their commercialization. DGGS will continue to conduct geologic hazard research to provide a scientific basis for community hazard mitigation efforts.

# FY2018–2019 Focus

## Goals for the upcoming year include:

### *Energy Resources*

- Focus on the North Slope basins to stimulate resource discovery in the state's primary oil and gas basin.
- Within the North Slope, focus on the Brookian sequence, and especially the Nanushuk and Torok Formations.
- Release new geology maps, reports and analyses from recent field mapping programs, including the Tyonek and Iniskin Peninsula/Chinitna Bay area in Cook Inlet.
- Conduct a field mapping program in the North Slope Foothills, as well as in ANWR 1002 area to provide new insights into the petroleum geology.

### *Mineral Resources*

- Continue the release of new geologic information from recent mapping in high-mineral-potential areas of the state; publishing new maps for the Tanacross, Styx River and Wrangellia areas.
- Publish summary reports on rare earth and platinum group occurrences.
- Begin making digital field-station mapping data available via the division's website.
- Conduct cost-effective field work in highly prospective areas to attract industry.
- Publish results of geophysical surveys in the Porcupine River areas.

### *Public Safety and Community Resilience*

- Provide online, interactive statewide hazards maps for avalanche susceptibility.
- Provide additional coastal inundation and erosion data, map products, and online tools to coastal communities.
- Continue training residents in coastal communities to monitor shoreline change.
- Continue to update shoreline position mapping of Alaska's north and west coast to allow erosion rate forecasting.
- Make additional weather and coastal water-level data available in real-time.
- Refine lidar collection protocols and equipment to allow quick, accurate, and effective evaluation of hazards to communities and infrastructure.

### *Data Delivery and Availability*

- Continue the transition to digital and interactive data delivery with new and upgraded interactive maps.
- Launch a redesigned website that provides users with easier access to the division's products and services.

### *Geologic Materials Center*

- Expand the use of the facility for confidential core storage and use by both resource industries.
- Continue outreach and education programs at the new facility to help guide university, grade-school, middle school, and high school students.
- Improve curation of geologic materials by linking location and sample information for the many samples currently without location information.

### *Volcanology*

- Begin the conversion to digital data transmission for the volcano monitoring equipment.
- Expand the Geologic Database on Volcanoes in Alaska (GeoDIVA) to hold tephra componentry and tephra petrographic descriptions.

# Energy Resources

## *Benefit to Alaska*

*The Energy Resources Section generates new, unbiased information on the geologic framework of frontier areas in Alaska that may host undiscovered oil, gas, coal, and geothermal resources for improving the success of state-revenue-generating commercial oil and gas exploration and development, and improved understanding of potential local sources of energy for rural Alaska.*

L to R: Bob Gillis, Marwan Wartes, Mandy Willingham, Trystan Herriott, Nina Harun, and Dave LePain.

## Major Programs and Projects

- Cook Inlet basin analysis program
- Brooks Range foothills and North Slope program
- Natural gas potential of the Nenana basin
- Natural gas potential of the Susitna basin
- Liquid hydrocarbon potential of Alaskan coals
- Alaskan Coal Database—National Coal Resource Database System

## Reconnaissance Geological Mapping and Stratigraphic Studies in the North Slope Foothills

The recent announcements of several major, new oil discoveries on the North Slope highlight the region's potential to remain a world class petroleum province far into the future. In an effort to improve our understanding of the regional petroleum system, the DGGS energy section conducted geological field studies across a wide region of the central North Slope. The detailed analysis of outcrop geology provided new constraints on the depositional history and correlation of important potential source and reservoir units. A noteworthy component of our 2018 work was the acquisition of 1.6 square miles of structure-from-motion (SfM) photogrammetry of a key exposure of the Nanushuk Formation—the unit that serves as the reservoir in new discoveries at Willow and Pikka. This image data is being paired with detailed outcrop observations to attain a high-resolution understanding of the stratigraphy of this potential reservoir analogue. Ultimately, this work is aimed at providing critical geologic data that reduces exploration risk and stimulates investment in northern Alaska.

## Reservoir Potential of Kuparuk-Equivalent Strata in the 1002 Area, ANWR

The coastal plain of the Arctic National Wildlife Refuge (ANWR) has long been recognized as having good potential to host oil and gas resources, but historic restrictions on development have led to the region remaining almost unexplored. Recent changes in federal policy dictate that lease sales will be held in this prospective region. In order to provide new data on the petroleum geology of this area, DGGS collaborated with the USGS on a field campaign this past summer. The work focused on collecting new stratigraphic and structural data from outcrops of economically important units that project northward into the subsurface of the 1002 Area. In particular, significant new observations were made on the Kemik Sandstone, a unit that is partly equivalent to the reservoirs at the Point Thomson and Kuparuk River fields.

## Core Workshop: Reservoir Potential of the Nanushuk Formation, Central North Slope

DGGS Energy Section geologists collaborated with Division of Oil and Gas (DOG) geologists to organize and lead a two-day core workshop at the Geologic Materials Center (GMC) in Anchorage for more than 40 petroleum geoscientists representing several oil companies. The workshop focused on the stratigraphy and reservoir potential of the Nanushuk Formation in the eastern National Petroleum Reserve-Alaska (NPRA). This event also included an informal poster session highlighting the work done by DGGS Energy Section geologists on the Nanushuk Formation and economically important younger formations exposed in the

Left: DGGS geologist measuring a stratigraphic section in the Kemik Formation between the Kavik and Canning Rivers. The Kemik is equivalent to the upper part of the oil reservoir at Kuparuk field and is an exploration target in the 1002 Area of the Arctic National Wildlife Refuge. Photograph by David LePain.

Top Right: View of the main core viewing room at the Alaska Geologic Materials Center in Anchorage. Several hundred feet of core from the Nanushuk Formation are on the roller tables for a two-day-long core workshop. Photograph by Kurt Johnson.

Bottom Right: DGGS geologists examining an outcrop of the uppermost Seabee Formation along the Nanushuk River at Shale Wall Bluff. Studies like this advance understanding of North Slope petroleum systems. Photograph by David LePain.

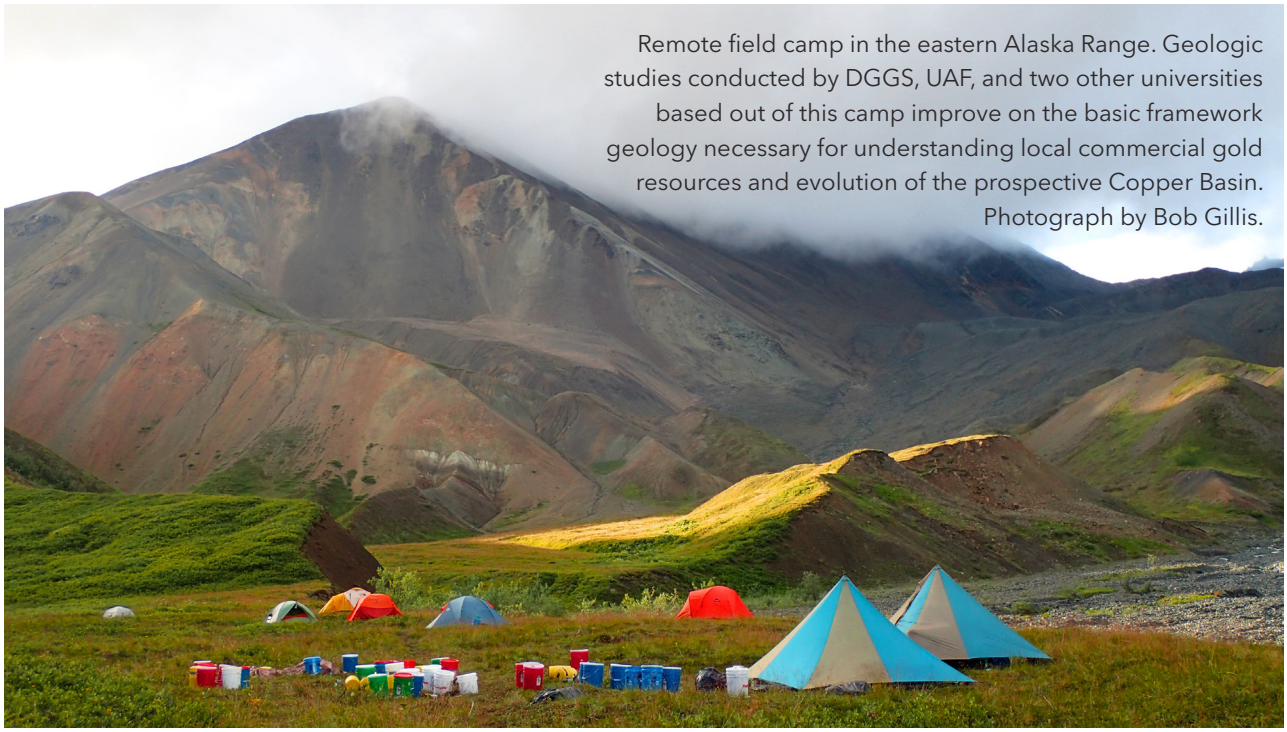
foothills belt of the central North Slope. The featured Nanushuk cores and outcrops potentially represent highly valuable analogues that provide important clues regarding the internal architecture of the reservoirs in the new discoveries at Pikka and Willow. This kind of detailed reservoir- and sub-reservoir-scale information cannot be obtained from even the highest quality 3D seismic datasets and is critical for developing efficient reservoir development plans. A published core workshop volume, focusing on the reservoir potential of the Nanushuk Formation is pending.

## Fracture Intensity in Unconventional Reservoir Potential in Lower Cook Inlet Basin

A new report on fracture intensity in sedimentary rocks exposed along the west side of lower Cook Inlet (doi.org/10.14509/29543) is the first of its kind for the basin and contributes to a growing dataset about Cook Inlet petroleum systems produced by DGGS. Fractures are an important source of secondary hydrocarbon porosity in rocks that have been defined as "tight" due to minimal intergranular pore space, and characterizing them is an important step towards understanding the unconventional resource potential of their host rocks. This report will help petroleum companies understand the distribution and orientations of fracture networks that could be critically important for producing oil from unconventional reservoirs in lower Cook Inlet.

## Recent Mapping in the Eastern Alaska Range and Minerals and Petroleum Resource Potential

Results of new geologic mapping along the northeastern margin of the Copper basin have been presented in a pending preliminary report, focusing on the McCallum-Slate Creek fault system (MSCFS). The map area, approximately 30 square miles (78 square km) of the MSCFS from the east side of the Gulkana Glacier to the East Fork of the Chistochina River, encompasses parts of an economic gold district and sedimentary rocks thought to extend into the basin subsurface to the southwest where natural gas might be an import local energy resource. The mapping provides a baseline geologic framework that will provide important insights for future resource exploration of the region.



Remote field camp in the eastern Alaska Range. Geologic studies conducted by DGGS, UAF, and two other universities based out of this camp improve on the basic framework geology necessary for understanding local commercial gold resources and evolution of the prospective Copper Basin. Photograph by Bob Gillis.

## Notable Achievements

Delivered 11 presentations on oil and gas related geology of the North Slope and Cook Inlet at the Arctic Energy and Environmental Alliance meeting in Houston, TX, Alaska Geological Society, University of Alaska Fairbanks Geology Seminar, University of Alaska Petroleum Engineering Seminar, and University of Alaska Anchorage Geology Seminar.

Described core from the Nanushuk Formation in the Linc Energy Umiat 18 well at Umiat oil field.

Submitted bedrock geological map of the Red Glacier-Tuxedni Bay area, Lower Cook Inlet, to the U.S. Geological Survey (deliverable to STATEMAP funding agency).

Collaborated with Boise State University researchers to develop geochronologic approaches that yield precise and accurate age constraints for use in stratigraphic correlations of potential oil and gas reservoir and source rocks in Alaska's sedimentary basins.

Contributed to a Division-wide effort to design and implement the capture of geologic data digitally in the field, in order to streamline accessibility, archiving, and publishing through a publicly available database.

Restructured the DGGS energy database to interact with the DGGS enterprise geodatabase which will ultimately make petroleum-related geologic data readily available to DNR geologists and the public.

## 2018 Publications

### Reports

Gillis, R.J., Fitzgerald, P.G., Ridgway, K.D., Keough, B.M., Benowitz, J.A., and Allen, W.K., 2018, Overview of the new 1:25,000-scale geologic mapping of the McCallum–Slate Creek fault systems, eastern Alaska Range, Alaska: Alaska Division of Geological & Geophysical Surveys, Preliminary Interpretive Report 2018-3, 10 p. [assumes PIR is released by the end of December 2018]

Herriott, T.M., Wartes, M.A., Decker, P.L., Gillis, R.J., Shellenbaum, D.P., Willingham, A.L., and Mauel, D.J., 2018, Geologic map of the Umiat-Gubik area, central North Slope, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2018-6, 55 p., 1 sheet, scale 1:63,360. http://doi.org/10.14509/30099

LePain, D.L., Decker, P.L., and Helmold, K.P., 2018, Core Workshop: Depositional Setting, Potential Reservoir Facies, and Reservoir Quality in the Nanushuk Formation (Albian-Cenomanian), North Slope, Alaska: Alaska Division of Geological & Geophysical Surveys, Miscellaneous Publication 166, 58 p.

### Presentations with Published Abstracts

Gillis, R.J., 2018, Reactivation of inherited structures and cryptic transtension along the Paleocene-Eocene forearc basin, Alaska, University of Alaska, Fairbanks geoscience colloquium, March 23, 2018

Herriott, T.M., Wartes, M.A., Stanley, R.G., Decker, P.L., Helmold, K.P., and Harun, N.T., 2018, Sequence-stratigraphic framework of the Middle Jurassic Chinitna Formation, Cook Inlet forearc basin, south-central Alaska (presentation): Alaska Geological Society, 20 March 2018, Anchorage, Alaska: Alaska Division of Geological & Geophysical Surveys, 77 p. http://doi.org/10.14509/30031

LePain, D.L., 2018, Contrasting Middle and Upper Jurassic deepwater successions in lower Cook Inlet and implications for arc-proximal forearc basin paleogeography: University of Alaska Anchorage, Geoscience Seminar, April 26, 2018.

Wartes, M.A., 2018, Geology of northern Alaska and petroleum potential of ANWR: University of Alaska, Fairbanks, Petroleum Engineering Seminar Series, February 2018.

## Mapping of the Umiat–Gubik Area: Insights into the Rocks Collectively Hosting Billions of Barrels of Oil

*The geology of northern Alaska is key to understanding the remaining hydrocarbon potential of the North Slope*

The DGGS Energy Resources Section's Brooks Range Foothills and North Slope program provides relevant, high-quality, publicly available geologic data that contributes to petroleum exploration models. Geologic mapping is an integral component of this program, and DGGS recently published a detailed geologic map of the Umiat–Gubik area of the central North Slope (doi.org/10.14509/30099). This area is well known for its oil and gas fields at Umiat, East Umiat, and Gubik. Additionally, economically significant rock units in the mapped area are also recognized in the subsurface of producing and prospective areas farther north. In fact, many of the Umiat–Gubik outcrops of Seabee, Schrader Bluff, and Prince Creek Formations are important analogues for oil reservoirs at the Tarn, Meltwater, West Sak, and Ugnu fields. Perhaps most notable are the excellent outcrops of Nanushuk Formation along the Colville River that are correlative to reservoir intervals at the recent Pikka–Horseshoe and Willow oil discoveries. These Nanushuk-hosted accumulations are collectively expected to yield more than one billion barrels of oil, providing approximately 200,000 barrels of oil per day of additional throughput to the Trans-Alaska Pipeline System upon development. DGGS-led field investigations of Nanushuk outcrops generate essential constraints for further delineating these rapidly developing plays and provide important analogue information for use in developing these newly discovered reservoirs.

Industry geologists highlighted the relevance of the Umiat–Gubik geologic map and accompanying report soon after they were released in October 2018, noting that geologic information that DGGS publishes is a vital part of the framework for successful oil and gas exploration programs. DGGS plans to extend their recent central North Slope work beyond the Umiat–Gubik area during 2019 as part of a geologic mapping project partially supported by Federal funds. This work, and associated studies, will provide additional timely and relevant context to the petroleum geology of northern Alaska. DGGS geologists and their state and federal agency collaborators have prioritized the continuation of these geologic investigations on the North Slope, recognizing the significance of this region to the economic growth of Alaska, domestic oil production, and the importance of this work in promoting exploration and production success.

Scharder Bluff and Prince Creek Formations exposed at Shivugak Bluff. These outcrops provide insights into reservoir character of heavy oil accumulations in West Sake and Ungnu.

# Engineering Geology

*Determines the potential geologic hazards to buildings, roads, bridges, and other installations and structures, and the locations and supplies of groundwater and construction materials.*

L to R: Jenny Jones, Trent Hubbard, De Anne Stevens, Ronnie Daanen, Barrett Salisbury, Katreen Wikstrom Jones. Inset: Gabe Wolken, Jaci Overbeck, Rich Buzzard.

## Major Program Elements

- Cryosphere
- Coastal Processes
- Construction Materials Resources
- Geohydrology
- Geologic Hazards
- Geologic Mapping

## *Benefit to Alaska*

*In many areas, Alaska lacks the fundamental geologic data needed to guide the proper development and implementation of building codes, land-use zoning, right-of-way siting, and contingency planning for natural hazards events. Maps and reports produced by the Engineering Geology Section are the front-line source of information about where damage is likely to be greatest and where mitigation efforts should be concentrated. Engineering-geologic maps depicting construction materials resources are useful for building infrastructure to support resource exploration and development, and for locating valuable placer-mineral deposits. Groundwater analysis and aquifer modeling and mapping in oil and gas basins and other areas of high development potential are essential to ensuring an adequate and safe supply of water for development and resource access.*

## Mind the Gap: Major Progress on Alaska Coastal Mapping

Alaska comprises nearly 40 percent of tidally-influenced shoreline in the United States, and evaluating erosion and flooding along its northern and western coasts has historically been cost-prohibitive due to the lack of baseline data. In October 2018, DGGS published an Information Circular, Alaska Coastal Mapping Gaps & Priorities for the Assessment of Coastal Flood & Erosion Hazards (doi.org/10.14509/30096), which outlines existing data and where data still need to be collected so Alaska's coastal communities can gain access to flood and erosion vulnerability assessments. To fill the data gap, DGGS improved coastal mapping coverage in 2018 by acquiring historical aerial image data and advocated for the state to secure an investment from NOAA's Office for

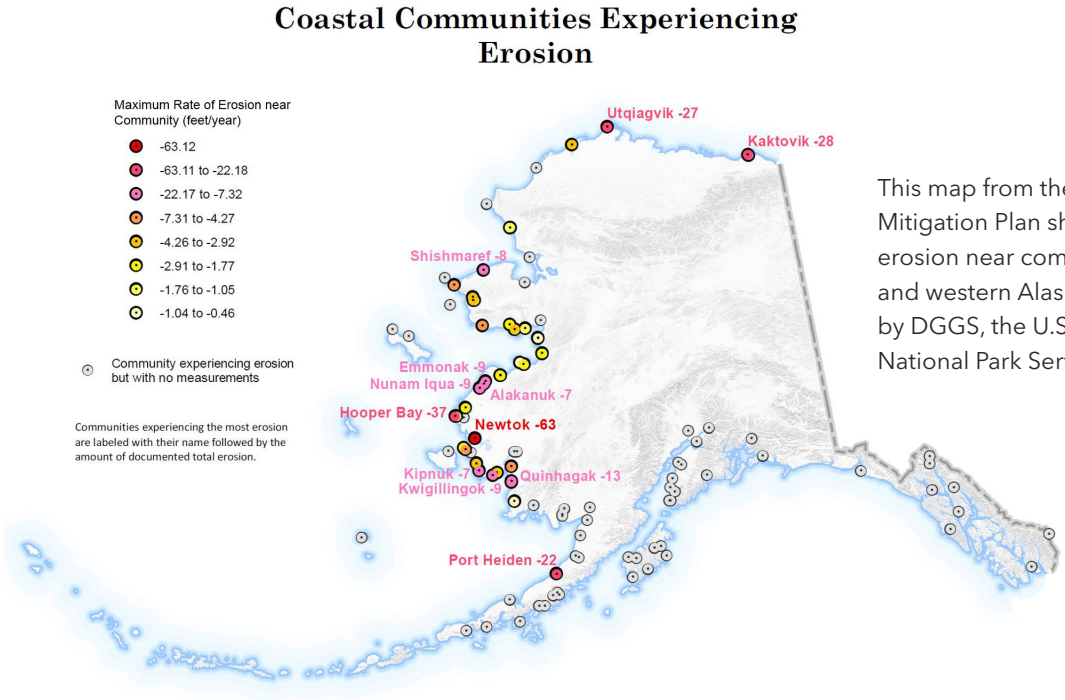
Coastal Management to collect aerial image data between 2018 and 2019 over the last remaining data gap in western Alaska. These data contribute to DGGS's updates to the 2018 Alaska State Hazard Mitigation Plan (SHMP)—aerial image data were used to determine where shorelines have been through time and compute rates of shoreline change, giving an estimate of relative vulnerability to coastal erosion along Alaska's northern and western shorelines based on scientific methods. Shoreline change data, made available through the SHMP, will be easily accessed for local hazard mitigation plan development.

While recent advances in technology and computer processing have allowed the state to make great strides in coastal mapping, major gaps in data still exist (for example, nearshore bathymetry). DGGS is working with collaborators to develop a coastal mapping strategic plan to quantify remaining gaps and document priorities for stakeholders interested in sectors outside of coastal flooding and erosion. Contact the Alaska Coastal Mapping Strategist at http://agc.dnr.alaska.gov/coastal.html for more information.

## Slippery Slopes: Landslide Hazard Evaluation for Multi-Hazard Risk Mapping in Sitka, Alaska

Landslides cause deaths, injuries, and homelessness every year and can damage or destroy buildings, roads, and other infrastructure. Many regions in Alaska are especially prone to landslides, including Sitka, which is surrounded by steep slopes and has a long history of landslides. On August 18, 2015, heavy rainfall and wind resulted in numerous landslides in and around Sitka, Alaska. More than 45 landslides were initiated during this event and documented on Chichagof and Baranof Islands. Four debris flows, a type of very water-saturated landslide, impacted roads and infrastructure in Sitka, and the southernmost of two flows at Kramer Avenue took the lives of three residents. This tragedy highlighted the importance of understanding landslide risk to inform mitigation efforts, guide future development activities, and protect public safety in and around Sitka.

To assist the City and Borough of Sitka in becoming more resilient to landslide hazards,



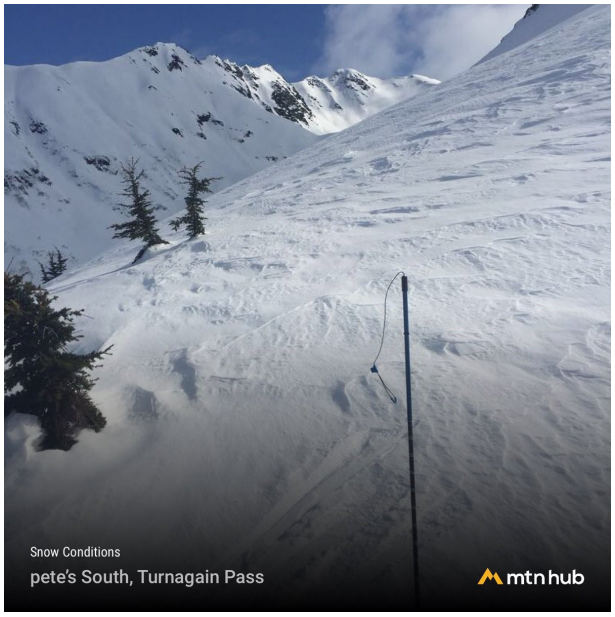

This map from the 2018 Alaska State Hazard Mitigation Plan shows maximum rates of erosion near communities along northern and western Alaska from studies completed by DGGS, the U.S. Geological Survey, and the National Park Service.

DGGS secured funding from the Federal Emergency Management Agency (FEMA) Cooperating Technical Partners Program (CTP) to map historic debris flows, debris flow susceptibility, and simulated debris flow runouts to assess landslide susceptibility for the Sitka area. The assessment was designed to help identify areas of elevated debris flow risk based on historical information, available geotechnical data, elevation data from high-resolution lidar acquired in the spring of 2018, and debris flow runout modelling. Based on our analysis, we were able to identify numerous historical debris flows not previously mapped, areas of elevated landslide susceptibility, and areas of elevated risk for debris flow runout. The results will be used by City planners and citizens to aid in identifying vulnerable areas and guide further assessment.

## Let it Snow: NASA Funds Expanded Community Snow Observation Project

Snow avalanches are the most deadly natural hazard in Alaska—responsible for 85 fatalities in Alaska during the last 20 years—and regularly impact infrastructure and transportation corridors, threatening public safety and impeding the flow of natural resources that drive Alaska's economy. Knowing the amount of snow that accumulates, and where, is important to stakeholders involved in recreation, water resources, ecological functions, and avalanche safety. A network of automatic snowpack observation stations, known as SNOTEL, measures snow depth at several locations across the state, and computerized snow distribution models are typically used to fill in the gaps between these stations. The problem, however, is that the network is not nearly dense enough for snow distribution models to provide accurate estimates of snow depth in many parts of the state, especially in mountainous areas. To help solve this problem, DGGS collaborated last year with the University of Alaska, University of Washington, and Oregon State University to launch the NASA-funded Community Snow Observations (CSO) project, which uses snowpack data submitted by citizen scientists to increase the number and distribution of observations for monitoring snowpack conditions in mountainous areas. Following the initial pilot project phase, the CSO team were awarded three years of additional NASA funding in 2018 to continue this highly successful

DGGS scientists are part of the Sitka Landslide Early Warning System Working Group, gathered here to evaluate and discuss one of the 2015 Sitka landslides.




A citizen scientist's photograph with a snow depth observation submitted to the CSO project from Pete's South in Turnagain Pass, Alaska, using the Mountain Hub app.

project. The crowdsourced data are helping to improve our ability to accurately model snow depth for avalanche safety in Alaska and elsewhere in western North America.

## Catching the Wave: A New Regional Approach to Tsunami Inundation Mapping

The Engineering Geology section at DGGS works closely with researchers and tsunami modelers from the Alaska Earthquake Center at the University of Alaska (UAF) Geophysical Institute to generate tsunami hazard reports for at-risk communities in coastal Alaska. Inundation maps showing areas that could be affected by future potential tsunamis were published for Kodiak, Juneau, Skagway, and Haines, and coseismic permanent flooding maps were published for Valdez, Chenega, Chignik, and Chignik Lagoon. These reports have typically required high-resolution bathymetric and topographic data to complete and, until now, tsunami hazards have only been assessed in communities with existing high-resolution data or resources to acquire new data. UAF and DGGS have developed a robust, regional approach to categorizing earthquake-induced tsunami hazards for communities that lack high-resolution data. This enables us to now publish community hazard reports generated with existing topographic data, thereby providing crucial first-order hazard information in places where new topographic data may be years (or more) away. The 2018 regional tsunami reports cover the communities of Adak and Atka in the Andreanof Islands, and Kasaan, Klawock, Metlakatla, Pelican, Point Baker, and Point Protection in Southeast Alaska. Our products are used by community members, scientists, engineers, community planners, and emergency response personnel to minimize property damage and loss of life in the event of a tsunami. Funding for this project is provided by the National Oceanic and Atmospheric Administration under the National Tsunami Hazard Mitigation Program.

Detail from new tsunami map of Adak, Alaska. Red line is maximum tsunami inundation, yellow line is modeled new shoreline location after earthquake-related subsidence.

## Notable Achievements

In support of the Arctic Strategic Transportation and Resources (ASTAR) project, we began work to identify potential sources of construction materials for transportation infrastructure and resource development in the northern National Petroleum Reserve–Alaska (NPRA). DGGS leads the effort to combine existing data with new targeted fieldwork to generate digital maps of prospective construction materials resources in the mapped priority areas.

Worked with University of Alaska collaborators on a federally-funded project to drill a new groundwater observation well in Goldstream Valley, Fairbanks. The well will be used to monitor groundwater in permafrost for this area, and the data will feed into the National Ground-Water Monitoring Network. This is the third well drilled for this project and brings the number of Alaska wells reporting to the network to four.

Provides other state and federal agencies with necessary information on geologic hazards for the purpose of land use planning and decision making. We completed agency reviews regarding potential geologic hazards and engineering-geologic considerations for multiple DNR land disposals, area plans, resource development and subdivision projects, Environmental Impact Statements, Resource Management Plans, and the State Hazard Mitigation Plan (SHMP). As a result of work we carried out in support of the Alaska Department of Transportation and Public Facilities (DOT&PF), we published a report on a landslide impacting the Alaska Highway near Northway.

The DGGS Coastal Hazards Program continues to establish new flooding/erosion monitoring stations and collect new data to measure the impacts of storms on Alaska's western coast. We played a key role in advocating for, securing, and providing contract specifications for NOAA investment in coastal mapping to collect orthorectified aerial imagery and elevation data in Bristol Bay, imagery over North Slope communities to leverage USGS and North Slope Borough investments in lidar, and the collection of short-term water level data at three Alaska communities to support flood mapping and products. Our program also organized and led the 2018 Alaska Water Level Meeting in which approximately 30 participants from state and federal agencies, non-profits, Native corporations, and private industry participated in determining technological options and priority locations and uses for Alaska's tiered coastal water level network.

The DGGS Coastal Hazards Program is hosting a two-year scientific fellowship focused on assisting rural Alaska communities impacted by significant and frequent coastal flooding. It is one of only three Digital Coast fellowships awarded nationally this year. The Alaska project will leverage existing data, online mapping tools, and partnerships to develop a flood forecast and catalog mapping tool, guidance on flood impact levels, and support ongoing community-based monitoring efforts. The Department of Natural Resources secured federal funding for the fellowship, which is administered by the National Oceanic and Atmospheric Administration, through the National States Geographic Information Council.

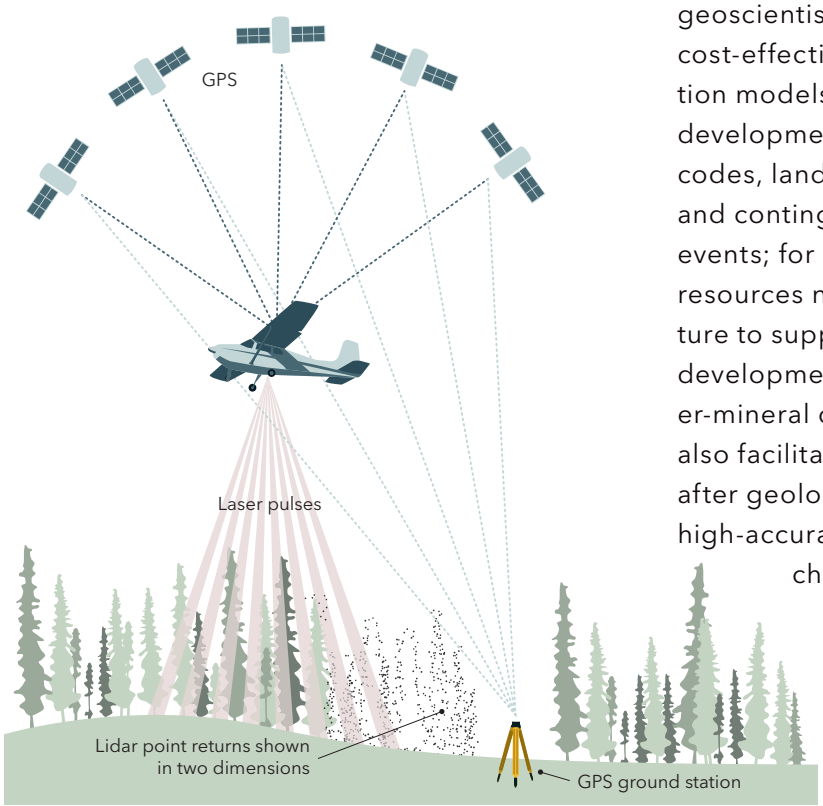
DGGS was a major contributing state agency and participant in the State Hazard Mitigation Plan Update, directing the portion of the State Hazard Mitigation Plan (SHMP) update relating to geologic hazards. We coordinated with the Plan Update Working Group, consisting of the State Hazard Mitigation Advisory Committee (SHMAC), the Division of Homeland Security and Emergency Management (DHS&EM) State Hazard Mitigation Officer (SHMO), and a

DHS&EM planning contractor to revise hazard descriptions and update histories for floods, snow avalanches, volcanoes, earthquakes, tsunamis, seiches, ground failure, erosion, sea ice, permafrost, and climate change. The Alaska SHMP serves as the strategy document for Alaska's hazard mitigation program and is required to meet FEMA requirements for a five-year State Hazard Mitigation Plan update under the Stafford Act to qualify the state for disaster relief funding.

## Turning on the High Beams

*New lidar sensor supports hazard and resource mapping*

In 2018, DGGS acquired a Light Detection and Ranging (lidar) system—a major new piece of scientific equipment to enhance emergency response, hazard mapping, and geoscientific investigations throughout the full breadth of the Engineering Geology Section's program elements. Lidar is a remote sensing method that uses light, in the form of a pulsed laser, to measure distance from the instrument to the ground surface being scanned, much like a laser rangefinder for golf or target shooting. These light pulses, combined with other data recorded by the lidar system, generate precise, three-dimensional information about the shape of the scanned surface. Recent development of easy-to-use, more affordable systems allows us to own a lidar collection system that is both compact and accurate. Airplanes and helicopters are the most commonly used platforms for acquiring lidar data over broad areas, but the versatility of the new DGGS lidar system allows for scanning of surfaces from a variety of moving vehicles, including a car, ATV, or even a backpack.



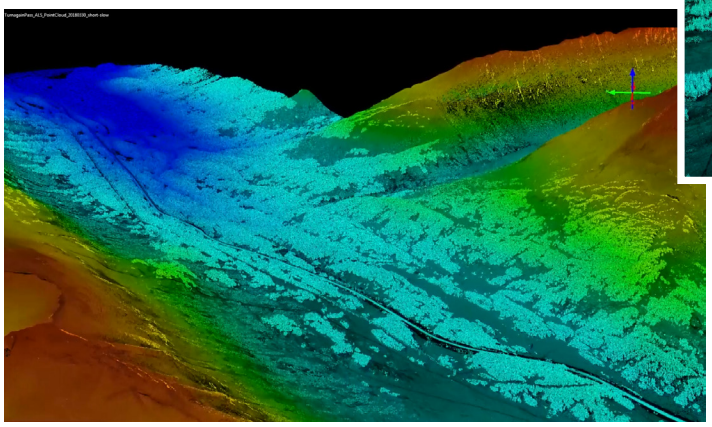

We rely on high resolution elevation data over many areas and multiple time epochs to carry out our mission, and owning our own dynamic lidar system enables DGGS geoscientists to efficiently, accurately, and cost-effectively generate land surface elevation models needed to guide the proper development and implementation of building codes, land-use zoning, right-of-way siting, and contingency planning for natural hazards events; for assessing construction materials resources necessary for building infrastructure to support resource exploration and development; and for locating valuable placer-mineral deposits. In-house lidar capacity also facilitates rapid emergency response after geologic hazards events, through repeat high-accuracy elevation surveys to detect changes in surface conditions. The system allows DGGS to cost-effectively collect high-resolution elevation data of smaller areas, as well as repeat data, that were previously inaccessible due to ▸

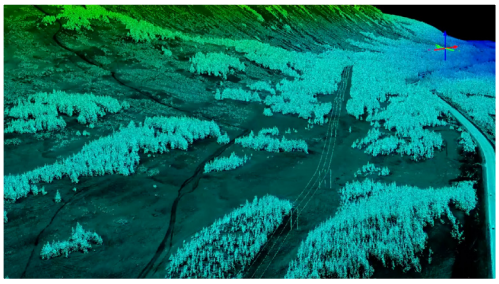
prohibitive costs of hiring contractors for these specialized collections. The system is available to support other divisions within DNR, as well as other departments' needs for small lidar surveys.

In this first year, we have successfully used the new lidar system to collect elevation data in support of landslide hazard mapping for Sitka and the Haines and Dalton Highways; avalanche mapping in Turnagain Pass, Thompson Pass, and Juneau; and assessing permafrost on the North Slope and in the Fairbanks area. This significant piece of equipment gives DGGS the unique opportunity to be a valuable collaborator with other DNR divisions on numerous projects, which can be leveraged to sustainably maintain and operate the lidar system for the foreseeable future. ◆

A side view of the Cessna 180 and custom-built, FAA-approved enclosure for the lidar scanner with close up view (inset) of the scanner mount and enclosure.

The Riegel VUX1-LR (red) attached to a Unmanned Aerial Vehicle (UAV) for its maiden calibration voyage.





DGGS collected more than 1 billion points over 170 sq km (66 sq mi) in Turnagain Pass. The aircraft used to collect this data flew between 180–240 m (600–800 ft) above ground level (AGL).

## 2018 Publications


Suleimani, E.N., Nicolsky, D.J., Koehler, R.D., and Salisbury, J.B., 2018, Regional tsunami hazard assessment for Andreanof Islands, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2017-2, 19 p., 2 sheets. http://doi.org/10.14509/29704

Overbeck, J.R., and Kennedy, K.S., 2018, Channel migration study of Emmonak, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2018-1, 14 p., 2 sheets, scale 1:5,000. http://doi.org/10.14509/30114

Nicolsky, D.J., Suleimani, E.N., and Salisbury, J.B., 2018, Tsunami inundation maps for Skagway and Haines, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2018-2, 69 p., 3 sheets. http://doi.org/10.14509/30029

Suleimani, E.N., Nicolsky, D.J., and Salisbury, J.B., 2018, Updated tsunami inundation maps for Homer and Seldovia, Alaska: Alaska Division of Geological & Geophysical Surveys Report of Investigation 2018-5, 97 p., 4 sheets. http://doi.org/10.14509/30095

Koehler, R.D., Carver, G.A., and Alaska Seismic Hazards Safety Commission, 2018, Active faults and seismic hazards in Alaska: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 160, 59 p. http://doi.org/10.14509/29705

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, Katey, Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd., 2018, Airborne electromagnetic and magnetic survey, Goldstream Creek watershed, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-5, 14 p. http://doi.org/10.14509/29681

Balazs, M.S., Wolken, G.J., and Wikstrom Jones, Katreen, 2018, Photogrammetry-derived digital surface model and orthoimagery of land areas near Resurrection Bay, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2018-2, 6 p. http://doi.org/10.14509/29824


*For a complete list of Engineering Geology section publications, visit dggs.alaska.gov/pubs*

# Minerals Resources

## *Benefit to Alaska*

*The Mineral Resources Section improves the success of exploration and mine development in Alaska by providing accurate, timely, and readily available geological, geophysical, and mineral deposit information for Alaska's lands, and assessing the mineral resource potential of Alaska's 160 million acres of land in support of the $3.15 billion per year mining industry, and its 3,392 direct jobs.*

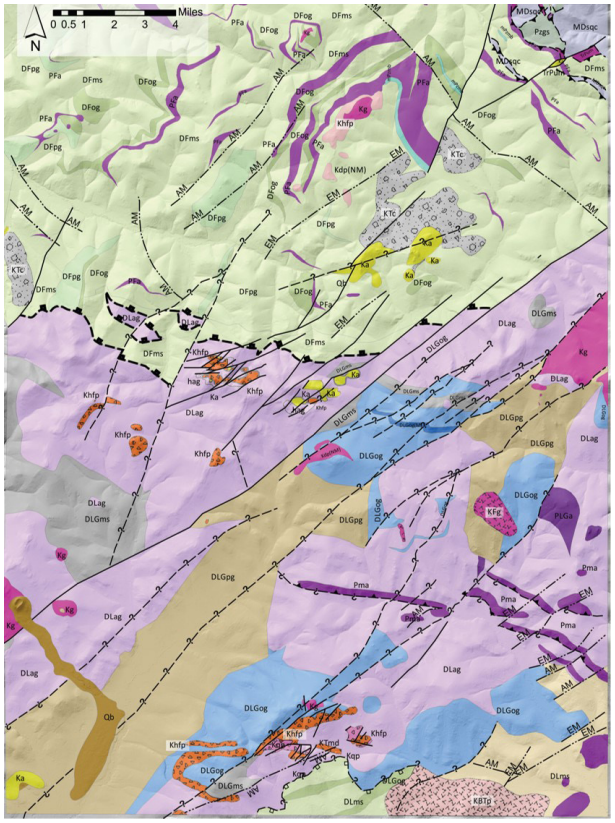
L to R: Gina Graham, Chris Wyatt, Abraham Emond, Melanie Werdon, Jennifer Athey, Karri Sicard, Travis Naibert, Evan Twelker, and Alicja Wypych.

## Airborne Geophysical & Geological Mineral Inventory Program Benefits State of Alaska

Data products of the DGGS's Airborne Geophysical & Geological Mineral Inventory (AGGMI) program (actively funded by the state 1993–2015) are important facilitators of industry's mineral-exploration success in Alaska. This information never becomes out of date, can be re-interpreted with new software, and, as a result, benefits the State of Alaska in perpetuity. AGGMI products contributed to private-sector discovery of more than 22 million ounces of gold in the Salcha River-Pogo and Livengood areas since 2004. Freegold Ventures Limited used AGGMI magnetic data to target drill holes and stake claims on their Shorty Creek project (2014–2016). Similarly, Endurance Gold used AGGMI magnetic and resistivity data to target drill holes on Elephant Mountain (2016–2017), and White Rock Minerals Ltd. used AGGMI geophysical data and the DGGS geologic map of the Bonnifield area to stake claims and identify exploration targets, some of which they drilled in 2018. Airborne geophysical datasets are used to assist geologic mapping of an area, particularly in areas with poor bedrock exposure. Mineral companies routinely use DGGS airborne geophysical surveys, geologic maps, and geochemical data to guide their more-detailed exploration work, which is necessary to make economic mineral discoveries. Exploration, discovery, and resource development contribute significantly to diversifying and building the State's economy, tax revenue, and job creation. The AGGMI datasets also advance the State's knowledge of its mineral resources, and promote informed state, federal, and native corporation land- and resource-management decisions.

## Geologic Mapping of Mineral Districts: Tanacross and Richardson-Uncle Sam's Gold

In 2017 and 2018, Mineral Resources geologists completed a 520-square-mile, detailed geologic mapping and geochemical sampling project in the northeastern Tanacross quadrangle adjacent to Yukon, Canada. The purpose of this project is to evaluate the area's mineral-resource potential and to create a geologic map to help guide industry exploration efforts. The area contains known porphyry gold-copper-molybdenum systems, such as Taurus, which are newly recognized to be spatially associated with high-angle fault systems, many of which can be identified in DGGS airborne geophysical surveys of the area. Ongoing work in FY2019 includes synthesis and interpretation of field data, and publishing the geologic map with accompanying reports and supporting geochronological data.




DGGS geologists completed project fieldwork, published geochemical and geochronological data, and presented a draft of the NE Tanacross geologic map during 2018.

Mineral Resources geologists completed fieldwork for the second phase of a 430-square-mile geologic mapping and geochemical sampling project in the Richardson-Uncle Sam gold exploration area northwest of Delta Junction. The purpose of this project is to integrate geological, geophysical, and mineral industry datasets to create an improved geologic map that will guide exploration and help to determine the area's mineral-resource potential, which is expected to be high based on known prospects, placer mines, and proximity to the Pogo gold mine. Ongoing work in FY2019 includes synthesis and interpretation of field data, and publication of the supporting geochemical and geochronologic data.

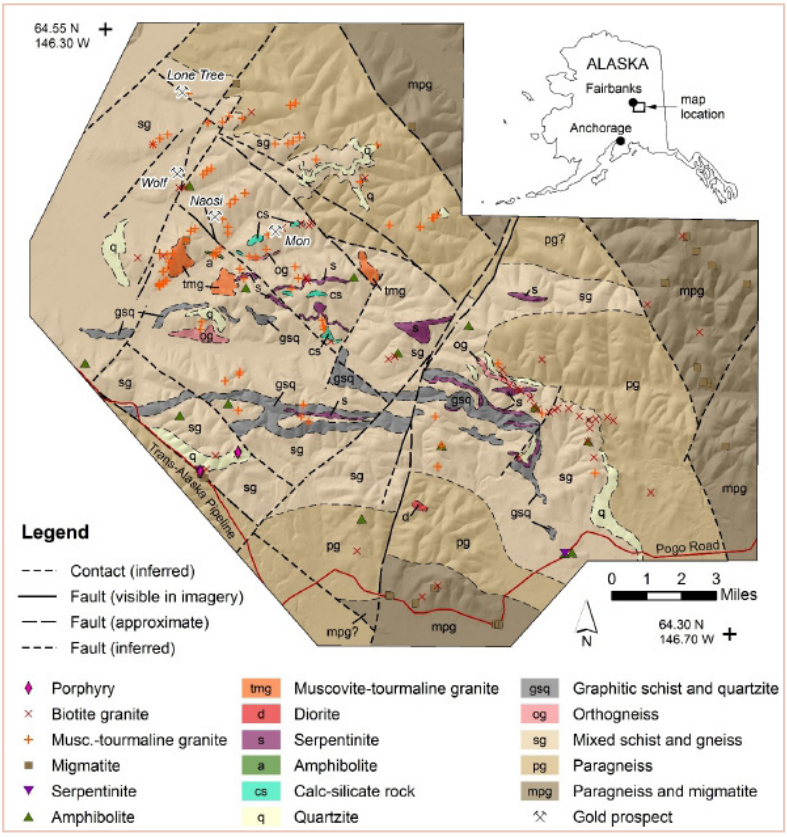
## Geophysics: The Second "G" in DGGS

DGGS completed analysis of the Yukon Crossing airborne electromagnetic data for the Alaska Department of Transportation & Public Facilities, and provided guidance on how to incorporate the geophysics into their next phase of the Yukon Crossing project to protect the vital bridge and oil pipeline infrastructure; guidance included suggested drill-hole locations. DGGS continued to provide geophysical support for the UAF-DGGS Goldstream Watershed project, and the Goldstream, Yukon Crossing, Yukon Crossing to Fox, and Western Yukon flats airborne electromagnetic surveys were published. A portion of the DGGS Airborne Geophysical/Geological Mineral Inventory program's VHS-format flight videos, collected as part of historical geophysical surveys, were converted into mp4 files to enable digital archiving, and will be published with their associated

surveys. DGGS improved the efficiency of its online geophysical-data-publication process and continued to prepare historical surveys for online publication, including the online publication of the 2001 Liberty Bell electromagnetic and magnetic survey. Abraham Emond, staff geophysicist, presented "Exploration, Mapping, Environmental Monitoring, Infrastructure Planning - Alaska Division of Geological & Geophysical Surveys' Geophysics Program" by invitation at the biennial USGS airborne geophysics workshop at USGS headquarters in Reston, VA (http://www.dggs.alaska.gov/pubs/id/30116). Geophysical Staff Gina Graham and Abraham Emond responded to 24 public requests for information.

## Showcasing Alaska's Diverse and Substantial Mineral Potential

By publishing Special Report 73 "Alaska's Mineral Industry 2017," (dggs.alaska.gov/pubs/id/30075) and by presenting annual overviews of mineral companies activities in Alaska at national and international mineral-industry conferences, the division fulfilled DNR's statutory requirement to "…conduct a continuing survey of the mineral resources and mining operations of the state and shall disseminate information regarding them…" (AS 27.05.050) and to "…make an annual report to the governor on all essential matters with regard to mining in the state"(AS 27.05.060). DGGS distributed more than 350 print copies of the 38th annual minerals report and more than 425 downloads during 2018, indicating this is a vital publication. Alaska is perennially recognized as having high mineral-resource potential and a healthy mining economy equal to that of many countries, but Alaska is competing to attract international mineral exploration investment with neighboring provinces and other U.S. states that have more developed infrastructure and perceived lower risk. The Alaska Mineral Industry Report and presentations to the mineral industry at mining conferences are the primary vehicle for demonstrating that Alaska has a diversity and quantity of mineral potential and an investment climate competitive with British Columbia, Yukon, Nevada, and Arizona as well as many countries.

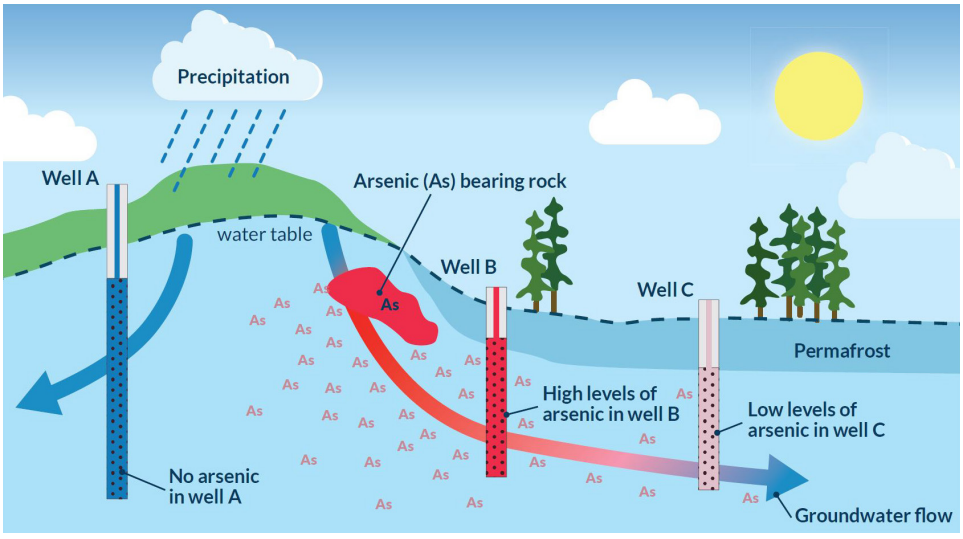

Mineral Resources geologists completed the second year of fieldwork in the Richardson-Uncle Sam area Mining District and published geochemical and geochronological data during 2018.

## Natrually Occurring Environmental Hazards in Alaska

The public's perception and experience is that environmental hazards are usually man made and that the natural environment is typically healthful. However, naturally occurring hazardous substances do exist in Alaska. DGGS's two-pronged approach of public education and hazard studies aims to help mitigate the risk of environmental hazards such as radon, arsenic in groundwater, and asbestos to Alaskans. DGGS works alongside other agencies, such as the University of Alaska-Cooperative Extension Service, Department of Health and Social Services, and Department of Environmental Conservation to conduct outreach, respond to public concerns, and collect environmental data. Hazard studies result in a better understanding of Alaska's naturally occurring deleterious substances, improved outreach materials, and more informed decisions about health, hazard mitigation, and property management by public and private land owners.

Naturally occurring radioactive radon gas, a decay product of uranium-238 in rocks and soil, is the second-leading cause of lung cancer after smoking and an under-recognized health risk in the state. The Environmental Protection Agency funded two projects in Alaska for conducting radon outreach, free radon testing, data collection, and the development of an online radon potential map to help the public visualize the risk from radon in Alaska. DGGS and project partners engaged more than 1,000 Alaska residents in free radon testing in 2018 and continue to populate DGGS' Alaska Radon Database, the only repository of radon test data in the state, to be used by state and national health professionals to explore the relationship between radon exposure and its health effects. For more information, please see DGGS Poster and Presentation "Geographic distribution for a quarter of a century of radon analyses" at doi.org/10.14509/29846.

Arsenic liberated from minerals makes its way into the groundwater of many Alaska communities. Health effects from arsenic vary from gastrointestinal upset to nerve and skin damage to cancers depending on quantity and duration of exposure. DGGS and outreach partners participated in several public health conferences and a community meeting in Ester, Alaska in response to an extremely high level of arsenic found in a private well. For more information, please see DGGS Information Circular 69 "Naturally occurring arsenic in Alaska groundwater" at doi.org/10.14509/30060.



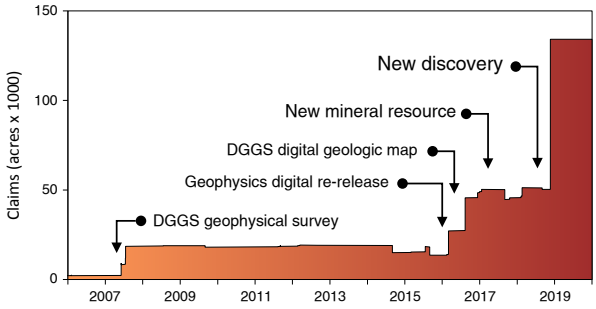

DGGS is working with the University of Alaska and other government agencies to study and inform the public about the risks of naturally occurring arsenic in Alaska's groundwater.

# DGGS Data Promote Industry Investment and Discovery

DGGS surveys increase the value of state land and generate revenue and economic activity for Alaska.

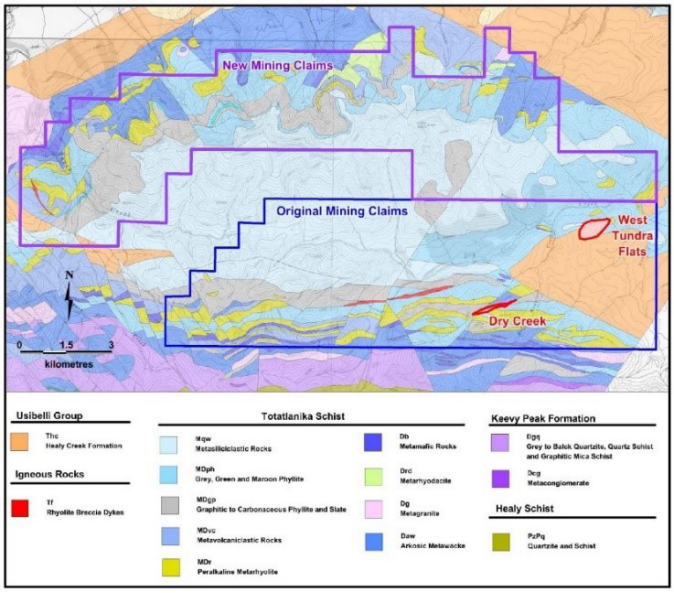
Case in point: DGGS played an instrumental role in the recent resurgence of exploration in the Bonnifield Mining District near Healy. The first discoveries of zinc-lead-silver-gold-copper mineralization were made during the 1970's and 1980's, but by 2000 exploration activity had all but ceased. In 2007, DGGS published the results of the Bonnifield geophysical survey and the most prospective areas were subsequently claimed by Fairbanks-based Metallogeny Inc.

In 2016, Metallogeny optioned the property to Australian exploration company White Rock Minerals Ltd. Assistance from DGGS's professional staff and drill core stored at DGGS's Geological Materials Center in Anchorage helped White Rock complete its due diligence prior to the acquisition. Timely release of a modernized version of the Bonnifield geophysical survey (dggs.alaska.gov/pubs/gpdata/34) and a new digital geologic map of the area (below left; dggs.alaska.gov/pubs/id/29661) helped the company develop new exploration targets and led it to aggressively expand its land position during 2016 (graph above).




Acreage of active mining claims in the eastern Bonnifield Mining District from 2006 to present, annotated with key DGGS data releases and milestones for White Rock Minerals' Red Mountain Project.

White Rock continues to invest heavily in the project, and this investment is already beginning to pay off. The company recently announced the discovery of a new, high grade sulfide zone, as well as the calculation of the property's first stock-exchange compliant mineral resource estimate. In late 2018, White Rock, once again, more than doubled its land position in anticipation of new exploration and additional discoveries in the near future.




Example of industry use of DGGS geologic map. White Rock Minerals Ltd. used the DGGS preliminary Bonnifield geologic map (doi.org/10.14509/29661) to help locate and stake additional mining claims. Map from White Rock Minerals Ltd., 2016, "White Rock expands its footprint at the highly prospective Red Mountain zinc-silver VMS prospect": White Rock Minerals Ltd. press release dated August 15, 2016, last accessed November 23, 2016. www.whiterockminerals.com.au/investor-centre/asx-announcements/20160815_White_Rock_expands_its_footprint_at_the_highly_prospective_Red_Mountain_zinc-silver_VMS_project.pdf.

## Notable Achievements

Maps, reports, and datasets produced by the DGGS Mineral Resources section provide important information that helps to attract mineral exploration companies to invest in Alaska.

DGGS identified the Tok River area, 20 miles southwest of the community of Tok, as an area of high potential for undiscovered gold, zinc, copper, lead, silver, and antimony. We began our investigation of the area with an airborne geophysical survey in 2014, followed by fieldwork by section geologists in 2015 and 2016. Data products include geochemical assays, a detailed geologic map, radiometric age dates, and descriptions of mineral occurrences encountered. Many areas of Alaska have poor coverage of these datasets, which are essential to attract and guide mineral exploration companies.

This work began to pay off within weeks of DGGS releasing the Tok River geochemical reports in November 2016. Following the publication, Peak Gold LLC, operators of the nearby Tetlin gold-copper-silver exploration project, staked an additional 436 mining claims, totaling 68,680 acres. To hold the claims, the company will pay approximately $60,000 in annual rental, and the exploration of these new claims is already generating economic activity in the region. Discovery of a minable resource would mean further economic development and tax revenue.

DGGS geologist Karri Sicard collects data on augen gneiss in the Tanacross area. Photo: Evan Twelker.

## Did You Know?

- Over half of the state's mining claim revenue is from the state land surveyed by the Mineral Resources Section.
- Industry geologists credit DGGS geophysical and geological maps and interpretations for discovery of 22 million ounces of gold at the Livengood deposit and at the Pogo gold mine, which when built contributed $280 million to the state and local economy. Added reserves at Pogo equal 6 years of additional mine life.
- DGGS airborne geophysical, geological, and geochemical data regularly facilitate increased claim staking and exploration success. Examples include a significant copper-gold discovery at Shorty Creek in 2015, and major claim staking in multiple localities statewide in 2016–2018.
- Mineral Resources staff responded to more than 375 industry, agency, and public requests for mineral-resource information.

# 2018 Publications


Athey, J.E., and Werdon, M.B., 2018, Alaska's mineral industry 2017: Alaska Division of Geological & Geophysical Surveys Special Report 73, 92 p. http://doi.org/10.14509/30075

Athey, J.E., and Daanen, R.P., 2018, Naturally occurring arsenic in interior Alaska groundwater: Alaska Division of Geological & Geophysical Surveys Information Circular 71, 2 p. http://doi.org/10.14509/30094

Athey, J.E., Daanen, R.D., and Hendricks, K.A., 2018, Naturally occurring arsenic in Alaska groundwater: Alaska Division of Geological & Geophysical Surveys Information Circular 69, 2 p. http://doi.org/10.14509/30060

Emond, A.M., Graham, G.R.C., Wypych, Alicja, Werdon, M.B., and Masterman, S.S., 2018, Exploration, mapping, environmental monitoring, infrastructure planning - Alaska Division of Geological & Geophysical Surveys'' geophysics program (presentation), USGS Airborne Geophysics Workshop, USGS Headquarters, Reston VA, September 11-13, 2018: Alaska Division of Geological & Geophysical Surveys, 50 p. http://doi.org/10.14509/30116

Emond, A.M., Daanen, R.P., Graham, G.R.C., Walter Anthony, Katey, Liljedahl, A.K., Minsley, B.J., Barnes, D.L., Romanovsky, V.E., and CGG Canada Services Ltd., 2018, Airborne electromagnetic and magnetic survey, Goldstream Creek watershed, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-5, 14 p. http://doi.org/10.14509/29681

Emond, A.M., Little, L.M., Graham, G.C., Minsley, B.J., and CGG, 2018, Airborne electromagnetic and magnetic survey, Yukon Crossing, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-4. http://doi.org/10.14509/29682

Emond, A.M., Minsley, B.J., Daanen, R.P., Graham, G.C., and CGG, 2018, Airborne electromagnetic and magnetic survey, Western Yukon Flats, interior Alaska: Alaska Division of Geological & Geophysical Surveys Geophysical Report 2016-2, 1 DVD. http://doi.org/10.14509/29683

Fugro Airborne Surveys, Stevens Exploration Management Corp., Burns, L.E., and Graham, G.R.C., 2018, Electromagnetic and magnetic airborne-geophysical survey of the Liberty Bell area, western Bonnifield mining district, Alaska (data compilation): Alaska Division of Geological & Geophysical Surveys Geophysical Report 2018-10, 12 p. http://doi.org/10.14509/29690

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Naibert, T.J., Benowitz, J.A., Wypych, Alicja, Sicard, K.R., and Twelker, Evan, 2018, 40Ar/39Ar data from the Tanacross D-1 and D-2, Big Delta B-4 and B-5, and Mount Hayes A-6 quadrangles, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2018-3, 15 p. http://doi.org/10.14509/30112

Twelker, Evan, Wypych, Alicja, Sicard, K.R., Naibert, T.J., Montayne, Simone, Newberry, R.J., and Wyatt, W.C., 2018, Major-oxide and trace-element geochemical data from rocks collected in the Richardson mining district, Big Delta Quadrangle, Alaska: Alaska Division of Geological & Geophysical Surveys Raw Data File 2018-6, 4 p. http://doi.org/10.14509/30119

Twelker, Evan, Newberry, R.J., Wypych, Alicja, Sicard, K.R., and Naibert, T.J., 2018, DGGS investigations of gold prospects in the Tok River area, eastern Alaska (presentation): Alaska Miners Association 26th Biennial Convention, Fairbanks, Alaska March 26-31, 2018: Alaska Division of Geological & Geophysical Surveys, 31 p. http://doi.org/10.14509/30030

Werdon, M.B., 2018, Alaska's mineral industry 2017: Mines, development, and exploration (presentation): Association for Mineral Exploration British Columbia Mineral Exploration Roundup, January 22, 2018: Alaska Division of Geological & Geophysical Surveys, 31 p. http://doi.org/10.14509/29851

Wypych, Alicja, Twelker, Evan, Athey, J.E., Hubbard, T.D., Naibert, T.J., Newberry, R.J., Sicard, K.R., Werdon, M.B., Willingham, A.L., and Wyatt, W.C., 2018, New geologic investigations of northeast Tanacross (presentation): Alaska Miners Association Annual Convention, Anchorage, Alaska, November 4-10, 2018: Alaska Division of Geological & Geophysical Surveys, 37 p. http://doi.org/10.14509/30123

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DGGS geologist Alicja Wypych collects samples during the 2018 field season in the Tanacross area. Photo: Evan Twelker.

# Geologic Information Center

*Creates, preserves, and distributes publicly available geologic maps, reports, and data to help improve the knowledge of Alaska's natural resources and geologic hazards.*

L to R: Tom Cerny, Sue Seitz, Trish Ekberg, Kristen Janssen, Mike Hendricks, Simone Montayne (front), Ken Papp.

## *Benefit to Alaska*

*Information availability creates value: Geologic information about Alaska's resources promotes informed land-management decisions and encourage investment, exploration, and development of the state's resources, resulting in billions of dollars of impact to Alaska's economy.*

*Protects lives and reduces property damage: Availability of information specific to the state's volcanoes, earthquakes, landslides, tsunamis, coastal erosion, and climate change helps mitigate these natural hazards, save lives, and reduce damage to property and critical infrastructure.*

## Our Audience

### Miners
Use our maps and data to search for and find minerals

### Exploration
Companies utilize our analytical data to help search for natural resources

### GIS Users
Rely on our digital geospatial data and online services

### Researchers
Investigate geoscience observations recorded in our data archive

### Public
Use our resources to learn about geologic hazards in the state

## GIC OBJECTIVES

- Create online geospatial applications for efficient delivery of geologic data
- Continuously develop and maintain Alaska's geologic data repository
- Publish geologic information (maps, reports, digital data)
- Maintain and develop division's computing resources
- Account for and maintain critical field safety and communication equipment

Many samples collected in the field and any subsequent analyses are now linked to a scanned field map and the samples' locations on the Earth.

## Where's that Sample?

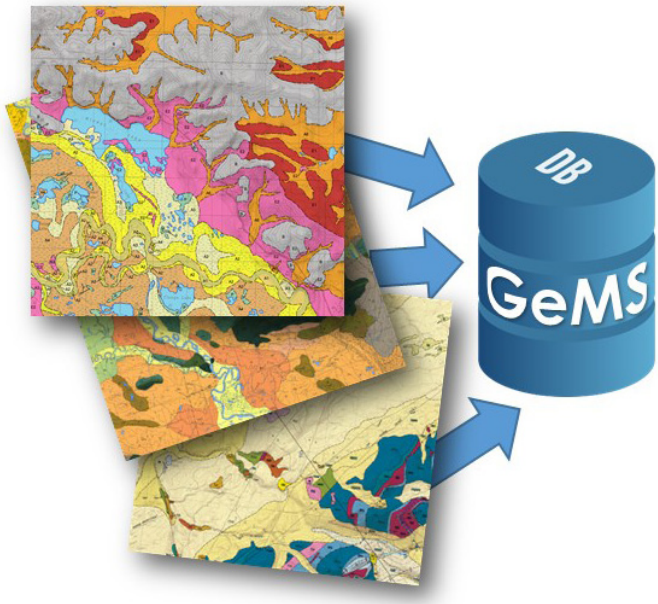
The Geologic Information Center (GIC) within DGGS and Geologic Materials Center (GMC) captured 51,362 locations for undocumented DGGS surface samples stored at the GMC, as part of the National Geological and Geophysical Data Preservation Program. The DGGS outcrop sample collection stands out as the GMC's most underutilized collection, largely because, prior to this work, 70,000 of the samples lacked specific locations. The collection contains more than 65 years' worth of undocumented surface samples collected by DGGS geologists from many Alaska projects—a significant untapped resource of geologic information. The GMC's database management system (maps.dggs.alaska.gov/gmc) allows the public easy access to the collection's new information.

As part of this project, GIC staff also scanned and digitized station locations from legacy field station maps to match up pre-2000 samples at the GMC. High-resolution scans of 113 field station maps are now available to the public through the Alaska Geologic Data Index (maps.dggs.alaska.gov/agdi) and locations for more than 6,000 DGGS field stations and samples were identified. DGGS continues work to identify locations and capture metadata for DGGS samples and other collections stored at the GMC.

To expedite public discovery and usability of geologic samples and data, DGGS is merging preexisting databases by linking geologic information to the physical samples from which the data are derived. This project significantly advanced the quality and completeness of our historic rock sampling records, which is needed to achieve the long-term goal of an integrated data management system. As a result of this work, the public will be able to more readily explore the breadth DGGS' data and sample repositories. The ability to provide enhanced access to baseline geologic data and samples from prior exploration efforts is a critical part of investing in the future of our state and crucial for researchers and exploration efforts to refine existing data and obtain a better understanding of our natural resources.

## The Future of Geologic Maps

Most people would describe a geologic map as a colorful print on paper with explanatory text representing geologic information on the surface of the earth. With the advancement in information technology, computers, and GIS in recent years, geologic maps are usually constructed from a database of geologic information. Now, the geologic database is often delivered as an additional or standalone geologic map product. The U.S. Geological Survey has designed the Geologic Map Schema (GeMS) to standardize the format and content of a geologic database, with




Researchers can develop new interpretations and geologic products when data from multiple geologic maps are stored in a single database.

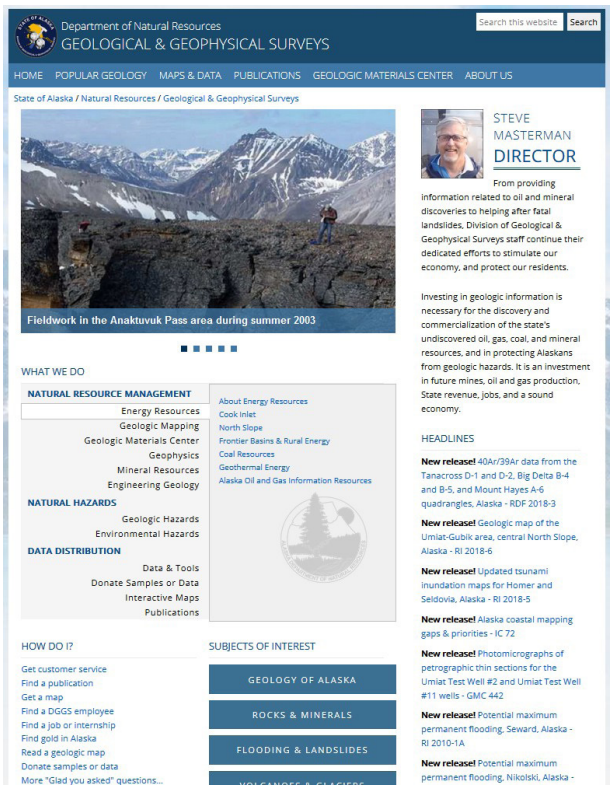
the goals of more efficient data sharing and national data compilation. DGGS is currently implementing the GeMS standard in the construction of new map products and developing procedures to translate legacy paper geologic maps into the standard format. As more Alaska geologic map data becomes available in the standard format, DGGS' long-term goal of compiling a 1:100,000-scale statewide map comes into focus.

The GeMS standard is designed for a single geologic map. Organizations such as DGGS, interested to build a database mapping system from a number of geologic maps, are working collaboratively to design a multi-map extension of GeMS. The DGGS-led project is in its third year of funding from the Environmental Protection Agency-Environmental Information Exchange Network.

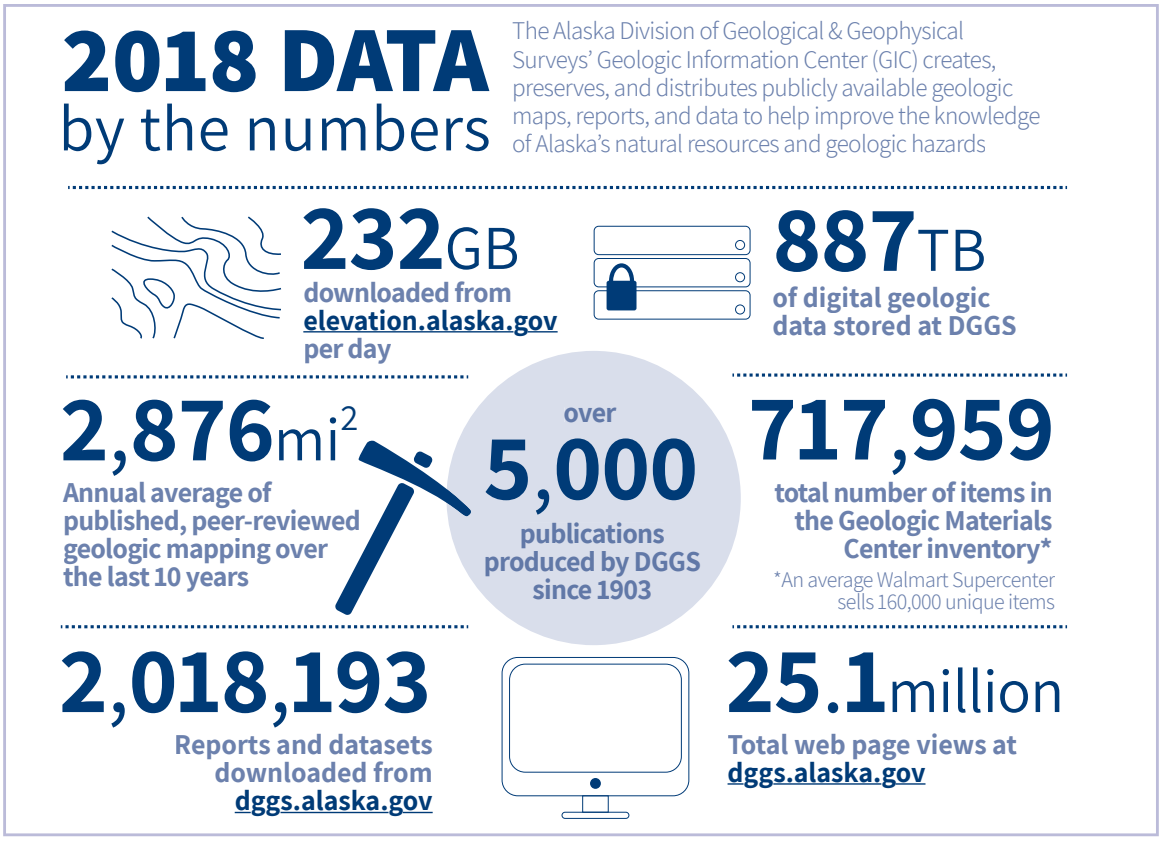
Geologists and GIS professionals from about 10 state geological surveys, the USGS, and the Geological Survey of Canada are involved in the development of the national geologic database model, which could eventually be adopted by multiple agencies. The DGGS multi-map enterprise geologic database will facilitate internal and external data sharing, business process efficiency, and enhanced products for those who use DGGS-derived data.

## Revitalizing our Web Presence

Quick and easy access to information about DGGS' diverse portfolio of geoscience programs, maps, and publications needs to




The new front page of DGGS' web site will link to both specialized scientific information and general interest topics.

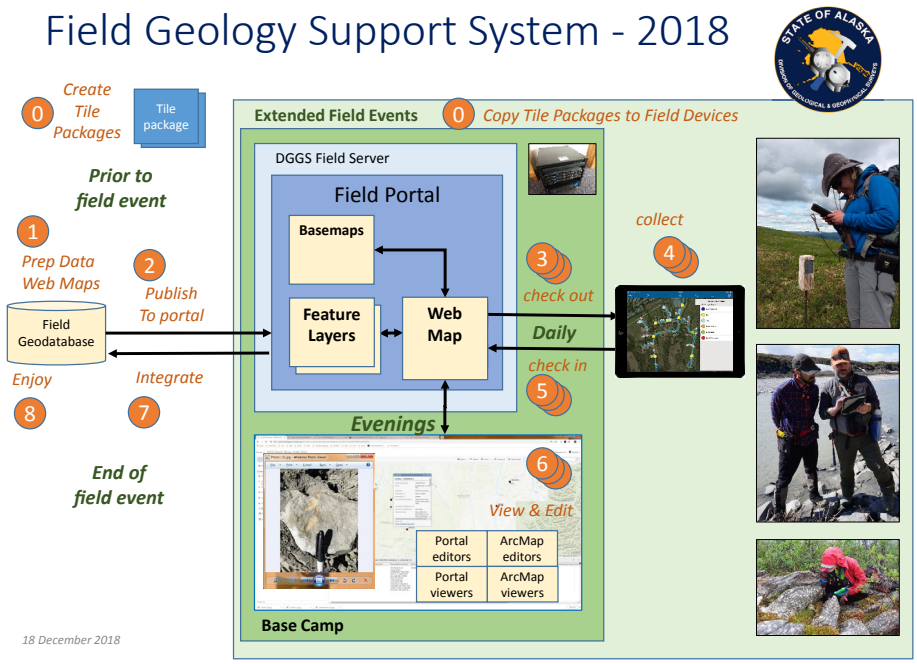



be right at the web-surfing finger tips of the public on their desktops and mobile devices. In addition, our audience of miners, explorationists, home owners, researchers, and agencies expects the information to be relevant to their needs and formatted for immediate consumption. To meet these requirements, DGGS has reimagined how we disseminate information over the Internet using best-practices in responsive web design for smartphones and tablets, and three additional tactics to automate data delivery and keep our information current– hierarchically and topically organized material for different user groups; database-driven content; and real-time web page updates by the folks actually doing the work.

The new web site will contain several content areas geared toward our different audiences. DGGS project managers have quadrupled the amount of information on Alaska geoscience studies with detailed descriptions of our programs and what we do. People with general questions, interested in geology education and outreach, or curious about geologic features, such as volcanoes and glaciers, will be able to easily navigate to their subjects of interest. The new web site also maintains previously available features, like the publications search and interactive maps page, to provide continuity for frequent past users of DGGS' web site.

Many of DGGS' dynamic projects produce frequent news updates and outcomes of interest to the public. High-interest geologic events such as earthquakes and landslides also require a rapid web response. To ensure that our web pages contain up-to-date information, DGGS is developing a database-driven content management system (CMS) for staff to quickly create and format information for web pages. A new, updated web server will host our web site, the CMS, and distribute other geologic data. The new site will be released soon at dggs.alaska.gov!

# Developing & Implementing a Modern Field Geology Support System

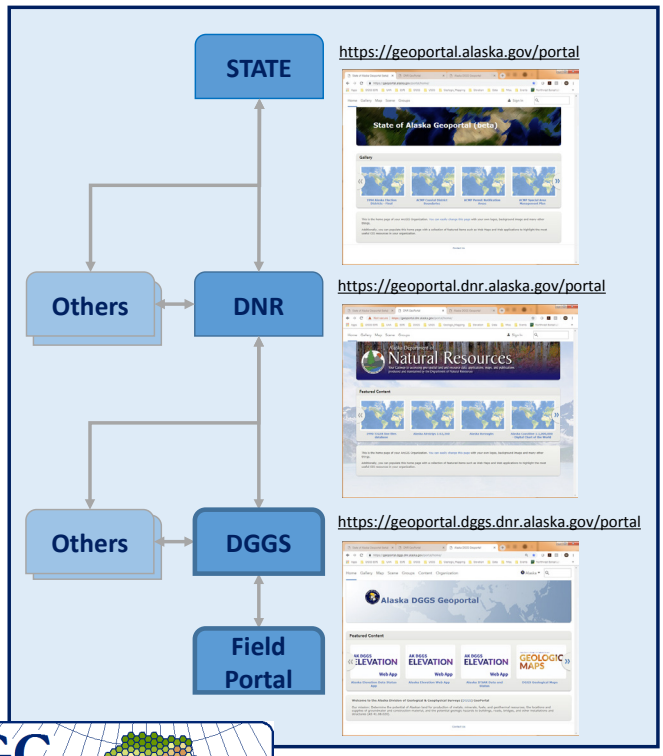



▼ DGGS geologists successfully transported and tested a Field Geology Support System during the 2018 field season.

DGGS requires the capability to collect geospatial data in remote areas without internet access for extended periods of time. For a number of years, the survey's mineral section has conducted field data collection with older generation Trimble Juno devices running ArcGIS for Windows Mobile. This technology, however, is slow and no longer supported by vendors. As a result, DGGS personnel explored various options to improve the effectiveness of field collection of geology data. Out-of-the-box solutions did not completely meet our requirements for long-term, disconnected editing and, as a result, we decided to build our own.

Based on our needs in the field, we developed a Field Geology Support System that runs a customized installation of Esri's ArcGIS Enterprise on a mobile server that can be transported to remote field camps. The Field Geoportal includes a wireless network that allows it to become the central data hub at the remote field camp and where all field personnel can easily, backup, access, edit, and share data. Each day, geologists can check out subsets of synchronized and relevant data from the Field Geoportal to a mobile device, brought along on field collection excursions. While away from the basecamp, they collect new data and update existing data on their device. Upon returning, the system provides the capability to synchronize their changes and new data with the Field Geoportal, instantly giving access to all changes to everyone in the field camp. In the evenings, newly acquired data can undergo quality control and used to plan the next day's activities. When the remote field event is complete and the geologists return to the office, the field data is synchronized with existing geodatabases.

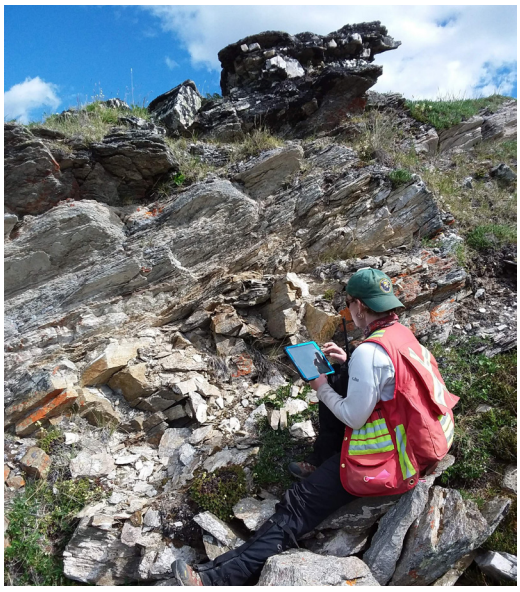
Two Field Geology Support System units were built and successfully tested by both the Minerals and Energy Resources Sections during the summer of 2018. Work is in progress to upgrade the system, based on lessons learned during this first year of implementation, and plans are in place for its use during future field campaigns.




# Testing, Developing & Implementing a DGGS Geoportal

The staff within the DGGS Geologic Information Center began testing and building a Geoportal in support of an overall statewide Geoportal infrastructure (left: agency flowchart). A geoportal allows users to efficiently share, discover and access a wide variety of geospatial information. An emphasis is placed on geospatial services, which provide an efficient mechanism to share data and ideas between state employees, and with the public. A well-designed Geoportal is a required element of the state's Spatial Data Infrastructure, of which DGGS data is an important component.

The DGGS geoportal is built on ESRI's ArcGIS Enterprise architecture, which fully integrates with DGGS's existing software, data, and procedures. When fully implemented the DGGS geoportal will dramatically increase the effective use of the geographic information systems in support of the survey's mission to the State of Alaska. Users can access the DGGS geoportal at geoportal.dggs.dnr.alaska.gov/portal.



DGGS Geologist Mandy Willingham using a tablet to collect data during field work that will be uploaded to the field portal at the end of the day.

## 2018 Publications

Athey, J.E., 2017, Hows and whys of data preservation at the Alaska Division of Geological & Geophysical Surveys (1998-2017; presentation): National Geological and Geophysical Data Preservation Program, Data Rescue and Preservation Workshop, Salt Lake City, Utah, September 26-28, 2017: Alaska Division of Geological & Geophysical Surveys, 26 p. http://doi.org/10.14509/29812

Athey, J.E., Hendricks, M.D., and Gallagher, P.E., 2017, Building an enterprise version of GeMS (formerly NCGMP09 map schema; presentation): Digital Mapping Techniques Workshop, Minneapolis, Minnesota, May 21-24: Alaska Division of Geological & Geophysical Surveys, 22 p. http://doi.org/10.14509/29732

Athey, J.E., 2017, 2017 Data Stewardship Survey results: Alaska Division of Geological & Geophysical Surveys Raw Data File 2017-3, 3 p. http://doi.org/10.14509/29726

Athey, J.E., Hendricks, M.D., Gallagher, P.E., and Seitz, S.S., 2018, Status of GeMS-compliant enterprise database model and Alaska GeMS maps (presentation): Digital Mapping Techniques Workshop, Lexington, Kentucky, May 20-23: Alaska Division of Geological & Geophysical Surveys, 22 p. http://doi.org/10.14509/30074

# Geologic Materials Center

*Permanently archive, index, protect, and make available for public inspection accessible geologic materials and related data to help advance exploration and knowledge of Alaska's natural resources.*

## Benefit to Alaska

*Alaska is home to world-class discovered and undiscovered natural resources. The cores and samples stored at the Alaska Geologic Materials Center (GMC) provide baseline geologic data and are critical for resource management and exploration in the state. The information they provide will likely help discover new and additional oil and gas reserves, viable geothermal energy regions, or new mineral prospects, as they have in the past. One foot of core can provide critical information to an exploration or development company, potentially leading to discovery and ultimately to millions of dollars in revenue to the State as well as hundreds of local jobs.*

## Overview

The GMC is the Alaska's largest and most comprehensive archive of geologic samples from offshore and federal, state, and private lands. It is the key entity directed to help industry, academia, and the public understand Alaska geology through the acquisition and preservation of physical and digital collections for future generations, assisting in the discovery of energy and mineral resources, and public outreach programs to illustrate the stories behind the science. The GMC is operated by the Alaska Department of Natural Resources, Division of Geological & Geophysical Surveys (DGGS). Cooperative partnerships with State and federal agencies have centralized collections from the U.S Bureau of Land Management (BLM), U.S. Geological Survey (USGS), U.S. Bureau of Ocean Energy Management (BOEM), former agency U.S. Bureau of Mines (BOM), and Alaska Oil and Gas Conservation Commission (AOGCC) into one repository. Grants from the USGS-led National Geological and Geophysical Data Preservation Program (NGGDPP) have aided the GMC in ongoing tasks of completing inventories

L to R: Kurt Johnson, Alexander Busk, Harrison Helton, Jean Riordan, and Walter Zimmerman.


The Alaska Geological Materials Center in Anchorage.

and generating a more comprehensive public, geologic collections database.

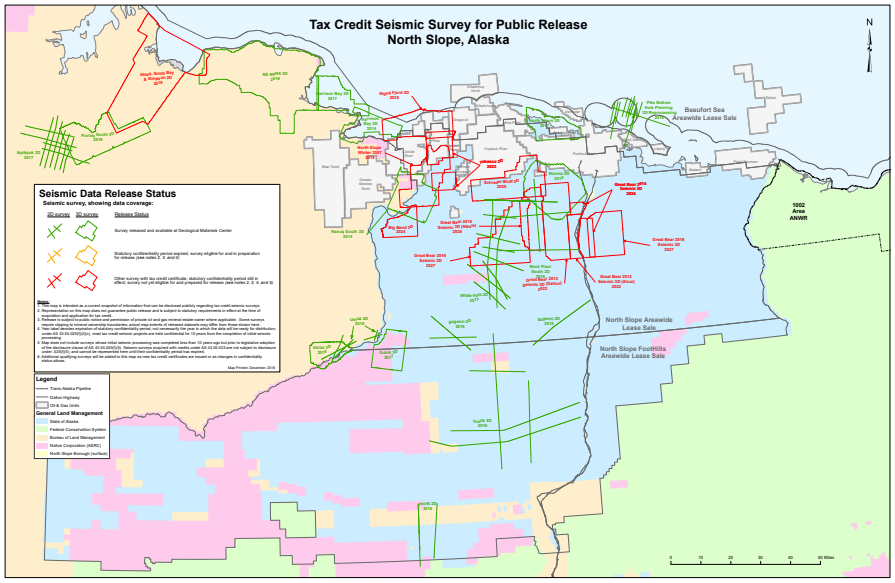
## Revenue from Fees

The signing of Senate Bill 170 (Ch27 SLA2016) in 2017 modified statute AS 41.08.030 ("Printing and Distribution of Reports") to add the new revenue section AS 41.08.045 ("Fees for facilities, equipment, products and services to the statutes governing the DGGS"). The new cost system balanced public access to GMC services with requirements to secure funding to ensure the facility continues to operate, grow, and serve long into the future. Typical GMC client fees include sample retrieval, table and room viewing space, and proprietary shelf sample storage.

The new revenue authority allows the implementation of fees to help offset operational costs of receiving, vetting, storing, and distributing energy industry geophysical datasets released to the State of Alaska through the Alternative Credit for Oil and Gas Exploration (AS 43.55.025) and Tax Credit for Certain Losses and Expenditures (AS 43.55.023). Over the year, the GMC distributed over 118 datasets of North Slope and Cook Inlet 2-D and 3-D seismic surveys, generating over a $1,000,000 in revenue for the state. The geophysical datasets are eligible for public distribution after two to ten years following the completion of exploration activity. The datasets are available through the GMC after extensive evaluation by the Division of Oil and Gas (DOG). For-profit institutions benefit from low cost access to very valuable energy exploration datasets, while research and education uses of the data are encouraged by offering the datasets to qualifying government, academic, and non-profit institutions at no cost.

## Bull in the Rock Shop

The GMC experienced its third 7 magnitude or greater earthquake in less than two years. Located just ten miles from the epicenter of the November quake, the four and a half million pounds of rocks stored in the center experienced powerful and sustained shaking. Fortunately, less than two dozen of the nearly 140,000 unconstrained boxes stored on warehouse shelves hit the floor. So far, the 100,000 square-foot facility appears to have weathered the event in good stead. While minor cosmetic and IT infrastructure damage has been repaired, the vast GMC collection,




Location map of tax credit surveys. For more information, visit [dggs.alaska.gov/gmc/seismic-well-data.php](dggs.alaska.gov/gmc/seismic-well-data.php).

conservatively estimated at $35-50B to reacquire, were shoved to the brink of catastrophe. Ongoing efforts to seek funding to seismically secure GMC assets will continue.

## Ambassador to Alaska geology

Alaska's interest to protect and support its stability and prosperity is a challenging set of tasks. The GMC encompasses unique qualities to publically support these goals on individual, state, national, and international levels. Situated in the state's population and transportation hub of Anchorage, the GMC facility centralizes wide-ranging geologic collections into one building with room to develop numerous collaborative and research opportunities. Colocation of Alaska resource and support industry assets with federal, state, and University of Alaska research projects can leverage extensive GMC rock materials to recognize new geologic knowledge and economic prospects.

## Global Outreach

The GMC recently hosted the largest, private oil and gas industry core viewing at the facility, with over forty attendees coming from around the world, including Alaska, Colorado, Texas, Australia, and Spain. Attendees included geoscientists, petrophysists, and engineers from joint-venture partners Repsol, Oil Search, and Armstrong Energy. Topical experts from DOG's Resource Evaluation Section and the DGGS Section Chief of Energy Resources hosted the two-day workshop with presentations, core examinations, and poster sessions. Close on the heels of this event, ConocoPhillips, Alaska viewed similar samples with a team of geologists from Anchorage and Houston.

Damage to the GMC's collection resulting from the November, 2018 magnitude 7 earthquake in Anchorage.


***"The Geologic Materials Center (GMC) in Anchorage, Alaska is such a valuable resource to our state. Oil Search plans to continue to use it as a resource moving forward as we pursue the Pikka Unit appraisal and development project as well as other exploration potential."***

*Joe Chmeilowski, VP of Reservoir Development, Oil Search, Alaska, 12/7/2018*

Industry geologists viewing core at the GMC.

## Regional Service

Numerous government agencies utilized the GMC this year to advance their resource agendas. The Alaska Gasline Development Corporation hosted the second and third tours of dignitaries and geologists from the Beijing office of the Sinopec oil company and the Bank of China to examine Prudhoe Bay oil and gas rock core. The Department of Natural Resources (DNR) filmed interviews and backdrops of the GMC collections to promote Alaska energy and mining resources for Governor Walker's trip to East Asia this last spring. Tours by other state agencies included the DNR Commissioner's Office, DOG, and Alaska State Information Office. Federal tours involved the Director of the US Geological Survey, Bureau of Ocean Energy Management workshops, and the US Forest Service hosted a resource symposium for the international Arctic Council. The GMC is also part of the Arctic Strategic Transportation and Resources (ASTAR) project, which is a federal, state, native corporation, and local North Slope community effort that seeks to identify regional infrastructure needs and water and gravel resources.

### *University Students Connect With the Public*

Education outreach at the GMC was highlighted by the fifth annual University of Alaska, Anchorage core study and public workshop. These stratigraphy labs challenge and extend the scientific capabilities of junior- to graduate-level geology majors. Students observe sedimentary structures, fossils, and rock compositions from multiple wells to determine likely depositional environments. To complement the analytical skills, students present their results to members of the public and geologic community. This year, students shared their interpretations of North Slope Jurassic sands and Cretaceous deltaic sediments.

Members of a Chinese delegation view rock samples at the GMC.

### *Local Interest*

GMC tours are very popular with Alaska students, professionals, and random visitors by way of small and large groups requesting facility appointments. Visitors learn about mega-thrust events, examine cores from the latest energy discoveries, peer at rocks under hi-power microscopes, and handle common rocks and not-so-common fossils. Gaining a fun and informative perspective on how geologists view the planet, GMC staff hosted 47 public tours for over 394 people in 2018.

Students from the University of Alaska, Anchorage participated in a poster session at the GMC.

Tours of the GMC are popular with professionals, the public, and school growups alike. Visitors get to view and handle rocks and fossils in the GMC's collection.

## *Research Connections*

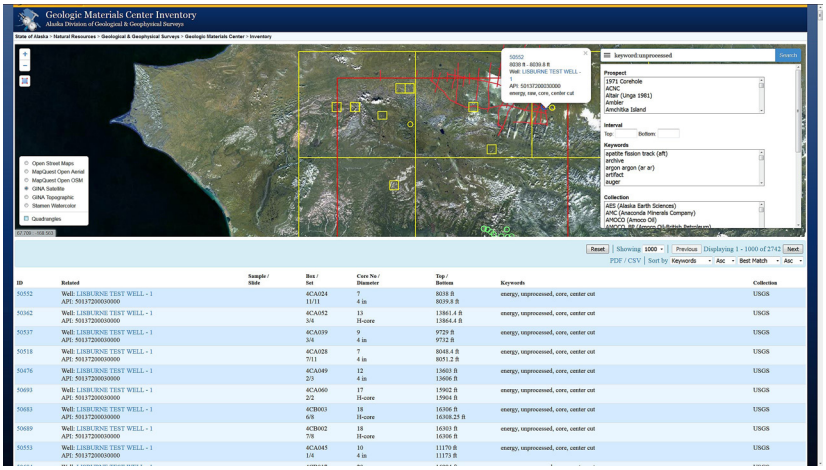
The GMC continues to foster collaboration with private and university colleagues to improve the geologic understanding of Alaska resources and enhance opportunities to seek project funding. tChemostrat, Great Britain, began a multi-well, multi-disciplinary approach to the stratigraphy and provenance of North Slope Brookian sequences. This study aims to generate an independent stratigraphic model based on the technique of chemostratigraphy. Graduate students at both University of Alaska campuses in Anchorage and Fairbanks are performing several analyses of cores from both the Cook Inlet and North Slope energy basins. Presentations on the application of hyperspectral analysis of rock samples were given by both private companies Corescan and Terracore. GMC staff looks forward to evaluating live demonstrations of this technology next year. Officials from Weatherford, one of the world's largest multinational oil and natural gas service companies, have also toured the warehouse this year. DGGS staff will reach out to geologic stakeholders this year to examine new approaches to capitalize on GMC assets and increasing research capacities for the facility.

Graduate students from the University of Alaska are performing several analyses of cores from Cook Inlet and North Slope energy basins.

## *Building the Backbone*

This fall saw several upgrades to the GMC. The 100,000 square-foot roof was replaced with new drainage systems, insulation, and waterproof layers and final work on the roof will finish this spring. A Drexel SLT-30AC forklift was purchased, with a rotating mast, that allows pallets to be placed on racks in narrow aisles at right angles to the vehicle. This machine will improve the safety aspects of moving heavy materials for both staff and the collections and increase efficiency and flexibility of storage. As previously mentioned, capabilities of the warehouse rack systems are being examined and GMC staff are looking to setup seismic restraint systems for boxes on shelves and to complete the top level of the existing rack system, to increase capacity for storing materials on pallets. IT infrastructure was upgraded during 2018 to be more resilient against failure, as was successfully demonstrated by remaining operational during the recent earthquake, despite the failure of a power unit. GMC data servers were increased by two petabytes of capacity to store local files, Alaska Tax Credit geophysical datasets, and provide redundancy for DGGS Fairbanks office network data.

An integral part of the GMC is its robust, open-source database. The system tracks each step of a sample




The GMC's public, searchable web-map used to identify area samples in its inventory.

container as it is organized, audited, and displayed for visitors. The GMC developed and maintains a publicly searchable web-map to identify area samples in its inventory. The browser-based tool (maps.dggs.alaska.gov/gmc) uses text searches, dynamic user-defined map boxes, and drop-down text filters to narrow results. Each inquiry generates a search-specific URL that can be sent to GMC staff or colleagues to exactly replicate the user's inventory results. All user search results can be easily transformed into downloadable PDF or plain-text CSV files.

## Notable Achievements

Two GMC internships provided practical geologic training and extensive work exposure to assisting professional Alaska geologists.

GMC and DGGS staff, with matching NGGDPP grant funds, researched and added 44,000 sample geolocations to the DGGS databases.

Volunteer projects continue to inventory of hundreds of megafossils from the Shell Oil outcrop collection.

The GMC was awarded a grant by the USGS-led National Geological and Geophysical Data Preservation Program to inventory and connect location metadata to thousands of Amoco outcrop samples.

Five unknown GMC "Mystery Core" mineral prospects were identified by Alaska prospectors at the DGGS Mineral Resources Section booth at the Alaska Miners Association convention in Anchorage.

Approximately, 1,226 people visited the GMC in CY2018.

## GMC Collection Highlights

| | |
|---|---|
| 3,122 | Alaska oil & gas wells |
| 26,800,000 | feet of oil & gas strata drilled |
| 17,000,000 | representative feet of oil & gas core and cuttings |
| 76,000 | linear feet of oil & gas core |
| 2,200 | Alaska mineral boreholes |
| 767,000 | feet of mineral rock drilled |
| 618,000 | representative feet of mineral core and cuttings |
| 356,000 | linear feet of mineral core |
| 216,000 | processed slides and thin sections |
| 420,000 | estimated surface and seismic shot-point samples |

## 2018 Publications

GMC 442

Repsol E&P USA Inc., 2018, Photomicrographs of petrographic thin sections for the Umiat Test Well #2 and Umiat Test Well #11 wells: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 442, 5 p., 1 DVD. http://doi.org/10.14509/30111

GMC 443

Bureau of Ocean Energy Management, Alaska OCS Region, and Weatherford Laboratories, 2018, Geochemical evaluation, including whole oil gas chromatography, aromatic biomarkers, saturate gcms, isotopes, metals, MSMS, SARA composition and sulfur from an oil sample from the Stinson #1 well: Alaska Division of Geological & Geophysical Surveys Geologic Materials Center Data Report 443, 1 p. http://doi.org/10.14509/30120

# Volcanology

## *Benefit to Alaska*

*The DGGS Volcanology Section conducts geologic studies to improve our understanding of volcanic systems to better forecast future eruptions and to assess their potential impact to society.*

L to R: Katie Mulliken, Janet Schaefer, Scott Crass, and Cheryl Cameron

## DGGS and the Alaska Volcano Observatory

Restless and erupting volcanoes are the norm here in Alaska and the Volcanology Section staff at DGGS play a key role in the three-agency partnership that comprises the Alaska Volcano Observatory (AVO). With colleagues from the University of Alaska Fairbanks (UAF/GI) and the U.S. Geological Survey (USGS), DGGS Volcanology Section geologists participate in around-the-clock monitoring of Alaska's 54 active volcanoes. In 2018, the section responded to unrest and eruptions from four volcanoes in Alaska: Cleveland, Great Sitkin, Semisopochnoi, and Veniaminof. At the time of this writing, Veniaminof volcano, on the Alaska Peninsula, is in an active state of eruption and on Thanksgiving Day, Perryville, located 20 miles south of the active vent, received trace ashfall as a ~200-mile-long ash cloud drifted in their direction. Volcanic ashfall is a concern for residents in communities near Alaska's active volcanoes and drifting volcanic ash clouds are the primary volcanic hazard for Alaska's busy commercial and passenger aircraft. Daily, more than 50,000 people travel in air routes over Alaska volcanoes. Keeping air traffic safe from volcanic ash encounters requires vigilance and expertise in volcanic processes to properly warn of unrest before it becomes a crisis. The volcanology team at DGGS conducts geologic studies of volcanoes to assess vulnerability of communities to volcanic events and to forecast eruptions based on real-time monitoring data and previous eruptive patterns. Communication of volcanic unrest and warning of imminent eruptions is a critical role that DGGS provides to the public and emergency managers through the management of AVO's communication pathways, including a public website, and popular Facebook and Twitter accounts.

AVO website: avo.alaska.edu @alaska_avo facebook.com/alaska.avo

◂ DGGS volcanologists Janet Schaefer and Katie Mulliken examine ash fall and lahar deposits on the south flank of Shishaldin volcano.

▾ Volcanologists Janet Schaefer (DGGS) and Jim Vallance (USGS) investigate ash fall deposits from Makushin volcano at a site near Unalaska/Dutch Harbor.

## Geologic Mapping and Ashfall Hazard Studies

At active volcanoes in Alaska, especially those close to communities, geologic studies help us better understand the history and nature of previous volcanic events, and better prepare for potential future eruptions and their associated hazards. This summer, the DGGS Volcanology Section participated in fieldwork at Makushin, Pavlof, and Shishaldin volcanoes. At Makushin volcano, work focuses on the Holocene ashfall record, with special attention to the historical ashfall impacts to nearby Dutch Harbor. Community outreach is an important component of volcanology fieldwork and Volcanology Section Chief, Janet Schaefer gave a well-attended public talk on ashfall hazards to the Dutch Harbor and Unalaska communities. Katie Mulliken (DGGS) and USGS-AVO colleagues investigated the eruptive history and geochemistry of the frequently active Pavlof Volcano, on the Alaska Peninsula, focusing on the ashfall record in the Holocene and will analyze their collected samples this winter. Schaefer and Mulliken also conducted a mapping project with USGS-AVO colleagues at the highly active Shishaldin Volcano, on Unimak Island. Two new fish processing plants are being built in False Pass, just 25 miles from Shishaldin, and this mapping project will contribute to the understanding of the hazard this community faces due to explosive eruptions from Shishaldin that have produced ashfall in False Pass and drifting ash clouds that disrupt air and marine traffic.

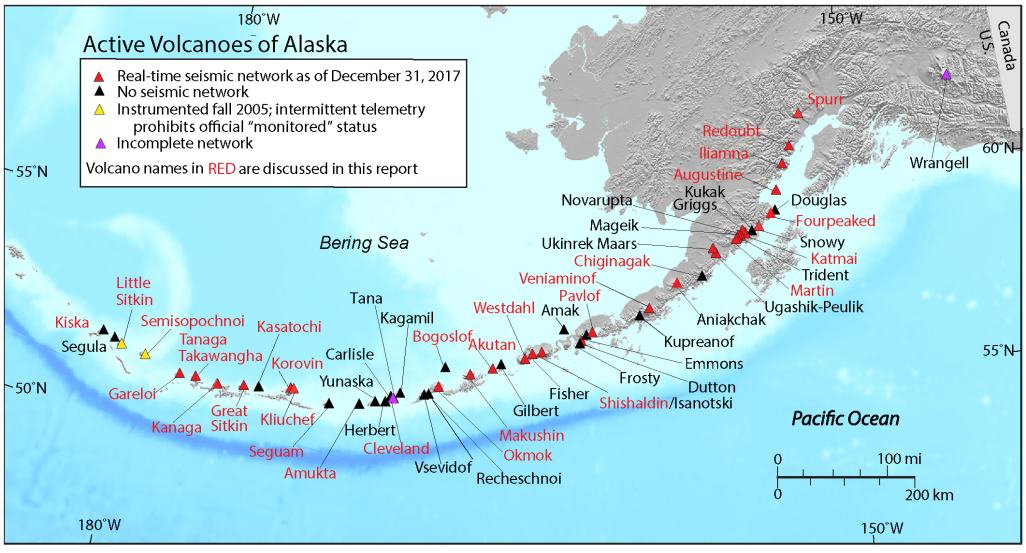
## Evaluation of the Timeliness and Accuracy of Eruption Forecasts

In its 30-year history, the Alaska Volcano Observatory (AVO) has responded to more than 50 eruptions at 20 volcanoes, beginning with Mount Redoubt's 1989-1990 eruption. DGGS's Cheryl Cameron, along with colleagues from the USGS and Carnegie Institution for Science, examined the timeliness and accuracy of AVO's eruption forecasts, and examined the results with respect to available monitoring instrumentation and data in place at the time of the event, and individual volcano and eruption

characteristics. This is the first time this analysis has been completed with an Alaska focus. For seismically monitored volcanoes with longer repose periods, larger eruptions, and greatest impact to Alaskans, infrastructure, and aviation, AVO has a 100% success rate in forecasting. In these circumstances, AVO is often able to provide weeks of warning, enabling protective mitigation measures. AVO is currently less able to forecast eruptions where there is no local seismic network, or for more mafic, frequently-active volcanoes. This analysis illustrates the importance of designing metrics for success within an individual monitoring agency's policies, alert levels, rationales, and procedures. When remote volcanoes are completely without ground based instrumentation, eruption forecasting is rare and AVO strives to decrease the delay between eruption onset, eruption detection, and notification to stakeholders. The results of this analysis will improve AVO's instrumentation strategies. The analysis is published and available online at doi.org/10.3389/feart.2018.00086.

## Fostering Volcano Database Collaboration

DGGS has created and maintained the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA), the back-end to the Alaska Volcano Observatory's public and internal websites, since 2002. This database now houses comprehensive, authoritative information (references, samples, whole-rock analyses, tephra glass analyses, images, petrographic data, eruption histories, internal logs and observations) on Alaska volcanoes, and is one of the largest volcano-centric databases in the world. Aspects of our successful database and web tools system are often utilized by other volcano observatories, including the Hawaiian Volcano Observatory's use of the "Is Ash Falling?" application during the 2018 eruption of Kīlauea. In 2018, we began the process to connect GeoDIVA to other databases, including DGGS's Geologic Materials Center sample repository (maps.dggs.alaska.gov/gmc), EarthChem, International Geo Sample Number, Smithsonian's Global Volcanism Project, Open Researcher and Contributor ID, and the tephra-based Throughput project. Enabling access to GeoDIVA's information via shared key fields will eventually permit these state, national, and global databases to include information from GeoDIVA in their portals. This shared volcanic knowledge will facilitate a deeper understanding of eruptive processes and hazards, improving our forecasting ability by drawing on global multi-disciplinary data streams.




Map showing location of active volcanoes in Alaska; volcanoes evaluated for AVO response labeled in red text. Map modified from Dixon and others (2017).

## Notable Achievements

Deployment of AVO chat server to aid in the Kīlauea eruption response. The AVO chat server allows responders to quickly share observational data and images to more efficiently evaluate the hazard and to communicate eruptive activity status to emergency response personnel.

Built and deployed a volcano seismic observation database. The seismic observation database allows AVO scientists to record daily seismic observations and to query that data to find patterns in activity to better assess volcanic processes and eruption potential.

Published a tephra occurrence map and a geodatabase of spatial distribution of ashfall. This data was used to assess community vulnerability to ashfall hazards in the newly revised State Hazard Mitigation Plan.

Fresh ski tracks through the ash near Unalaska on January 31, 2017. Photo by Andy Dietrick of Unalaska, submitted to AVO via our database and web application "Is Ash Falling" during the Bogoslof eruption.

## 2018 Publications


Cameron, C.E., Prejean, S.G., Coombs, M.L., Wallace, K.L., Power, J.A., and Roman, D.C., 2018, Alaska Volcano Observatory Alert and Forecasting Timeliness: 1989-2017: Frontiers in Earth Science, v. 6, https://doi.org/10.3389/feart.2018.00086

Coombs, M.L., Wech, A.G., Haney, M.M., Lyons, J.J., Schneider, D.J., Schwaiger, H.F., Wallace, K.L., Fee, David, Freymueller, J.T., Schaefer, J.R., and Tepp, Gabrielle, 2018, Short-term forecasting and detection of explosions during the 2016-2017 eruption of Bogoslof Volcano, Alaska: Frontiers in Earth Science, v. 6, article 122, doi.org/10.3389/feart.2018.00122

Mulliken, K.M., Schaefer, J.R., and Cameron, C.E., 2018, Geospatial distribution of tephra fall in Alaska: a geodatabase compilation of published tephra fall occurrences from the Pleistocene to the present: Alaska Division of Geological & Geophysical Surveys Miscellaneous Publication 164, 46 p. http://doi.org/10.14509/29847

Power, J.A., and Cameron, C.E., 2018, Analysis of the Alaska Volcano Observatory's response time to volcanic explosions - 1989 to 2016: Frontiers in Earth Science, v. 6, https://doi.org/10.3389/feart.2018.00072

Waythomas, C.F., and Cameron, C.E., 2018, Historical eruptions and hazards at Bogoslof volcano, Alaska: U.S. Geological Survey Scientific Investigations Report 2018-5085, 42 p., https://doi.org/10.3133/sir20185085

Worden, A.K., Schaefer, J.R., and Mulliken, K.M., 2018, Tephra occurrence in Alaska: a map-based compilation of stratigraphic tephra data: Alaska Division of Geological and Geophysical Surveys Miscellaneous Publication 165, 19 p., http://doi.org/10.14509/30059

# Relationships with Other Agencies

DGGS develops its strategic programs and project schedule through consultation with the many users of geologic information: state and federal agencies, the Alaska Legislature, the federal congressional delegation, professionals in the private sector, academia, and individual Alaskans. Their input to DGGS programs comes through the Alaska Geologic Mapping Advisory Board, liaison activities of the Director, and personal contact between DGGS staff and the groups listed above.

## State Agencies

DGGS provides other Department of Natural Resources (DNR) and state agencies with routine analyses and reviews of various geologic issues such as geologic hazards; evaluations of pending oil and gas lease tracts; area plans; competitive coal leases; geologic assessments of land trades, sales, selections, or relinquishments; oil and gas and mineral potential; and construction materials availability.

### *Each year DGGS works closely with:*

- **DNR Division of Oil & Gas (DOG)** on issues related to energy resources, and in providing geologic control for the subsurface oil-related geologic analyses conducted by DOG;
- **DNR Office of Project Management and Permitting (OPMP)**, with technical expertise during large project permitting;
- **Division of Economic Development in the Department of Commerce, Community, and Economic Development (DCCED)**, to report on the status of Alaska's mineral industry;
- **Division of Homeland Security & Emergency Management (DHSEM; in the Department of Military and Veterans Affairs [DMVA]), and the Department of Environmental Conservation (DEC)** to evaluate volcanic and other hazards, develop scenarios for hazards events, and update the State Hazard Mitigation Plan;
- **Department of Transportation & Public Facilities (DOT&PF), University of Alaska Fairbanks (UAF)**, and other agencies to assess the impacts of landslides, slope failures, avalanches, flooding, erosion, and construction materials availability;
- **Alaska Energy Authority (AEA)** to evaluate hazards to proposed hydroelectric, geothermal, and other energy projects; to provide technical expertise on geothermal resource potential, and; to evaluate resource potential around the state that might provide viable alternatives for energy development in rural Alaska;
- **DNR Division of Mining, Land, and Water (DMLW)** to evaluate groundwater issues and address land selection and sale questions;

In recent years with the Alaska Natural Gas Pipeline project, Alaska Gasline Development Corporation (AGDC), and the State Pipeline Coordinator to assist in geologic data collection and hazards assessment for proposed natural gas pipelines.

Large inter-division or other one-time efforts responding to special needs are generally supported by interagency fund transfers. Smaller requests are funded by DGGS's annual general fund appropriation.

## Local Governments

Many of the cooperative efforts implemented by DGGS with borough and municipal governments are conducted on a mutually beneficial, but informal basis. For example, DGGS participates in a federally-funded cooperative program to develop tsunami-inundation maps for coastal communities. In communities for which inundation maps have been prepared in recent years, DGGS works closely with collaborators and city and borough governments to design project outputs to meet community needs for planning evacuation areas and routes.

DGGS works closely with local communities to help assess hazards and alternatives for mitigating the effects of erosion, flooding, and other surface processes that threaten their sustainability. DGGS also sends personnel to respond to natural disasters, such as the Sitka landslides in September 2015. Similarly, DGGS works with rural communities to help assess potential local energy resources as alternatives to diesel fuel. During volcanic unrest and eruption, DGGS, as a partner in the Alaska Volcano Observatory, communicates with local villages, industry sectors, the aviation community, and the military to share information and observations of volcanic unrest.

## The University of Alaska

DGGS has a longstanding and productive professional association with geoscientists and students at the University of Alaska. University of Alaska faculty often work as DGGS project team members on a wide range of collaborative research projects. University student interns are also an important part of the DGGS workforce; while working on DGGS projects, students learn a wide variety of geology-related skills. Some graduate students are able to apply their DGGS intern work to their thesis projects through research programs established through a Memoranda of Agreement with the University of Alaska, Fairbanks (UAF) Department of Geology & Geophysics and Department of Mining & Geological Engineering. DGGS and the university make frequent use of each other's libraries and equipment and University of Alaska faculty and students also frequent the Geologic Materials Center in Anchorage, where faculty conduct core logging classes. DGGS' Volcanology Section has a long-term cooperative relationship with the UAF Geophysical Institute, resulting from partnership in the Alaska Volcano Observatory.

## Federal Agencies

DGGS has cooperative programs with numerous federal agencies including the U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (FWS), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), and periodically with the Federal Emergency Management Agency (FEMA), U.S. Department of Housing and Urban Development (HUD), the U.S. Bureau of Land Management (BLM) and the U.S. Department of Energy (DOE). In the past, DGGS has also engaged in cooperative programs with the U.S. Minerals Management Service (MMS), now the Bureau of Ocean Energy Management.

DGGS receives federal funds from matching grants for which the division must compete nationally with other organizations on a yearly basis. DGGS has been successful in securing federal funds to support mineral inventory mapping, surficial and earthquake hazards-related mapping, geologic-hazards evaluations, and studies related to oil and gas and geothermal potential. Although DGGS has historically been very successful in receiving federal grants and appropriations,

the process is competitive and these funds are therefore project-specific or complementary to state-funded programs and do not replace state general fund support. Federal funding is pursued only for projects that advance and serve the division's statutory mission.

Two ongoing cooperative federal programs have provided support for key elements of the DGGS mission for many years. One is the Alaska Volcano Observatory (AVO), a partnership established in 1988 consisting of USGS, DGGS, and the UAF Geophysical Institute. The USGS funds and administers the program for the purpose of providing a coordinated approach to mitigating volcano-hazard risks to the public, state infrastructure, and air commerce. The second ongoing program is the STATEMAP component of the National Cooperative Geologic Mapping Program, established by Congress in 1992 and administered by the USGS. STATEMAP provides matching funds for geologic mapping projects according to priorities set by the Alaska Geologic Mapping Advisory Board (GMAB; see next page).

DGGS has been successful in receiving cooperative agreements from the National Geological & Geophysical Data Preservation Program (NGGDPP) and the National Cooperative Geologic Mapping Program (NCGMP). The NGGDPP, funded by the USGS, has supported several DGGS projects to preserve and make geologic information publicly available. STATEMAP funds provide a stable source of federal funding for geologic mapping in the state.

# Alaska Geologic Mapping Advisory Board

The Alaska Geologic Mapping Advisory Board (GMAB) guides DGGS in pursuing its goal of providing earth science information to the Alaska public. A number of prominent geologists and community leaders, with a variety of backgrounds and a broad spectrum of experience in Alaska, have agreed to serve on the advisory board. The board held its first meeting in Fairbanks on October 22, 1995, and normally meets three times a year to discuss state needs, review DGGS programs, solicit and welcome comments and suggestions from the public, and provide recommendations to the state geologist.

This year, DGGS said goodbye to Ethan Schutt of Cook Inlet Region, Inc, and Dr. Anupma Prakash. DGGS welcomed Dr. Paul McCarthy to the board. Dr. McCarthy is Chair of the University of Alaska Fairbanks, Department of Geoscience, and has a strong background in alluvial architecture and nonmarine sequence stratigraphy.

## Current members of the board are:

*Steve Adamczak*
Vice President, Shannon and Wilson, Inc. Mr. Adamczak has more than 30 years of experience in geotechnical engineering, and represents the engineering geology and geotechnical community.

*Margaret Darrow*
Chair of the University of Alaska Fairbanks, Department of Mining and Geological Engineering. Dr. Darrow has a background in engineering geology with, and represents the University, the Department and also the engineering geology discipline.

*Curt Freeman, Chair*
President, Avalon Development Corporation. Mr. Freeman runs a well-known and successful consulting mineral exploration firm in Fairbanks and represents minerals industry interests.

*Tom Homza*
Principal Regional Geologist, Shell Exploration and Production, Alaska. Dr. Homza has 20 years oil and gas exploration experience and represents petroleum industry interests.

*James Jones*
U.S. Geological Survey. Dr. Jones specializes in tectonic evolution and mineral resources with the USGS Anchorage office, and represents the Federal government, earthquake hazards, and mapping interests.

*Paul McCarthy*
Chair of the University of Alaska Fairbanks, Department of Geoscience. Dr. McCarthy has research interests in paleolandscape evolution, alluvial architecture and nonmarine sequence stratigraphy. He represents the University of Alaska Fairbanks on the Board.

*Gregory Wilson*
Director Arctic Exploration and Services, ConocoPhillips Alaska. Dr. Wilson has more than 25 years of oil and gas exploration experience in Alaska and also represents the oil and gas industry.

# DGGS Mission and History

## Mission Statements

**Department of Natural Resources:** *Develop, conserve, and enhance natural resources for present and future Alaskans*

**Division of Geological & Geophysical Surveys:** *Determine the potential of Alaskan land for production of metals, minerals, fuels, and geothermal resources, the locations and supplies of groundwater and construction material; and the potential geologic hazards to buildings, roads, bridges, and other installations and structures (AS 41.08.020)*

## History

The present Division of Geological & Geophysical Surveys (DGGS) evolved from Alaska's Territorial Department of Mines. That heritage is reflected in the Division's ongoing commitment to the application of geology to improve the welfare of Alaska citizens. The current name and mission of the Division were established in 1972 with the passage of Alaska Statute AS 41.08.

- Territorial Department of Mines, prior to 1959
- Division of Mines and Minerals, 1959–1966
- Division of Mines and Geology, 1966–1970
- Division of Geological Survey, 1970–1972
- Division of Geological & Geophysical Surveys, 1972–Present

## Leadership

Eleven qualified professional geoscientists have served as State Geologist:

- Jim Williams, 1959–1971
- William Fackler, 1971–1973
- Donald Hartman, 1973–1975
- Ross G. Schaff, 1975–1986
- Robert B. Forbes, 1987–1990
- Thomas E. Smith, 1991–1995
- Milton A. Wiltse, 1995–2002
- Rodney A. Combellick (Acting), 2003–2005
- Mark D. Myers, February–October 2005
- Robert F. Swenson, November 2005–November 2013
- Steven S. Masterman, November 2013–present

Linda Natrop, Julia Garrity, Steve Masterman, Shelly Showalter, and Ken Papp

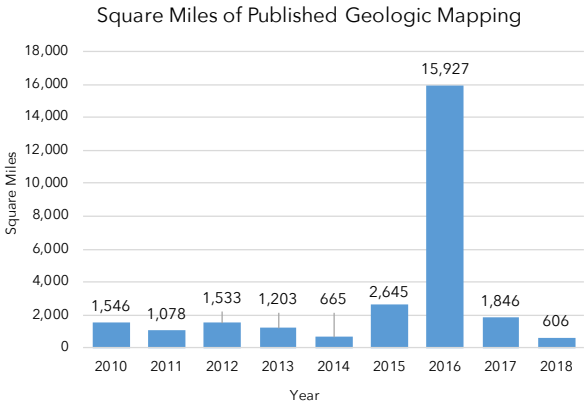
By statute the State Geologist serves as the Director of the Division of Geological & Geophysical Surveys in the Department of Natural Resources (DNR) and is appointed by the DNR Commissioner. Since the early 1970s, State Geologists have been selected from lists of candidates prepared by the geologic community and professional societies in Alaska. A department order in 2002 formalized a process whereby the Geologic Mapping Advisory Board oversees evaluation of candidates and provides a list to the Commissioner. The qualifications and responsibilities of the State Geologist and the mission of DGGS are defined by statute.

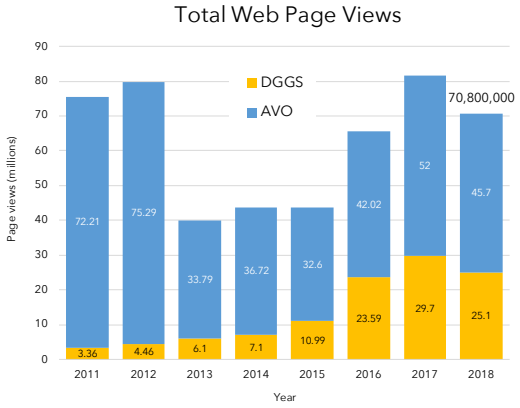
## Organization

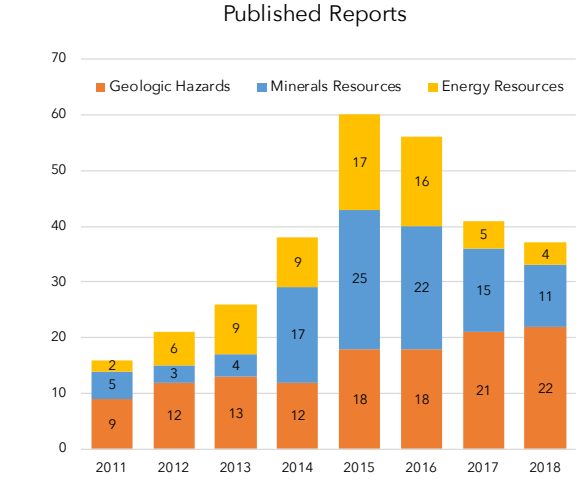
DGGS is one of seven divisions and six offices in the State of Alaska Department of Natural Resources. Under the overall administration of the Director's Office, the Division of Geological & Geophysical Surveys is organized into five sections and the Geologic Materials Center (see see http://dggs.alaska.gov/about-us/staff-directory.php). The Division also administers the 11-member Alaska Seismic Hazards Safety Commission.

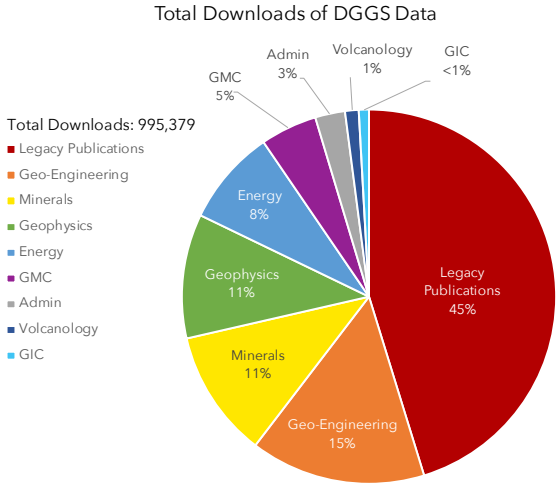
Current DGGS staff totals 37 permanent full-time professional and support positions, with additional nonpermanent staff, and student interns.

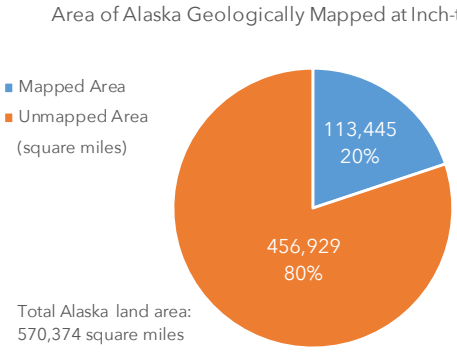
# Performance Measures



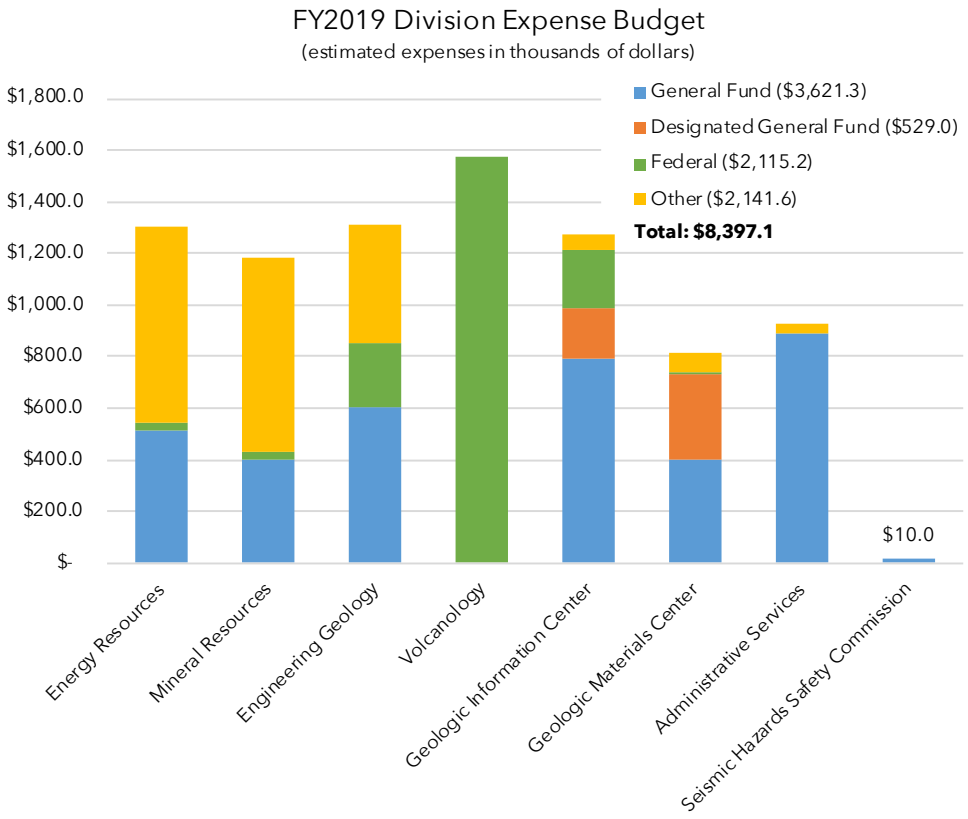



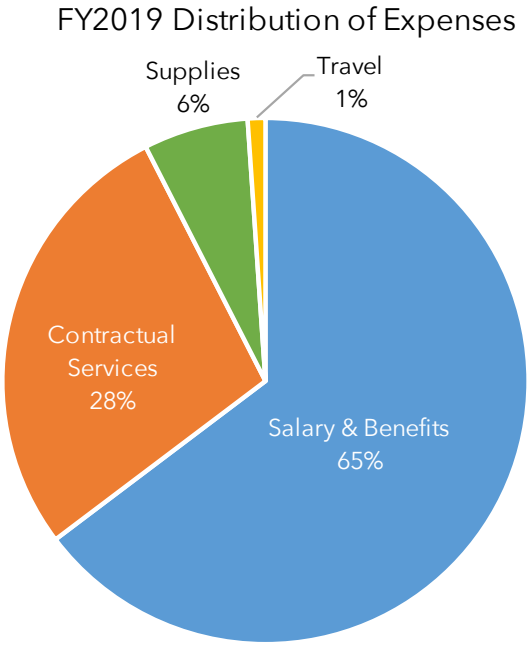



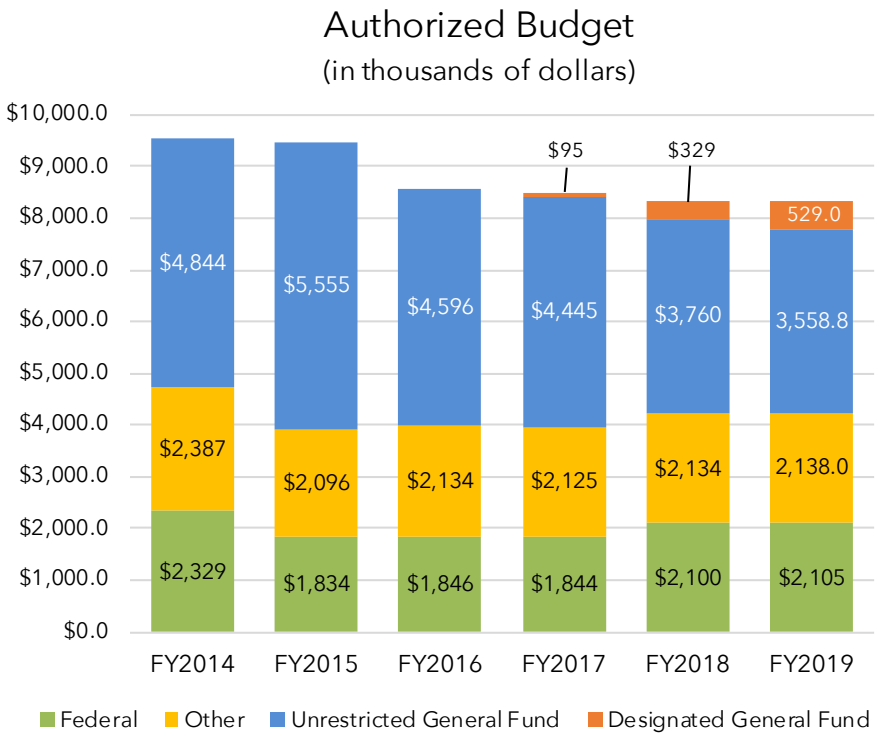



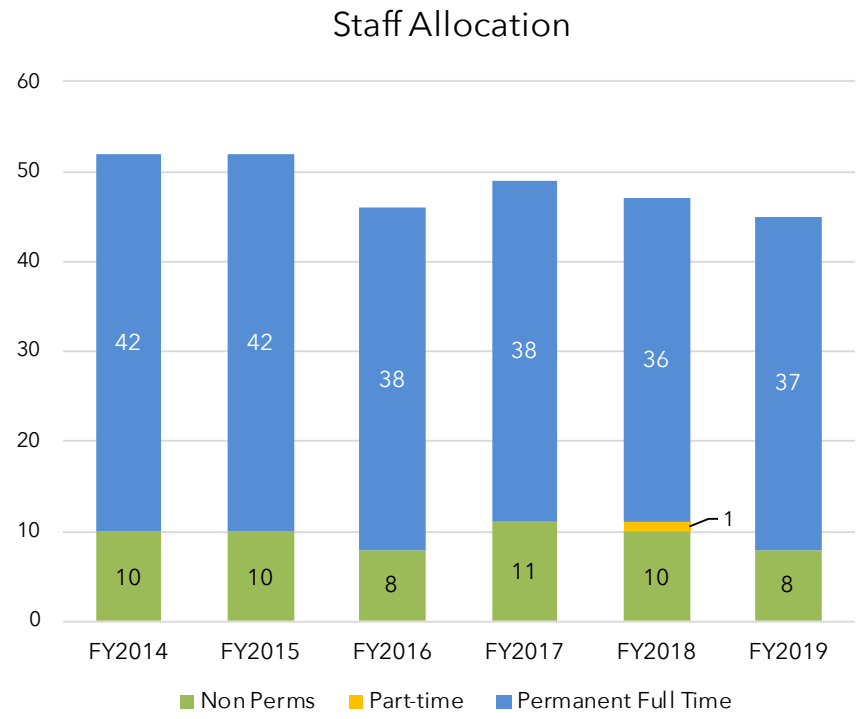

*Note that the numbers here may not exactly match the number of reports listed for each section in the text, as these numbers only include publications in the Raw Data File, Perliminary Interpretive Report, Report of Investigations, and Professional Report series*

# Finances


FY2019 Division Expense Budget
(estimated expenses in thousands of dollars)
$1,800.0
$1,600.0
$1,400.0
$1,200.0
$1,000.0
$800.0
$600.0
$400.0
$200.0
$-
General Fund ($3,621.3)
Designated General Fund ($529.0)
Federal ($2,115.2)
Other ($2,141.6)
Total: $8,397.1
$10.0
Energy Resources
Mineral Resources
Engineering Geology
Volcanology
Geologic Information Center
Geologic Materials Center
Administrative Services
Seismic Hazards Safety Commission


FY2019 Distribution of Expenses
Supplies
6%
Travel
1%
Contractual
Services
28%
Salary & Benefits
65%


Authorized Budget
(in thousands of dollars)
$10,000.0
$9,000.0
$8,000.0
$7,000.0
$6,000.0
$5,000.0
$4,000.0
$3,000.0
$2,000.0
$1,000.0
$0.0
$4,844
$5,555
$4,596
$4,445
$3,760
3,558.8
$95
$329
529.0
$2,387
$2,096
$2,134
$2,125
$2,134
2,138.0
$2,329
$1,834
$1,846
$1,844
$2,100
$2,105
FY2014
FY2015
FY2016
FY2017
FY2018
FY2019
Federal
Other
Unrestricted General Fund
Designated General Fund


Staff Allocation
60
50
40
30
20
10
0
42
42
38
38
36
37
1
10
10
8
11
10
8
FY2014
FY2015
FY2016
FY2017
FY2018
FY2019
Non Perms
Part-time
Permanent Full Time

# Staff Highlights

## Welcome, New Employees!

Jenny Jones joined DGGS in July 2018 as a Geologist I for the Arctic Strategic Transportation & Resources Project (ASTAR) in the Engineering Geology Section. Jenny earned a B.A. in Geology at Western State Colorado University in Gunnison, Colorado, in 2010. Positioned in the heart of the Rocky Mountains, field geology was strongly emphasized. Jenny's professional experience includes oil & gas, environmental consulting, and some hard rock mining. While working full time as an operations geologist in the petroleum industry, she earned her M.S. in Mineral Exploration from Colorado School of Mines in 2015. With a strong technical education and several years of experience in industry, Jenny was ready for a new adventure in Alaska. Originally from Colorado, she was drawn to the unexplored possibilities of Alaska's resources. She is now exploring for sand and gravel resources in northern Alaska to help benefit communities through the ASTAR project.

Richard Buzard earned his bachelor's degree at the University of Washington Bothell and continued his education at the University of Alaska Fairbanks. While earning his master's degree, he worked with DGGS on an Alaska Sea Grant funded project to establish community-based erosion and flood monitoring sites. Richard has developed a broad skillset, ranging from remote sensing and GIS analysis to conducting fieldwork and working directly with community residents. Richard is joining DGGS as a NOAA Digital Coast Fellow. For his Digital Coast project, he is determining the flood risk categories of individual coastal communities in northwest Alaska using a combination of fieldwork, storm reports, and GIS techniques. Richard is also developing an online tool to visualize storm surge impacts, to be used by a broad range of end-users in the state.

The results of this effort will help Alaskans relate storm forecasts to their community, boosting their capacity to prepare for and respond to coastal hazards.

Julia Garrity joined DGGS in December 2018 as an Administrative Assistant after working for several years in other roles within DNR. Fairbanks born and raised, she studied art at the University of Alaska, Fairbanks before traveling the world for the next ten years. Her travels eventually brought her to Ashland, Oregon where she continued to study art, and successfully pursued her dream of starting a community visual art center. In 2011 she returned to Alaska where she began her career with the state. She began by working at the Division of Forestry where she supported wildfire response in finance and logistics from 2011 to 2013. From there she moved to DNR's Support Services in Accounts Payable in Juneau, eventually transitioning back to Fairbanks in November 2017. She is happy to be back home in Fairbanks where she can be closer to her parents, extended family, and many long-time friends, and is looking forward to working with the friendly faces and great minds at DGGS. Welcome, Julia!

## 20 Years of Service!

Melanie Werdon currently serves as Chief of the Mineral Resources Section at DGGS. She and her team of coworkers contract and manage airborne geophysical surveys over Alaska's mineral belts and conduct geologic mapping, geochemical sampling, and mineral-resource assessments. She joined DGGS in 1999, and, since that time, has managed numerous geologic mapping projects, conducted district-level and statewide mineral-resource assessments, and currently coauthors the Alaska Mineral Industry report. She earned a B.Sc. degree in Geology from Michigan Technological University with a focus on geophysics and geology, and a Ph.D. in ore deposits from the University of Alaska Fairbanks. Melanie has also worked for industry as a mine and exploration geologist, and as a geologist with the U.S. Geological Survey.

Congratulations, Melanie, for 20 years of service to the people of the State of Alaska!

# Farewell!

April Woolery is a lifelong Alaskan who lives in Fairbanks with her family. She has served the people of Alaska for more than 15 years, beginning as a clerk in the Alaska H&SS Division of Juvenile Justice, continuing at the DEC and DNR. She served as an Administrative Assistant at the Division of Geological and Geophysical Surveys and helped with the transition from the old AKSAS database to the new IRIS system. April is currently a Planner with the DOT's Northern Region, serving communities in northern and western Alaska.

Congratulations, April, on your new gig at DOT! You will be missed.

Ken (Kenny) Woods, formally known as "the DGGS IT guy," designed and managed the division's complex Unix-based computer network and, for nearly 13 years, was an excellent systems analyst for the state. The system is comprised of more than 300 components, including servers, switches, hardware firewall, physical and virtual machines, JBODs (Just a Bunch of Disks), cephs, glusters, etc. Many of us thought he was simply making up some of these things and, it was rumored, that all of his daily work was performed by bash scripts, kicked off by CRON jobs. It turns out, a ceph is a unified, distributed storage system designed for excellent performance, reliability, and scalability, a gluster is an open source, distributed file system, capable of scaling to several petabytes and handling many clients, and he worked very hard to achieve his goals. During his dedicated service to DGGS and the state, Kenny made himself available 24/7/365 to fix, reboot, patch, repair, and trouble-shoot pretty much anything that used electricity and achieved an uptime of nearly 99.999% (according to Kenny, the number of digits to the right of the decimal point is significant). Unbeknownst to many, Kenny successfully hiked the 2,500-mile Appalachian Trail in the eastern United States…twice. He is now part of a team, some 4,233.7 miles from Fairbanks in the Netherlands, working on complex data storage solutions for multinational corporations, governments, and agencies. Needless to say, he can go the distance.

Good luck, Kenny, and thank you for your service to the people of the State of Alaska.

Alexandra Busk worked as an undergraduate and graduate intern at the Alaska Geologic Materials Center (GMC) for the last four years. She is an extremely personable and intelligent young woman with an obvious love for geology. Alex brought a high level of energy and commitment to the job and has been a wonderful asset to the GMC's mission during some very challenging transitions. She also enjoyed working with the public both on individual and group levels. She led geologic educational tours and activities for ages from primary school to adults and helped identify rocks and minerals brought to the facility by the public.

Many experiences at the GMC allowed Alex to progress and enrich her background as a geologist. She laid out and prepared thousands of rock samples for visiting energy, mineral, government, and academic geologists and, as a result, she has likely examined more Alaska core than any other student in the University of Alaska system. Alex also enjoyed developing a rapport and networking with geologists from across the state of Alaska, the nation, and globally. Alex was a privilege to work with and she will be greatly missed. Good luck in your next academic adventures, Alex!

Front cover: DGGS geologist Katreen Wikstrom Jones measures snowpack depth in Turnagain Pass.

Back cover: View of Besboro Island near Unalakleet. Besboro Island is located northwest of Unalakleet in Norton Sound, Bering Sea.

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