Alaska Division of Geological & Geophysical Surveys

Annual Report 2020

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

Contents

MISSION

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).

BACKGROUND

The Alaska Division of Geological & Geophysical Surveys (DGGS) is part of the Alaska Department of Natural Resources (DNR) and is organized into six program sections: Energy Resources, Mineral Resources, Engineering Geology, Volcanology, Geologic Information Center (GIC), and the Alaska Geologic Materials Center (GMC). In FY2019, the division had 36 full-time permanent positions, one part-time position, and 8 non-permanent positions. The total FY2019 expense budget for the division was $8.31 million, consisting of $3.56 million state general fund receipts, $2.1 million federal receipts, $2.14 million capital improvement projects and interagency receipts, and $529 thousand in designated general fund and publication sales. DGGS maintains a website at dggs.alaska.gov, which provides access to its publications and digital data as well as to all pre-digital USGS publications on Alaska geology. DGGS also administers websites for the Alaska Volcano Observatory (avo.alaska.edu), the Alaska Seismic Hazards Safety Commission (seismic.alaska.gov), and the Alaska Geospatial Council (agc.dnr.alaska.gov).

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
Corri A. Feige, Commissioner

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

Publications produced by the Division of Geological & Geophysical Surveys (DGGS) are available for free download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

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Historical Collections & Talking Book Center
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Juneau, Alaska 99811

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Cover. Geologist Janet Schaefer (AVO/DGGS) collects sparse ash encased in ice and snow on the southeast flank of Shishaldin volcano. Photo: Wyatt Mayo.

Back cover. Ground control collection in Barry Arm. Photo: Katreen Wikstrom Jones.

MESSAGE FROM THE DIRECTOR

As for many, 2020 was a challenging year. COVID-19 profoundly disrupted our plans—restricting travel, impacting fieldwork, mandating teleworking, and challenging everyone to remain productive and engaged in the face of events that upended personal and professional plans. But, in true DGGS style, things went on: projects were advanced and completed, hires were made, maps and reports were published, and we found new ways to work within the confines of teleworking. The DGGS staff rose to the occasion, and their intellect, professionalism, and dedication shone through.

In addition to COVID-19, 2020 brought landslides. First, in May, the Barry Arm landslide in Prince William Sound demanded attention from DGGS in collaboration with a number of federal agencies to very quickly stand up a working group and generate information to assist in understanding the hazard. Then, late in the year, DGGS sent staff to Haines in support of the landslide response activities there. These efforts, in addition to ongoing landslide investigations and new landslide legislation, clearly indicate the need for us to establish a landslide program within DGGS.

In this letter last year, I listed a set of goals for 2020. COVID-19 impacted and postponed many of them. This has resulted in a backlog of fieldwork across the division that will make 2021 an extremely busy year. After 2020, it is hard to make assumptions or predictions about normal operations, but with impending vaccination, and assuming we can complete fieldwork in 2021, here are a few of the projects we have planned:

- **Fly three airborne geophysical surveys and contract for a fourth to complete coverage of the Yukon–Tanana uplands, for a combined 52,500 km² in eastern Alaska**
- **Complete the 2020 and 2021 critical minerals geologic mapping projects totaling 3,500 mi²**
- **Complete two STATEMAP mapping projects in the foothills of the Brooks Range**
- **Formalize a landslide program within DGGS**
- **Conduct sand and gravel reconnaissance in the western NPR-A in support of community development projects**
- **Continue the analog-to-digital (A2D) conversion of volcano monitoring equipment at Alaska's high-threat volcanoes**
- **Continue providing support to communities in southeast Alaska impacted by the December 2020 disaster**
- **Continue collaborations with partner agencies on landslide assessments in Prince William Sound, and continue engaging with the communities to provide up-to-date information**
- **Complete a shallow coring project on the North Slope with the USGS to assess Brookian source and reservoir rocks**
- **Complete re-analysis of USGS stream sediment samples from the Yukon–Tanana upland and make the results available through a web-viewing service**
- **Begin assembling a statewide groundwater arsenic database**

Another year has flown by, and even though I have said it before, I continue to be amazed by the impact of the work by the staff at Alaska's Geological Survey, or DGGS, as we 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, mapping Alaska's mineral belts, or educating Alaskans about arsenic and radon, the work done by DGGS touches the lives of all Alaskans.

DGGS provides geologic information to help industry discover and develop Alaska's energy and mineral resources. DGGS also informs on geologic hazards, general geology, construction materials, and groundwater resources—topics which are critical to sustaining our communities and developing our natural resources. We view public geologic information as a key element in unlocking our natural resources, protecting our communities, and helping grow Alaska's economy.

This is just a glimpse of the very busy year we have ahead. I encourage you to read this report and learn more about us, our people, activities over the past year, our products, impacts, and also the challenges we face. We like to hear from our constituents about the

work we do. We feel the information we produce benefits the state by facilitating the discovery and commercialization of the state's undiscovered resources, and by protecting Alaskans from geologic hazards. We hope this report gives you a better understanding of that work, and we encourage you to reach out with questions or feedback on any of our projects and programs.

Finally, I informed DGGS that this will likely be my last year as Director. I intend to retire, and while a date has not been set, it is unlikely I will be writing this letter next year. It hasn't always been easy, but what a fun time. It has been geology in all flavors—volcanoes, earthquakes, glaciers, permafrost, gold, storm surge, oil and gas, avalanches, critical minerals, sand and gravel, helicopters, erosion, gas hydrates, core collections, databases, imagery, geophysical surveys, geochemistry, landslides, age dating, flooding, lidar, groundwater, geothermal, radon, geospatial data... All in support of Alaska and its residents, and all in Alaska, the beautiful raw state others call the Last Frontier, but we call home. I could go on for pages about the bittersweet nature of this decision, but suffice it to say, being Alaska's State Geologist and Director of Alaska's Geological Survey has been an incredible privilege and an honor, and I just want to say thank you for your trust and the opportunity.

Respectfully,

S. Masterman

Steve Masterman
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Director, Alaska Division of Geological & Geophysical Surveys

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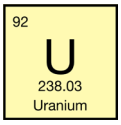
Jennifer Athey
Geologist IV

Abraham Emond
Geologist IV



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Travis Naibert
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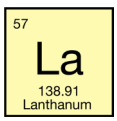

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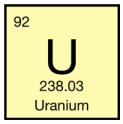

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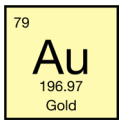

Dylan Avirett
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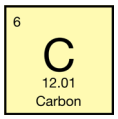

Simone Montayne
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This is a vacant position

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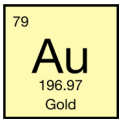

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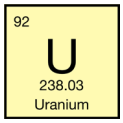

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De Anne Stevens
Engineering Geology Section Chief
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Brandon Browne
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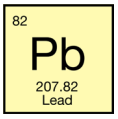

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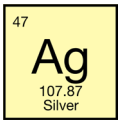
GIS Analyst II (LTNP)



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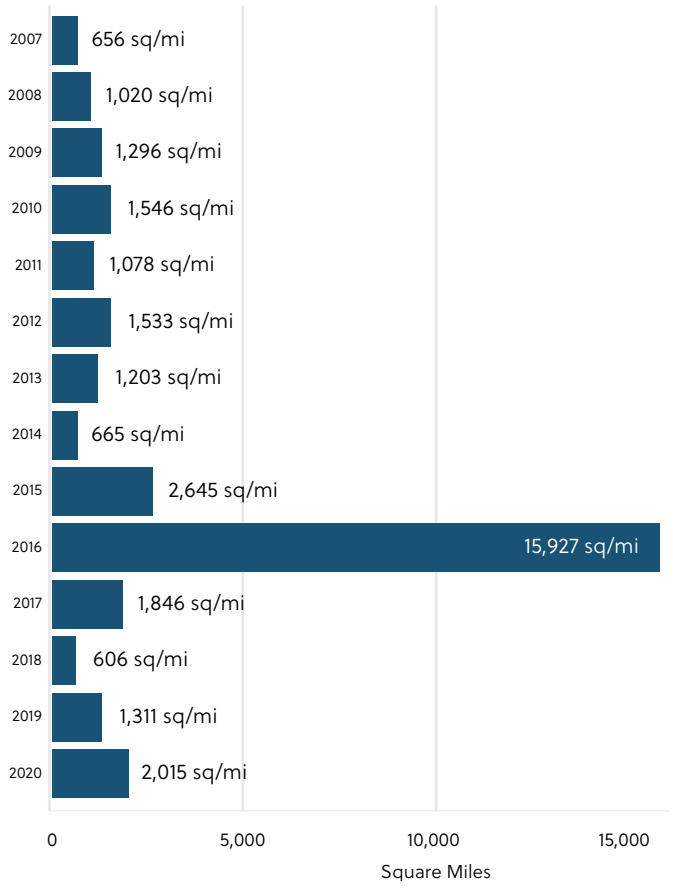
MAPPING

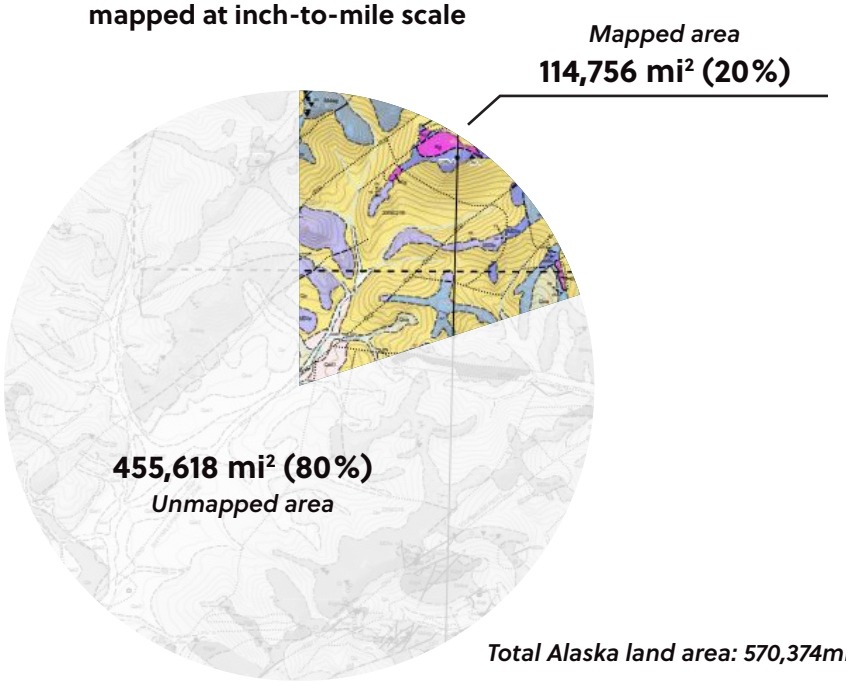
Geologic Mapping

Detailed geological and geophysical maps of Alaska at scales needed for resource exploration, land-use management, and geologic-hazards assessment are currently available for only about 20 percent of the state, but our field programs are increasing this coverage gradually each year. DGGS prioritizes the selection of new mapping areas in consultation with other state agencies, appropriate state boards and commissions, its Geologic Mapping Advisory Board, industry resource-interest groups, and other stakeholders. The survey is committed to delivering the results of its extensive field mapping programs to the public in a timely manner. In FY2020 DGGS published **geologic mapping for a total of 2,015 mi²** of Alaskan lands. Over the past 10 years, **DGGS has published an annual average of 2,883 mi²** of peer-reviewed geologic mapping.

Squares miles of published geologic mapping



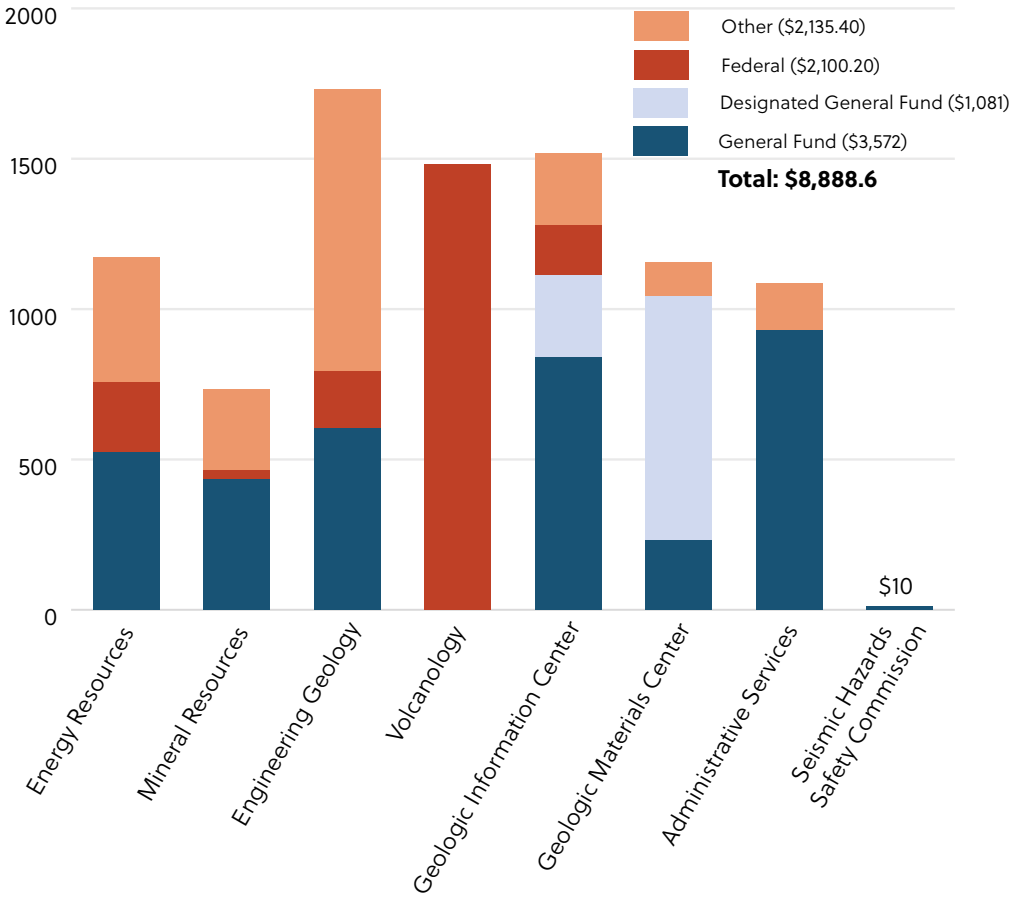
Area of Alaska geologically mapped at inch-to-mile scale



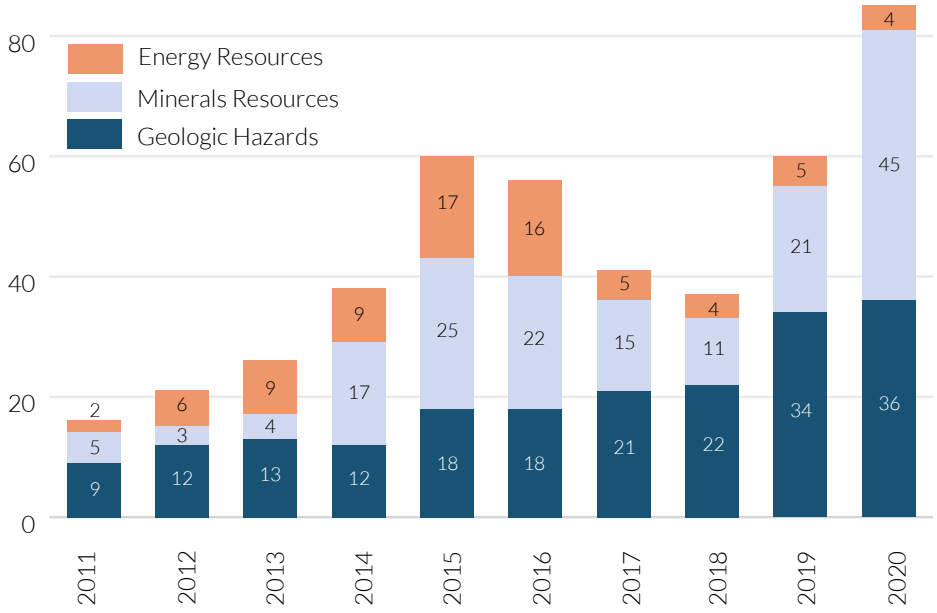
Total Alaska land area: 570,374mi²

...BY THE NUMBERS

FY20 Division Budget (in thousands of dollars)



Published Reports



ENERGY RESOURCES

Alaska's Statewide Energy Resource Assessment program generates new geologic information about the state's oil, natural gas, coal, and geothermal resources and presents this information to industry, the public, and state and federal agencies through formal reports and presentations. DGGS collaborates with the Alaska Division of Oil & Gas (DOG) to incorporate subsurface data in the analysis and interpretation of complex depositional and tectonic settings in order to better understand hydrocarbon systems.

Applied research on the North Slope by the Energy Resources Section was supported by successful funding proposals to industry and the USGS STATEMAP program. Additional industry support was also provided through a two-year collaborative project with the Texas Bureau of Economic Geology assessing important Brookian reservoir intervals on the eastern North Slope. In June and July 2019, the team conducted 31 days of helicopter-supported fieldwork on the North Slope, performing geologic mapping and topical studies evaluating petroleum systems relevant to exploration on state lands, the National Petroleum Reserve-Alaska (NPRA), and the Alaska National Wildlife Refuge (ANWR). Industry support and collaboration continued as the section led a two-day field tour for industry to examine key exposures of the Nanushuk, Torok, Seabee, Prince Creek, Sagavanirktok, and Canning Formations on the central North Slope to highlight their petroleum potential.

DGGS geologist Mandy Willingham examines the Tuluvak Formation in the central Brooks Range foothills. Samples from Tuluvak outcrops commonly yield very good reservoir quality parameters, and equivalent strata in the subsurface serve as the main reservoir at the Gubik gas field. Photo: Trystan Herriott.

Reconnaissance evaluations of frontier regions of the state with hydrocarbon potential, but no production, continued with fieldwork during summer 2019. This effort is in collaboration with various academic institutions working in the Alaska Range and Talkeetna Mountains and is improving understanding of the evolution of the nearby Susitna and Copper River basins.

The 2020 field campaign was postponed due to COVID-19; pending resolution of the pandemic, this work will be combined with planned 2021 activities. Furthermore, a major collaborative project with the U.S. Geological Survey has resumed, with planning and permitting efforts underway in advance of drilling multiple stratigraphic test cores on the North Slope.

DATA DISTRIBUTION AND PUBLICATIONS

DGGS has accumulated a vast amount of relevant petroleum-related geologic data over the past few decades and aims to release both new and legacy information in appropriate formats. For example, the Energy Resources Section worked with geophysicists in the Mineral Resources Section to publish a revised, fully digital compilation of ground-based gravity data for the prospective Holitna basin in southwestern Alaska. Important progress continues on creating a division-wide energy resources geodatabase that will eventually allow industry and the public to search for relevant geologic data from throughout the North Slope, Cook Inlet, and other Alaska frontier basins. An example of this effort is the recent release of a statewide geothermal dataset as a digital publication and interactive map accessible through the DGGS website. Another effort in this area is DGGS' participation in the U.S. Geological Survey's National Coal Resources Database System. The goal of

this cooperative program is the eventual digital compilation of all known coal occurrences and associated data. Additional information was added this year based on a new DGGS publication addressing coals in the Prince Creek Formation on the North Slope (doi.org/10.14509/30556). The preliminary in-house version of the coal database proved helpful in composing a major multi-agency collaborative funding proposal in response to a Department of Energy solicitation for research on rare earth and critical minerals in carbon ores.

READ MORE

RDF 2020-2

Photogrammetry-derived digital surface model and orthoimagery of the Usibelli Group type section, Suntrana Creek, Alaska

doi.org/10.14509/30425

The Energy Resources Section has modernized its field data collection and successfully collaborated with other DGGS professionals and IT support to hone digital field data capture methodology using tablet devices, including integration of varied software into the data collection workflow.

Despite the challenges associated with COVID-19, the section produced a series of important publications relevant to the petroleum geology of Alaska. Two major digital products were published, both the result of large helicopter-based structure-from-motion surveys. One survey was of the Usibelli Group type section in Suntrana Creek, and represents a potential analogue for fluvial reservoir geometry in the nearby Nenana basin subsurface. The other survey is from key exposures of the Nanushuk and Torok Formations at Slope Mountain on the North Slope (doi.org/10.14509/30419). This data will be used to inform seismic and reservoir models, including at the newly discovered oil fields at Pikka and Willow. This photogrammetric method produces very high resolution digital surface models and orthoimagery of important outcrops, and serves as a base for mapping reservoir-scale sand bodies. A team member has successfully earned a Remote Pilot Certificate to operate future drone-based aerial surveys, a method that is likely to become increasingly important for characterizing key outcrops.

Another area of growing expertise in the section is showcased by recent companion papers that report very high precision stratigraphic ages using U-Pb geochronology. The first paper was published in an influential peer-reviewed journal and focuses on novel statistical techniques and protocols developed in collaboration with Boise State University. The second paper was published through DGGS and focuses on the application of these new methods to important potential reservoir units in Cook Inlet.

The group also published important sedimentologic, stratigraphic, and petrologic studies from deepwater rocks in the Upper Jurassic Naknek Formation of Cook Inlet and the Upper Cretaceous Canning Formation on the North Slope (doi.org/10.14509/30553). These newly discovered outcrops are important analogues for potential reservoirs in the nearby subsurface and provide critical insight into sedimentation process and sand body geometry, which are important constraints that reduce risk during exploration.

Finally, the team released a major milestone publication highlighted by more than 100 new $^{40}Ar/^{39}Ar$ and U-Pb ages from sedimentary and igneous rocks in the south-central Tyonek Quadrangle in southern Alaska. These data dramatically improve the age constraints of geologic units in Cook Inlet and provide the temporal foundation for understanding the basin's Cenozoic tectonic, thermal, and petroleum systems evolution.

Geologist standing near the base of the Nanushuk Formation at Slope Mountain. Characteristics observed in this outcrop suggest it may serve as a valuable analogue to the reservoir at Pikka and Horseshoe, which is currently being developed. Photo: Dave LePain.

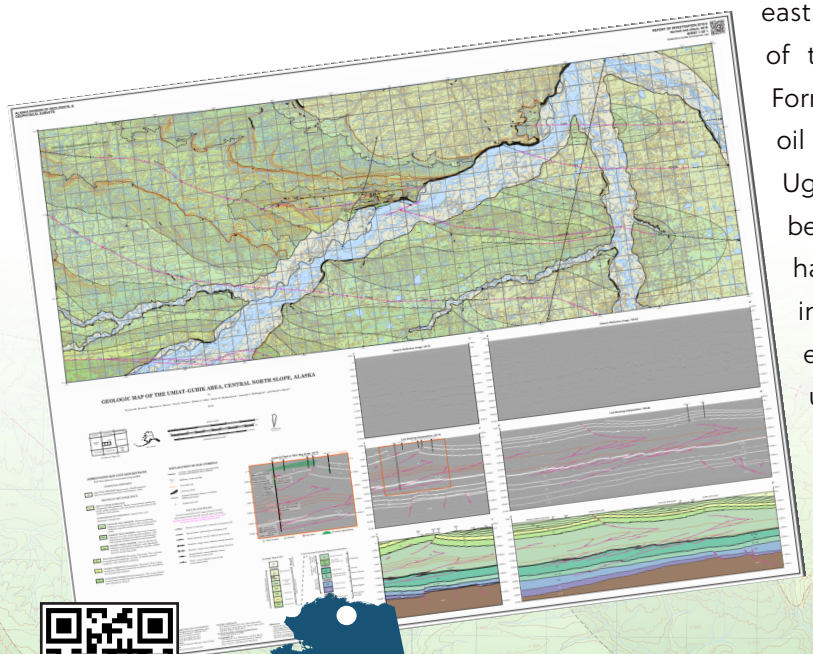
Detailed Bedrock Geologic Mapping

A Unique Window Into The North Slope Petroleum System

Northern Alaska is a world-class petroleum province and one of the most prospective onshore regions remaining in North America. This promise has recently been affirmed by several recent oil discoveries, some of which may prove to be among the largest in North America in decades. Despite this potential, **the North Slope remains underexplored** relative to other sedimentary basins around the world. New exploration ventures are hampered by the limited amount of published geologic data, much of which is reconnaissance. In an effort to stimulate hydrocarbon exploration in northern Alaska, the Alaska Division of Geological & Geophysical Surveys (DGGS) developed a program to acquire and publish high-quality geologic data to improve our understanding of the regional petroleum system and entice new exploration investment.

An integral element of the DGGS North Slope Program is detailed geologic mapping (1:63,360-scale) along the northern foothills of the Brooks Range. Many of the geologic relationships delimited by our surface mapping between the mountain front and the rolling hills of the central North Slope can be projected northward into the subsurface of the coastal plain. Outcrops offer unique high-resolution 2- and 3-D perspectives into the stratigraphy which are generally not possible with remote geophysical methods. **Examination of key reservoir and source rock intervals provides new constraints on petroleum systems, and serves as the baseline data used in models predicting where hydrocarbons are likely to accumulate in the subsurface**.

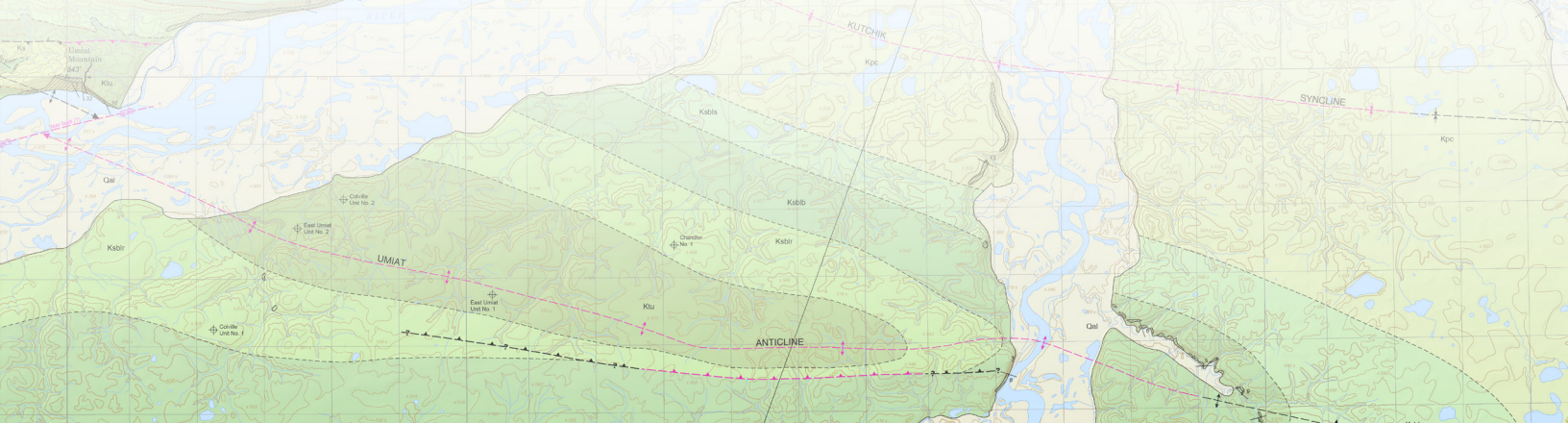
A long-range objective of DGGS is to produce a contiguous series of detailed geologic maps along the entire foothills belt, thereby establishing a regional geologic framework necessary to understand the evolution of petroleum systems. In the past 20 years, the Energy Section has published eight geologic maps from the central North Slope. The most recent published map covers the Umiat area (doi.org/10.14509/30099), encompassing the only known oil field in the foothills (Umiat) as well as discovered gas fields at Gubik and east Umiat. The region includes excellent exposures of the Seabee, Schrader Bluff, and Prince Creek Formations—units that are important analogues for oil reservoirs at the Tarn, Meltwater, West Sak, and Ugnu fields. Subsequent mapping efforts have been focused on the areas southeast of Umiat, and have resulted in the discovery of new oil-stained intervals. The current and future map areas include extensive outcrops of the Nanushuk Formation, a unit that has long been a focus area for DGGS, and one that has recently emerged as among North America's hottest plays and host to recent giant



The Nanushuk Formation crops out prominently along the Nanushuk River at the southeast end of Rooftop Ridge. DGGS plans to map the geology of this area during 2021. Photo: Trystan Herriott.

oil discoveries in the Colville delta area at Pikka and Horseshoe, as well as at the Willow field in northeastern NPRA. The 2020 field season was postponed due to COVID-19; however, pending successful funding, **an ambitious mapping program spanning more than 500 mi² is planned for 2021**.

Most of the DGGS North Slope mapping is supported by proposal-based awards administered by the U.S. Geological Survey STATEMAP program. These funds have been successfully received every year since 1993 and are typically matched by Capital Improvement Grants from the State of Alaska and supplemented by industry financial support. Geologic mapping is an important long-term investment, providing regional context that encourages new exploration, while ultimately accelerating development of Alaska's petroleum resources and contributing to future revenue for the state.

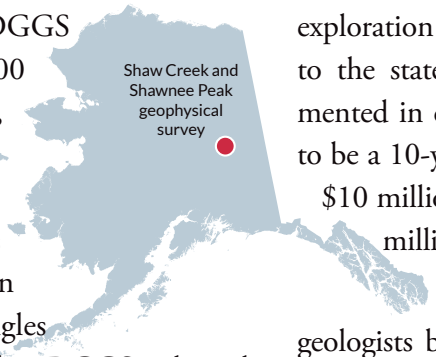


MINERAL RESOURCES

To attract interest in mineral exploration and to support responsible development of Alaska's mineral endowment, DGGS conducts geological mapping and geochemical and geophysical surveys of the most prospective Alaska lands that are open for resource development. **Since 1993 the data products of the Airborne Geophysical/Geological Mineral Inventory (AGGMI) program have been an important component of successful resource exploration programs**; products have contributed to the private-sector discovery of more than 22 million ounces of gold in the Salcha River–Pogo and Livengood areas since 2004.

GEOPHYSICAL SURVEYING

During July 4–25, 2020, DGGS conducted approximately 1,000 mi^2 of state- and industry-funded, helicopter-based magnetic and radiometric surveying in the Shaw Creek and Shawnee Peak areas surrounding Pogo gold mine, in the Big Delta and Eagle quadrangles northeast of Delta Junction, Alaska. DGGS solicited participation from outside entities, and Northern Star (Pogo), Millrock Resources, and Northway Resources contributed funds to increase the surveying area and/or tighten up line spacing within the DGGS' predefined "area of interest," which reduced the cost of geophysical surveying by ~20 percent. DGGS rapidly released preliminary raw data in early August to benefit active industry exploration programs, and final data were published by December 2020 (doi.org/10.14509/30551).



FIELDWORK

DGGS initiated Alaska's portion of the critical-minerals-focused Earth Mapping Resources Initiative (Earth MRI) project in 2019, the purpose of which is to increase the nation's mineral security by conducting geophysical surveys, geologic mapping, and lidar surveys. This primarily federally funded project, supplemented with state matching funds, will help DGGS Mineral Resources geologists create and disseminate geophysical and geological map products that historically have been shown to stimulate mineral industry interest, staking, and exploration activity in Alaska, as well as increase revenue to the state. The Earth MRI project is being implemented in cooperation with the USGS and is expected to be a 10-year national program funded at greater than $10 million per year. In FY2020, Alaska received $1.1 million in federal funds under this program.

In June 2019, DGGS Mineral Resources geologists began their first Earth MRI field project by conducting 1,900 mi^2 of geologic mapping in the eastern Tanacross region. The final map deliverable is due in July 2021. The project targets a region of the state that has inadequate geologic mapping but the potential to host deposits of rare earth elements and other critical minerals. The area is also prospective for more conventional minerals, including copper, gold, and molybdenum. In summer 2020, Mineral Resources geologists planned a

The Taylor Highway and the 2019 Earth MRI Eastern Tanacross project area, as seen from the top of Mount Fairplay. Photo: Evan Twelker.

second year of field mapping in the western Tanacross region to cover an area of 1,730 mi^2 with similar mineral-resource potential. The project was canceled due to COVID-19 but will be conducted in summer 2021 in conjunction with the third phase of Earth MRI-funded work in the Taylor Mountain batholith area near Chicken, Alaska. As part of the Earth MRI program, DGGS selected ~2,500 historical USGS stream-sediment pulps for re-analysis with modern techniques, including a full suite of elements, from across the Yukon–Tanana upland; publication is scheduled for spring 2021.

In summer 2018, the Mineral Resources Section completed fieldwork for the second phase of a 520-mi^2 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 create a geologic map to help guide industry exploration efforts. The area contains known porphyry gold-copper-molybdenum systems, which are newly recognized as being spatially associated with high-angle fault systems, many of which can be identified in DGGS airborne geophysical surveys of the area. Remaining work in FY2021 includes addressing reviewer comments and publishing the geologic map and report.

DGGS completed fieldwork for the second phase of a 430-mi^2 geologic mapping and geochemical sampling project in the Richardson–Uncle Sam gold exploration area northwest of Delta Junction. The area's mineral-resource potential is expected to be high, based on known mineral systems and proximity to the Pogo gold mine. The purpose of this project is to integrate geological, geophysical, and mining industry datasets to create an improved geologic map that will guide exploration and help to further determine the area's mineral-resource potential. Ongoing work in FY2021 includes synthesis and interpretation of field data and publication of the supporting geochemical and geochronologic data.

DGGS geologist Travis Naibert on traverse in the Tanacross Quadrangle. Photo: Karri Sicard.

Earth Mapping Resources Initiative (Earth MRI)

The federal Earth Mapping Resources Initiative (Earth MRI) is designed to address the United States' heavy reliance on imports of certain mineral commodities that are vital to the Nation's security and economic prosperity. The U.S. is currently 100 percent reliant on imports for 11 of the most critical minerals, and more than 50 percent reliant on imports for another 17.

The goals of Earth MRI are to:

- **Identify domestic sources for critical minerals**
- **Produce nationwide geophysical, geological, and topographical surveys of the U.S.**
- **Partner with state geological surveys, including the Alaska Division of Geological & Geophysical Surveys (DGGS), to complete these surveys**

The 35 elements currently considered most critical are:

- aluminum [bauxite]
- antimony
- arsenic
- barite
- beryllium
- bismuth
- cesium
- chromium
- cobalt
- fluorspar
- gallium
- germanium
- graphite [natural]
- hafnium
- helium
- indium
- lithium
- magnesium
- manganese
- platinum-group elements
- potash
- rare-earth elements
- rhenium
- rubidium
- scandium
- strontium
- tantalum
- tellurium
- tin
- titanium
- tungsten
- uranium
- vanadium
- yttrium
- zirconium

The Earth MRI program, anticipated to last 10 years, was initially funded at $10 million per year by the U.S. Congress in federal-fiscal-year 2019 with Alaska receiving $1 million in funding. A capital project, appropriated by the Alaska Legislature in FY2019, provided supplemental, state matching funds to expand Earth MRI work. Alaska received $1.1 million in funding in federal-fiscal-year 2020, and anticipates receiving the same amount in 2021.

Mines in Alaska currently produce the critical minerals germanium and indium, and have historically produced tin, fluorspar, platinum-group elements, antimony, tungsten, and barite. In addition to these elements, Alaska's geology is favorable for locating "as-yet-undiscovered" deposits of additional critical minerals. Earth MRI- and state-funded geophysical surveys, geologic mapping, and resulting datasets and reports will help identify areas of Alaska that have potential for precious and base metals, as well as for critical minerals, which may occur solely as primary commodities, or as co-products or by-products of precious- and base-metal mining.

For the Earth MRI program, DGGS Mineral Resources geologists will be creating and disseminating geophysical and geological map products that historically have been shown to stimulate mineral industry interest, staking, and exploration activity in Alaska, as well as increase revenue to the state. The first area of focus is the Yukon- Tanana Uplands, one of Alaska's premier gold-mining districts that also has high potential for critical minerals. The USGS tasked DGGS with managing Alaska's geophysical surveying contracts. Consequently, initial magnetic and radiometric surveying of about 15,600 mi^2 is planned for spring/summer 2021 in parts of the Big Delta, Eagle, and adjacent quadrangles, with initial publication of survey data by year-end 2021.

In June 2019, DGGS geologists initiated their first Earth MRI geologic mapping project, which covers 1,900 mi2 in the eastern Tanacross Quadrangle, and in summer 2021 will expand geologic mapping into adjacent parts of the Tanacross and Eagle quadrangles, covering an additional 2,440 mi2. These projects target a region with inadequate-scale geologic mapping and the potential to host deposits of rare earth elements and other critical minerals. The area is also prospective for copper, gold, silver, and molybdenum. DGGS is evaluating the area's mineral-resource potential and will be producing 1:100,000-scale geologic maps, to be published in 2021 and subsequent years, that will help guide industry exploration efforts.

Future Earth MRI goals for Alaska include a three-year plan to complete airborne geophysical surveying over the areas in the Yukon-Tanana Uplands that are open to mineral entry, and a seven- to nine-year plan to upgrade the scale of geologic mapping to at least 1:100,000.

DATA DISTRIBUTION AND PUBLICATIONS

The section archived and prepared 43 historical airborne geophysical surveys for online publication; all "modern" airborne geophysical surveys were made available online in FY2020.

The Mineral Resources Section is in the process of finalizing Alaska's Mineral Industry 2019, an annual summary of activity in the mining sector during the previous calendar year. The report provides a consistent, factual snapshot of exploration, development, and production of Alaska's mineral resources and serves as the authoritative historical record of mining in the state.

Airborne Geophysical Surveys
dggs.alaska.gov/pubs/geophysics

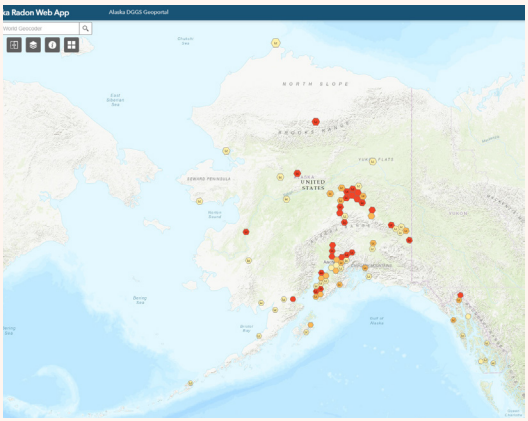
GEOLOGIC HEALTH HAZARDS

Naturally occurring radon gas is the second leading cause of lung cancer—after smoking—and an under-recognized health risk in the state. DGGS is preparing deliverables for the final year of an EPA-funded, three-year project to (1) create an Alaska radon database and compile radon test results from across the state, (2) collaboratively develop an enterprise database model for standardized geologic map data, and (3) create an online radon potential map to help the public visualize the risk from radon in Alaska. The Alaska radon map became available at the end of 2019 and will be used for radon education and outreach in conjunction with a program that provides free radon testing for Alaskans.

NATIONAL GEOLOGIC MAP DATABASE

DGGS continued to lead geologists and GIS professionals from more than 10 state geological surveys, USGS, and the Geological Survey of Canada in the development of a national geologic database model, which is being considered for implementation by the USGS National Geologic Map Database.

Yes, There is Radon in Alaska



Radon is a naturally occurring radioactive gas that can concentrate in buildings. It is responsible for about 21,000 lung cancer deaths every year. Because you can't see or smell radon, the only way to know it's there is to test your home. DGGS and UAF's Cooperative Extension Service partner to educate the public about radon. In FY20, DGGS estimates that **742 homes in Alaska were tested, many through free test kits as incentive, and approximately 15,080 Alaskans were reached through events and social media**. With available test results, DGGS created the first radon map of Alaska (maps.dggs.alaska.gov/radon) since the EPA's original map was published in 1993. Even so, many Alaskans remain unaware of this health hazard. Due to the lack of demand for radon services, extremely few certified providers of professional testing and certified contractors who mitigate homes for radon and build radon-resistant homes do business in the state. The division recently published three radon Information Circulars, one of which is a Do-It-Yourself mitigation guide that should appeal to handy Alaskans and help those needing scarce services. Through EPA-funded State Indoor Radon Grant outreach, DGGS hopes to increase the number of people testing for radon and decrease the number of people breathing it.

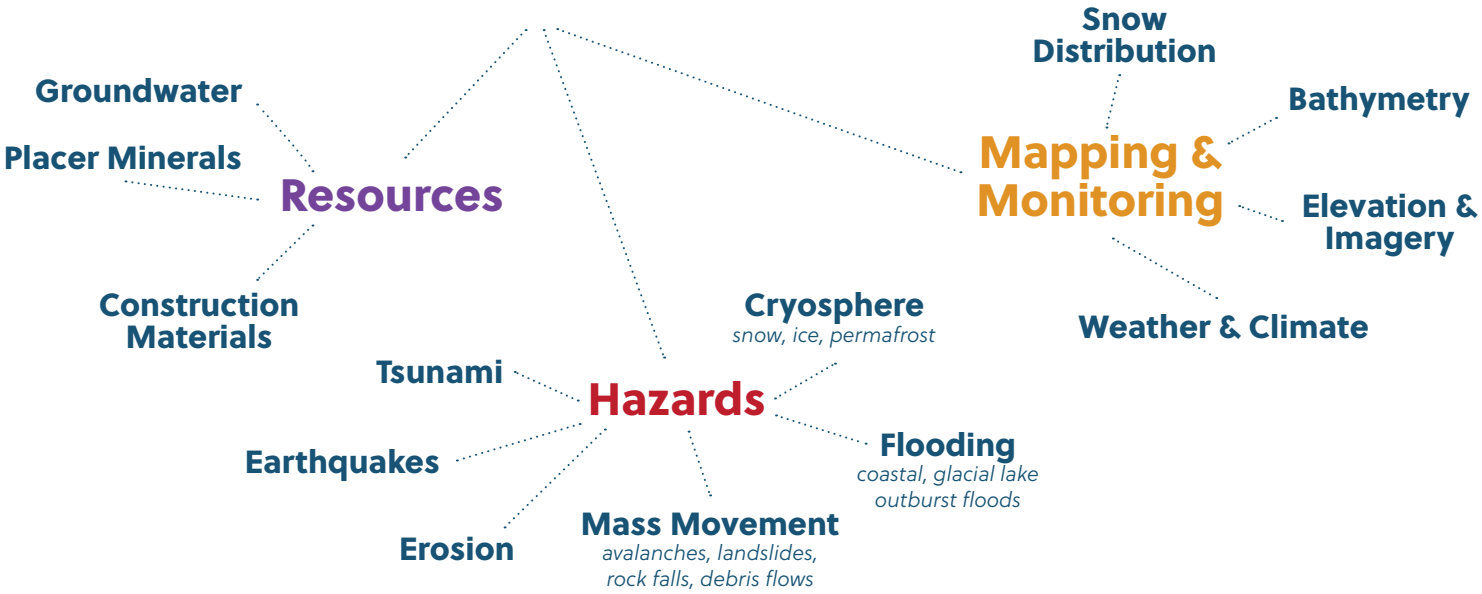
READ MORE

Mitigating radon levels at home
doi.org/10.14509/30474

Understanding your radon test results
doi.org/10.14509/30467

Naturally occurring radon in Alaska
doi.org/10.14509/30163

Engineering Geology



Engineering geology applies the science of geology to understanding the engineering considerations of geologic materials, geologic hazards, and other geologic problems for society. Engineering geologists identify where geologic processes are most likely to have an adverse impact on humans, the structures we build, and the environment, and assure that the geological factors relevant to the location, design, construction, operation, and maintenance of engineering works are recognized and accounted for. In addition to these considerations, DGGS' Engineering Geology Section also maps the distribution and character of surface materials to help identify potential construction materials resources and economically valuable placer deposits.

In many areas of the state, 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. We develop baseline data, monitoring systems, and provide maps and tools to assist in these efforts.

BY THE NUMBERS

Responded to **3 Natural Disasters** or Emergencies

750+	(nearly) 5,000	17	9	43	175 mi²
Public Information Requests	Shot Holes Analyzed for Gravel Resources	Staff Members	External Publications	Public Presentations	Mapped with Lidar

ENGINEERING GEOLOGY

The Engineering Geology Section is structured around individual programs that focus on specific geologic hazards, resources, and support activities. Many projects require overlap between programs to boost scientific expertise and maximize individual staff contributions. Each program not only is collaborative among the section but also maintains relationships with other state and federal agencies, regional and local governments, tribal and Indigenous organizations, academic institutions, nonprofits, and other groups. Alaska is too big to do our work any other way.

MAPPING WITH LIDAR

In response to the increasing demand for reliable topographic information over Alaska, the Engineering Geology Section is mounting a concerted effort to establish baseline data across the state. In early October, we used the lidar laser scanner to investigate faults in the Japan Hills region, 50 miles south of Fairbanks. The penetrating capabilities of the instrument allowed the team to reveal a bare earth surface beneath the boreal forest, which gives insight into the potential for seismic activity in the Interior. Later that month, the team collected data over the villages of Napakiak and Napaskiak that contributed to flood and erosion risk assessments and a channel migration model of the lower Kuskokwim River. Additional collections were made in Southcentral and Southeast Alaska to support avalanche and landslide hazard mapping and monitoring.

Our lidar technicians are capable of swiftly reacting to geologic emergencies across the 665,000 mi^2 of Alaska and are able to deploy equipment and coordinate airborne missions within just a few days' notice. In early May, the team was alerted to a potentially massive landslide/tsunami hazard in the Barry Arm area in Southeast Alaska. Despite additional logistical obstacles created by COVID-19, the Engineering Geology Section fielded the first geologists who were able to adequately survey the area on-site. Later, in December, the team fielded another rapid deployment: this time to Haines, where ongoing storms triggered multiple landslides, putting the local population in extreme danger. Our professionals once again succeeded in providing the earliest high-resolution topographic information necessary to assess the catastrophe.

Alaska remains the most poorly mapped state in the U.S. due to a vast number of logistical hurdles that come with mapping not only a huge geographic region, but one with limited infrastructure to support mapping—and weather that can turn on a dime. The Engineering Geology Section strategically plans collections to support state priorities and make good investments.

DGGS scientists Ronald Daanen and Katreen Wikstrom Jones set up a GNSS base station on the ridge above the Barry Arm landslide to assist with the aerial lidar survey.

CLIMATE & CRYOSPHERE

Program director Gabriel Wolken carries a sensor to a weather station at Snettisham, SE Alaska, that is part of the early warning system network for snow avalanches.

It was another busy year for the Climate and Cryosphere Hazards Program (CCHP). In February and March, we continued our snow distribution and snow avalanche research, conducting fieldwork in multiple locations in Southcentral and Southeast Alaska and working with partners from Alaska Railroad, University of Alaska Southeast, Alaska Energy Light & Power, Alaska DOT&PF, Eaglecrest Ski Area, Kensington Mine, Tongass National Forest, and Sitka Sound Science Center. We also made significant advances in 2020 on our large-scale snow avalanche hazard mapping in Southeast Alaska, which is a collaborative project with the Swiss Institute for Snow and Avalanche Research SLF and the University of Alaska Fairbanks' Alaska Climate Adaptation Science Center.

Despite the pandemic, snow citizen science surges. CCHP's Community Snow Observations project (CSO; with multiple collaborators) continues to be a huge success. This year, with the help of the crowd, we gathered more snow observations than ever before, and the momentum continues as we bring on new ambassadors, implement the Mountain Hub app acquired through a donation from Mammut, advance snow modeling in new domains, and have meaningful conversations on the topics of diversity, equity, and inclusion. In September 2020 we submitted our continued funding proposal to NASA CSO-2!

Glacial change and the associated hazards continue to be important topics for Alaska. In 2020, CCHP published a paper on the glaciers and climate of the upper Susitna basin, and contributed to the State of the Climate report and the Arctic Report Card. We continue to work with partners to monitor glacier-dammed lakes and glacial lake outburst floods (GLOFs) in a number of locations in the state, and we remain deeply committed to assessing and monitoring glacier-related landslides capable of producing destructive tsunamis in coastal Alaska (see Barry Arm Landslide).

EARTHQUAKES & TSUNAMIS

DGGS continues to administer the Alaska Seismic Hazards Safety Commission. The Neotectonics program at DGGS represents the State of Alaska Department of Natural Resources (DNR) on the Commission, and uses this position to amplify results of earthquake and tsunami hazard research from DGGS and elsewhere, provide information to the public after significant earthquakes, and promote public education and legislative policy to reduce the state's vulnerability to earthquakes.

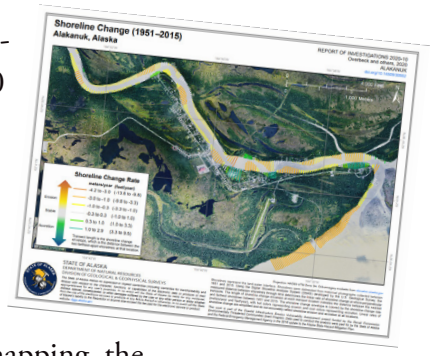
DGGS also continues to manage the DNR portion of the federally funded National Tsunami Hazard Mitigation Program (NTHMP), increasing earthquake and tsunami hazard awareness across the state. Working closely with the University of Alaska Fairbanks Geophysical Institute, we published inundation maps and reports depicting areas that could be affected by future potential tsunamis at Kasaan, Klawock, Metlakatla, Pelican, Point Baker, Port Protection, Hydaburg, Nelson Lagoon, Platinum, Dillingham, and St. Paul and St. George islands. We work with the Division of Homeland Security and Emergency Management (DHS&EM) to disseminate results to local emergency planners and at-risk communities—both in person and through published reports.

Tsunami extent at Klawock, Alaska (red line). Digital tsunami maps can be viewed at tsunami.alaska.edu.

COASTAL FLOODING & EROSION

The Coastal Hazards Program (CHP) is making progress on identifying and filling statewide data gaps and producing community risk assessments on flooding and erosion. Monitoring water levels around the state remains a key priority for CHP, and is coordinated through Alaska Water Level Watch. On the same day that we installed a water level sensor in Homer, a tsunami warning triggered the evacuation of the entire spit. Fortunately, a tsunami did not reach Homer, but the event highlighted the importance of installing devices for communities all around Alaska. Whether at risk to tsunami or coastal flooding, and particularly when operating ports and harbors, Alaska communities need reliable water level monitoring systems. In 2020, three major storm events impacted western Alaska. CHP successfully documented these storms with photographs collected by local residents (storm photo catalog: maps.dggs.alaska.gov/photodb/#show=96&search=storm).

CHP received funding from the Denali Commission in 2019 to support erosion risk assessments for 45 coastal communities. The first step was to quantify the historical shoreline change rates, which are now available in a major publication published this year (doi.org/10.14509/30552).



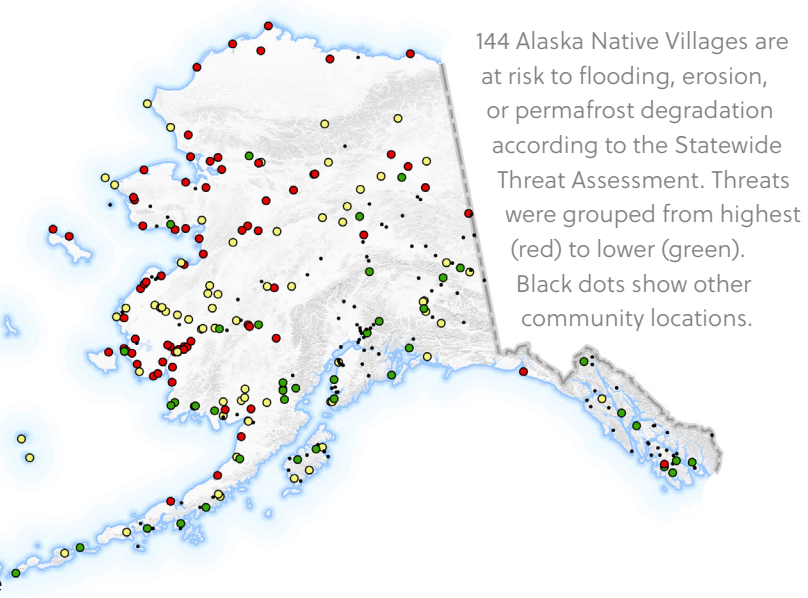
The second step is to forecast erosion into the next 60 years and determine what infrastructure is at risk. This work is scheduled for completion in 2021.

CHP continues to make progress toward mapping the coastline and nearshore of Alaska through leadership of the Alaska Mapping Executive Committee's Coastal Mapping Subcommittee and the Alaska Geospatial Council Coastal Mapping Initiative. These efforts require interagency coordination and communication of stakeholder priorities to ensure federal mapping programs meet the state's needs. CHP will contribute to further mapping efforts through the collection of elevation and aerial imagery by unmanned aerial vehicles, as well as through bathymetry by using a new bathymetric sonar system: the HydroBall®. A HydroBall® was purchased by the Alaska Ocean Observing System in 2020. CHP collaborated with the National Oceanic and Atmospheric Administration to carry out tests of the device near Anchorage, and plans to collect pilot data in coastal communities in 2021.

Left. Water level sensor installed in Homer, Alaska. Photo: Rich Buzard. **Top Right.** Testing the Hydroball bathymetric sonar system. Photo: Jacquelyn Overbeck. **Bottom Right.** Coastal erosion at Golovin, Alaska following a November, 2020 storm. Photo: Tony Anungazuk Jr.

Alaska Coastal Resilience Partnership

The Alaska Native Tribal Health Consortium (ANTHC) Center for Environmentally Threatened Communities, Alaska Division of Community & Regional Affairs (DCRA) Risk Map Program, and Alaska Division of Geological & Geophysical Surveys (DGGS) Coastal Hazards Program have solidified their collaboration to work with Alaska communities facing coastal flood and erosion hazards with a project titled "Building Capacity and Conducting Coastal Risk Assessments in Remote Alaska Native Communities." The project is funded by the National Coastal Resilience Fund with match from the State of Alaska, ANTHC, and the Denali Commission.



144 Alaska Native Villages are at risk to flooding, erosion, or permafrost degradation according to the Statewide Threat Assessment. Threats were grouped from highest (red) to lower (green). Black dots show other community locations.

This project aims to **boost resilience in communities facing flood and erosion hazards** by taking a stepwise approach to working with community leaders through collection of baseline data and creation of maps that quantify vulnerability, assistance with developing resilience strategies and choosing mitigation solutions, building capacity to develop shovel-ready projects, and establishing community-led monitoring programs to evaluate effectiveness.

44 **communities** will gain access to flood and erosion **risk assessments**

Resilience

1. Assess Vulnerability

2. Identify Solutions

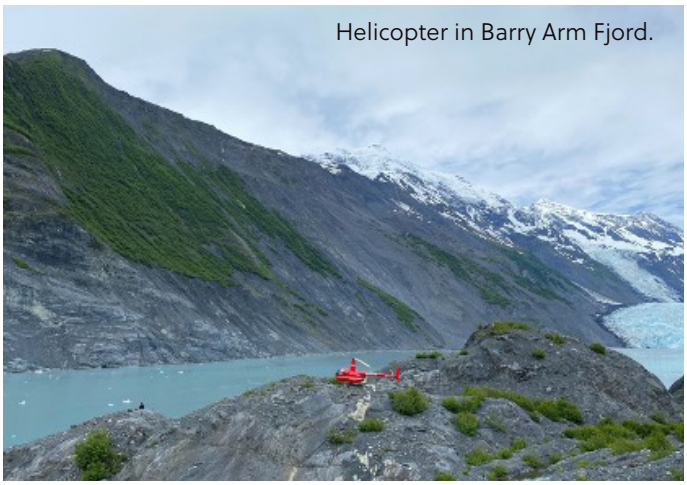
3. Take Actions to Reduce Risk

4. Monitor Effectiveness

Alaska Native Communities face **$4.3 Billion** of costs to infrastructure from environmental threats

Shishmaref is one of the 44 targeted communities facing flood and erosion hazards. Photo shows erosion of the landfill access road during a November 2020 fall storm. Photo: Twyla Thermond, Native Village of Shishmaref.

HYDROGEOLOGY


Helicopter in Barry Arm Fjord.

The hydrogeology program has collaborations with scientists from all over the world to study groundwater associated with landslides. In addition to assessing landslides in Haines, Sitka, and at Barry Arm, the hydrogeology program assesses frozen debris lobes (FDLs; slow-moving landslides in frozen ground). Alyeska Pipeline Service Company funded mapping with lidar to assess movement of eight FDLs. After comparing data from multiple years, we found that FDLs are moving at a faster rate than at any other time in the last decade. The Department of Transportation and Public Facilities funded installation of instrumentation on the old Dalton Highway to measure the future impact of FDL-A on the road embankment. Alyeska Pipeline is planning to fund the development of a 10-year study to identify solutions to stop FDL-A before it reaches the Trans-Alaska oil pipeline.

The hydrogeology program has many ongoing projects to assess permafrost across Arctic Alaska. With funding from the National Science Foundation (NSF), we assisted on hydrological studies of ice-rich Arctic tundra soils near Prudhoe Bay and Point Hope. These studies will focus on the relationship between vegetation, ice wedge degradation, and aggradation with respect to the local hydrology, and will contribute to community planning in Point Hope. WaSiM, a hydrologic model, will be used in the NSF project, as well as in a study of Arctic polygons. A study of Fairbanks Goldstream Valley permafrost and groundwater hydrology finished in 2020. Permafrost maps from the project will be released in 2021. Data collected during this study was also used in a graduate thesis that identified more than 1,400 inactive landslides across the Fairbanks North Star Borough. Another collaboration with the University of Alaska Fairbanks resulted in a thesis of best practices using Ground Penetrating Radar for assessing ice thickness underneath natural and enforced ice bridges in order to assess ice strength.

The hydrogeology program is investing in the future by expanding its capabilities with bathymetric survey equipment. The self-propelled surveyor scans the elevation of lake and river bottoms and uses a seismic chirp to visualize the structure of the sediment below for the assessment of mass movement. This tool can also be used to assess the presence of gravel resources below the surface of a lake.

What's a... Frozen Debris Lobe?

Frozen Debris Lobes (FDLs) are slow-moving landslides in frozen ground made of soil, rocks, trees, and ice. Several FDLs in the Southern Brooks Range threaten to impact the Dalton Highway.

CONSTRUCTION MATERIAL MAPPING

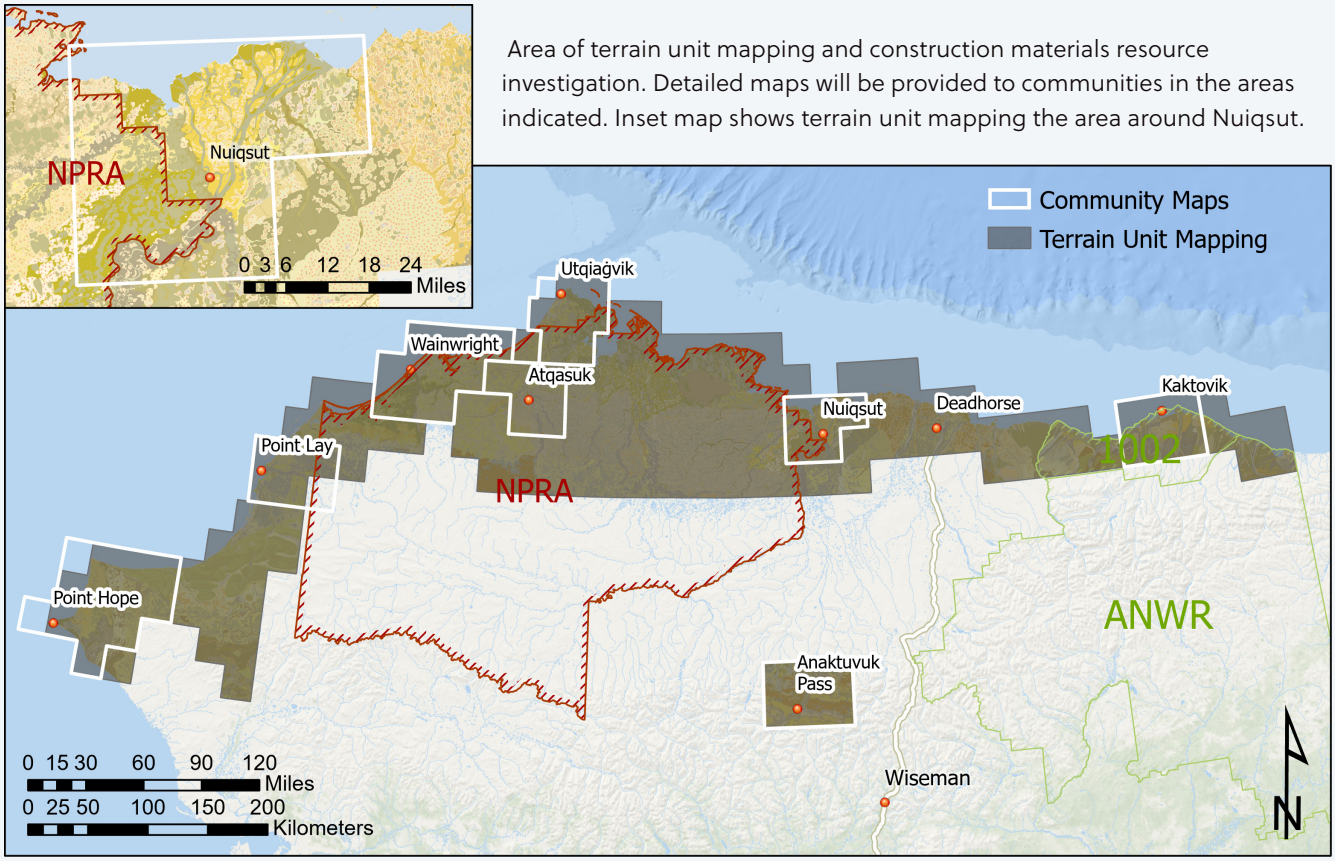
This year, construction material mapping was focused on sand and gravel resource assessment of the North Slope as part of the ASTAR project (see ASTAR).

Arctic Strategic Transportation and Resources Project (ASTAR)

In 2020 the Alaska Division of Geological & Geophysical Surveys (DGGS) continued multifaceted work in support of the ASTAR project, including investigations of coastal hazards and hydrology, a shallow core drilling program, and a sand and gravel resource assessment. The collective DGGS ASTAR work supports a collaborative effort between the North Slope Borough and the Department of Natural Resources to strengthen community infrastructure and facilitate access to arctic resources while enhancing the quality of life and economic opportunities for North Slope communities. It also provides valuable information for land-use management and planning decisions. Program accomplishments are highlighted below.

Key coastal hazards program accomplishments as part of ASTAR included working with North Slope communities to improve infrastructure and erosion monitoring (dggs.alaska.gov/hazards/coastal/monitoring-utqiagvik.html), as well as executing an agreement with National Oceanic and Atmospheric Administration (NOAA) to establish tidal datums at Point Lay and Wainwright.

In 2020 the hydrology program received three climate stations to study snow distribution on the North Slope in support of planned lake studies in the 1002 area of the Arctic National Wildlife Refuge (ANWR). Work continued on the planning for a 2021 field season that will include using a bathymetry drone to scan lakes and estimate their volume.



Area of terrain unit mapping and construction materials resource investigation. Detailed maps will be provided to communities in the areas indicated. Inset map shows terrain unit mapping the area around Nuiqsut.

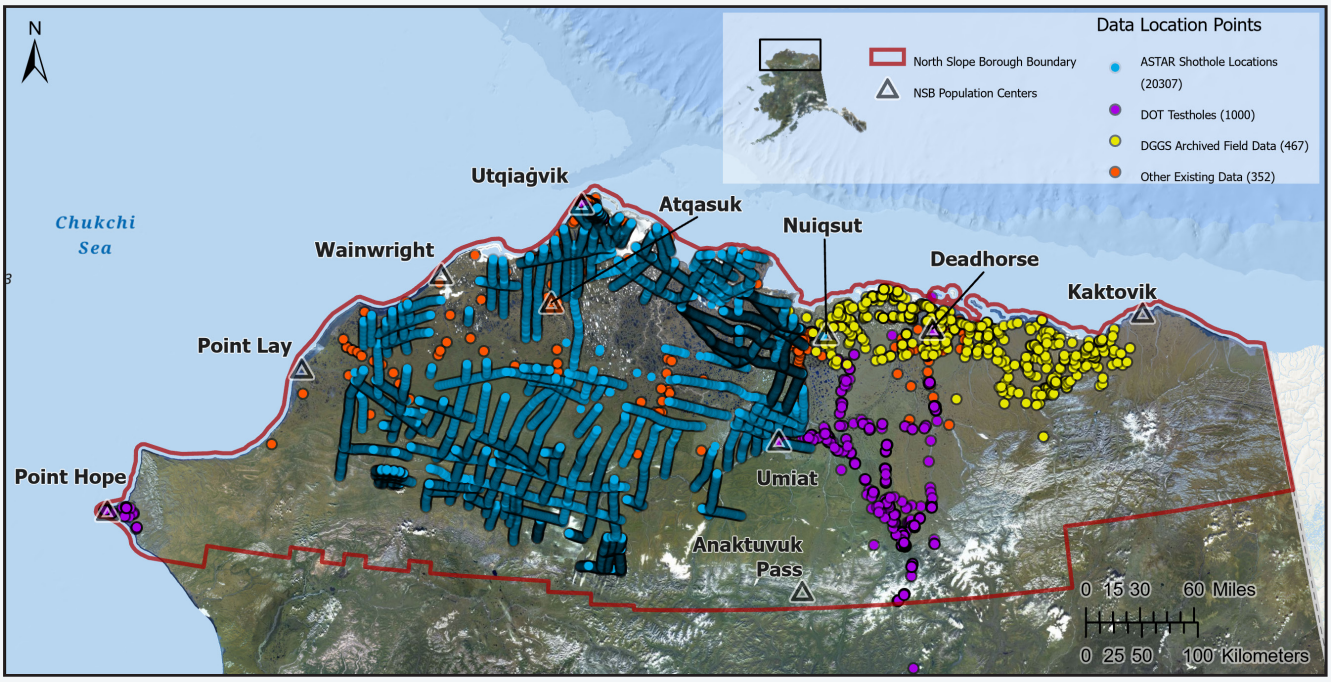


Image showing the location of points in the DGGS database. Each point has information about material properties at that location. The different colored dots represent unique datasets, and the number in parenthesis indicates the number of data points in each set.

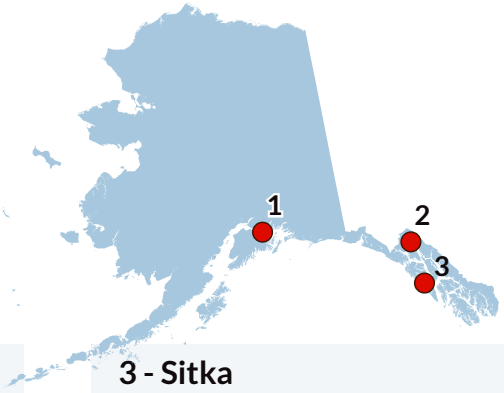
COVID-19 considerations resulted in the delay of shallow core drilling program work in 2020, but 2021 field season preparation has begun.

The sand and gravel resource assessment program continued to identify potential sources of construction materials (chiefly sand and gravel) on the North Slope, focusing on community-interest lands (map at left). We built upon previous years' accomplishments by (1) completing the acquisition of the terrain unit mapping from ASRC Energy Services (AES Alaska), covering a total area of 32,000 mi^2, (2) continuing to populate a geodatabase with sand and gravel resource information from shothole sediment samples (see map above), and (3) developing and adding data to a reference database containing information about material properties from historical investigations.

The ASTAR sand and gravel resource assessment program will benefit Alaska by providing a comprehensive surface and subsurface construction materials dataset, consistent geologic mapping at a more detailed scale than is currently available, and new information about potential geologic hazards. These datasets provide vital information for land-use decisions and planning efforts.

DGGS LANDSLIDE RESPONSE

DGGS's expertise in mapping and evaluating geologic hazards is an important state asset for ensuring Alaska's public and infrastructure safety. Over the last five years, emergency science response to large, damaging, and deadly slope hazards has become a critical and growing responsibility for the DGGS Engineering Geology Section.



1 - Barry Arm Fjord

In **summer 2019**, scientists realized that a large steep slope in the Barry Arm fjord 30 mi (50 km) northeast of Whittier, Alaska, has the potential to fall into the water and generate a tsunami that could have devastating local effects on those who live, work, and recreate in and around Whittier and in northern Prince William Sound.

2 - Haines

Beginning **November 30, 2020**, a complex weather system produced record rainfall and triggered landslides and flooding across all of Southeast Alaska, including a December 2 debris flow that killed two people in Haines. This and other slope failures in Haines caused the destruction or severe damage of many homes, community evacuations and sheltering of residents and at-risk persons, extensive damage to local roads and highways, and severe impacts to community water, power, and communication utilities.

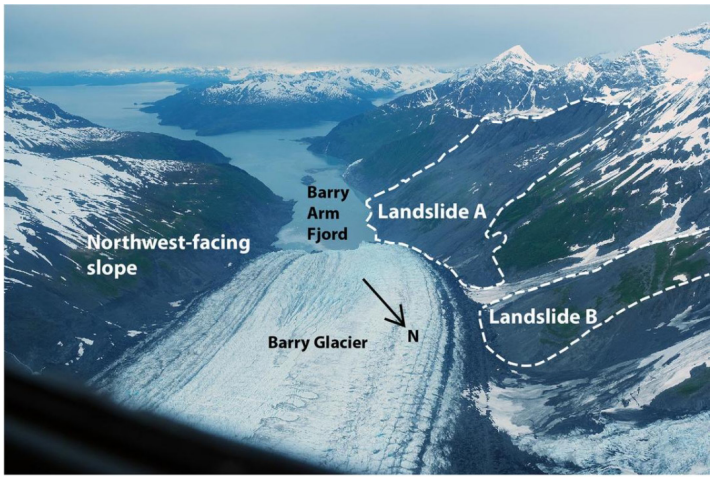
3 - Sitka

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 are documented on Chichagof and Baranof Islands. Four debris flows impacted roads and infrastructure in Sitka, and one of the flows took the lives of three residents.

We responded immediately to the Sitka and Haines debris flows by deploying rapid-response geologic hazards science teams. For both events, we conducted ground and air-based investigations of the debris flows and adjacent areas, acquiring lidar and aerial photographic data from which high-resolution orthophoto mosaics and digital elevation models (DEMs) were produced for debris flow mapping and analysis. Initial hazards evaluation by joint DGGS-DOT&PF-local geologist teams provided critical information to emergency responders regarding the nature of existing and potential ground failures, and if there should be concern for additional slope failures that would pose an immediate threat to rescue personnel or residents. **DGGS in-house lidar capability was crucial for the Haines response to identify ongoing areas of concern**. FEMA funding allowed us to conduct a slope hazard assessment project for Sitka, with report and maps currently in final pre-publication review. We have two similar FEMA-funded projects underway in Homer, and plan to propose additional studies for Haines and several other Southeast Alaska communities impacted by the 2020 storm event.

Responders to the Haines, Alaska landslides. Photo: Mining, Land & Water.

At this time, there is no way to know when, if, or how much of the Barry Arm slope may fall into the water. Because of this challenge, DGGS has partnered with State of Alaska and Federal science and emergency management teams to **develop tools to provide monitoring and alerting capability for a reliable early-warning and rapid-detection system for the potential risk from a Barry Arm landslide and tsunami**. While the slope moved about 600 ft (180 m) toward the fjord between 2009 and 2015, its motion has slowed in recent years. Data from scientific observations in June and July 2020 indicate the slope movement was less than a few inches (centimeters) during that period, suggesting that the risk from a potential landslide-generated tsunami is lower now than it was between 2009 and 2015. Research continues and efforts to monitor this slope with satellite and airborne sensors, and with sensors attached to the surface and buried into the slope, are ongoing.



Barry Arm Fjord landslides. Photo: Gabriel Wolken.

These events spotlight the importance of DGGS efforts to map, monitor, and respond to slope stability hazards in Alaska. We played (and continue to play) a key role in each of these events and are using lessons learned to help inform and improve our ability to act as science advisors to emergency response organizations, state and local governments, and community planners.

VOLCANOLOGY

The volcanology program of DGGS is part of the Alaska Volcano Observatory (AVO), an interagency consortium that mitigates hazards from Alaska volcanoes. AVO was formed by a Memorandum of Understanding in 1988 with its partners, the U.S. Geological Survey (USGS) and the University of Alaska Fairbanks Geophysical Institute (UAF/GI). The volcanology program is entirely funded by cooperative agreements with the USGS Volcano Hazards Program.

AVO's primary objective is to conduct monitoring and scientific investigations in order to assess the nature, timing, and likelihood of volcanic activity in Alaska. Knowledge of particular volcanic systems, combined with operational monitoring that includes satellite remote sensing, seismology, infrasound, gas emission, and ground deformation, allows AVO to assess volcanic risk and provide timely and accurate information on impending dangerous activity.

Volcanic hazard information is communicated to local, state, and federal officials through formal interagency operation plans, and to the public via subscriptions to volcano alert messages (volcanoes.usgs.gov/vns/) as well as social media outlets such as Facebook, Twitter, Instagram, and a public website (www.avo.alaska.edu). A new addition this year is AVO Radio, a weekly radio program summarizing volcanic activity in Alaska, currently airing on 10 public radio stations across the state.

Shishaldin Volcano from the northeast, August 19, 2020. Photo: Malcolm Herstand.

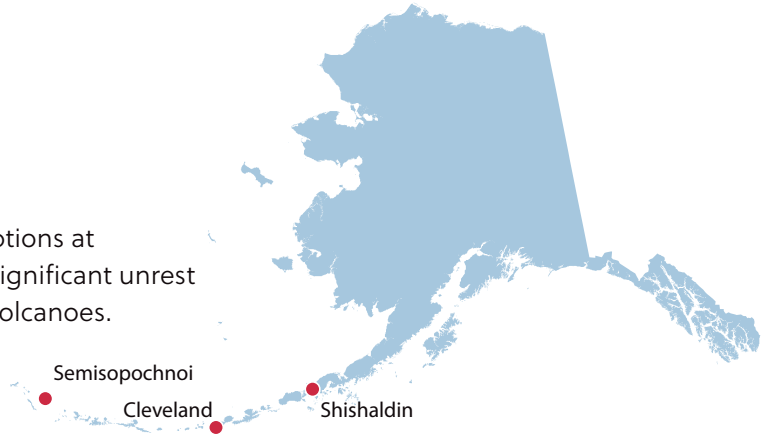
Volcanology Section staff maintain the most comprehensive volcano database in the world— the Geologic Database of Information on Volcanoes in Alaska (GeoDIVA). GeoDIVA serves as the back end of the AVO public website, where users can find the latest information on volcanic unrest and eruption; search and download geochemical data and publications; search, view, and download thousands of well-captioned images of Alaska volcanoes; and learn about eruptive history and current hazards. In addition to its public-facing side, GeoDIVA has internal modules that store information that AVO scientists use to keep track of monitoring data and fieldwork operations.

Volcanology Section staff geologists are working on a variety of research projects to advance the understanding of active volcanic systems. Recent publications include a summary of the geology and eruptive history of Bogoslof volcano, a data release of geochemistry of rocks collected at Little Sitkin volcano, an interdisciplinary study linking the caldera-forming eruption at Okmok volcano with the fall of the late Roman Republic, a Makushin volcano (Unalaska/Dutch Harbor region) ash hazard fact sheet, a post-eruptive study of gases and thermal waters at Okmok volcano, and a paper describing the petrology and geochemistry of three early Holocene eruptions from Makushin volcano.

As part of the Alaska Volcano Observatory, DGGS Volcanology staff author annual summaries of volcanic activity. These documents describe notable volcanic activity in Alaska per calendar year and include information on AVO's response. Information about all volcanoes at elevated alert status and events that prompted increased attention from AVO staff are included, even if no formal public notification ensued. Observations, images, and data typically not published elsewhere are also included. AVO's annual summary publications are available at www.avo.alaska.edu/downloads/classresults.php?pregen=annsum.

2020 VOLCANIC ERUPTIONS AND UNREST IN ALASKA

In 2020, DGGS Volcanology staff responded to volcanic eruptions at Shishaldin, Cleveland, and Semisopochnoi volcanoes, and significant unrest at Makushin, Veniaminof, Great Sitkin, Pavlof, and Korovin volcanoes.



Shishaldin volcano 2019–20 eruption

Shishaldin volcano in eruption, January 18, 2020, as viewed from Cold Bay. Photo: Aaron Merculief.

Shishaldin volcano is located on Unimak Island, approximately 60 miles southwest of Cold Bay and about 700 miles southwest of Anchorage. Shishaldin volcano is one of the most frequently active volcanoes in Alaska, with at least 27 historical eruptions. The Shishaldin 2019–20 eruption began during the summer of 2019, with activity largely confined to the summit crater. The eruption waned in September 2019, but a new lava effusion began October 13, 2019. In late October 2019, a DGGS Volcanology field crew placed a time-lapse camera at Shishaldin. This camera was in operation through the first quarter of 2020. In November 2019, the summit cone partially collapsed, generating a pyroclastic flow. On December 12, 2019, a short-lived explosion produced an ash cloud up to 25,000 ft above sea level. During late December 2019, lava flows and low-level explosive activity continued. On January 3, 2020, seismicity sharply increased, and through January 7 there were heightened ash emissions to 27,000 ft. January 18–19, 2020, saw another increase in eruptive activity, with lava flows and an ash-rich plume to 20,000 ft. The December and January explosions and lava flows were highly visible from Cold Bay, Alaska (see photo above). The January 7–9 ash emissions produced trace amounts of ashfall on the communities of Cold Bay, King Cove, and False Pass. The January 19 activity generated trace ashfall on False Pass. During late January and early February 2020, eruptive activity decreased. AVO observed a new cone and lava flow at the summit on March 13, 2020, along with weak seismic tremor. The March renewal of eruptive activity was short-lived, however, and after observing a continued decline in seismic, satellite, and infrasound detections, AVO lowered the aviation color code and volcano alert level to "Green/Normal" on June 24, 2020.

Mount Cleveland 2020 eruption

Mount Cleveland, June 3, 2020. Herbert volcano in the background. Photo: Burke Mees.

Mount Cleveland is located on the western half of Chuginadak Island in the central Aleutian Islands, 46 miles southwest of Nikolski, ~160 miles southwest of Unalaska, and nearly 1,000 miles southwest of Anchorage. From 2005 to 2020, Cleveland experienced intermittent explosive eruptions, characterized by short-lived ash explosions, lava fountains, lava flows, and pyroclastic avalanches (see photo at left). During 2020, activity at Cleveland decreased, and only one small explosion was detected, on June 2, 2020. After a sustained pause in eruptive activity, AVO lowered Cleveland to "Unassigned" on September 3, 2020. Cleveland volcano is monitored with a limited real-time seismic network. This smaller network inhibits AVO's ability to detect precursory unrest that may lead to an explosive eruption, which results in Cleveland's designation of "Unassigned" instead of the color code "Green" that is assigned to quiescent volcanoes with more instrumentation. Rapid detection of an ash-producing eruption may be possible using a combination of seismic, infrasound, lightning, and satellite data.

Semisopochnoi 2020 eruptive activity

Semisopochnoi Island is the largest young volcanic island in the western Aleutians. Although there are several volcanic vents on the island, as well as a 5-mile-diameter caldera, most recent activity originates from Mount Cerberus, on the southwestern portion of the island. Semisopochnoi is ~160 miles northwest of Adak and ~1,300 miles southwest of Anchorage. From 2018 to 2020, Semisopochnoi exhibited elevated seismicity, degassing, and anomalous surface temperatures, along with occasional small explosions. A period of heightened seismicity in mid-June, with tremor and ground-coupled airwaves, produced a minor tephra deposit visible in satellite images acquired June 21, 2020. No further eruptive activity was detected at Semisopochnoi for the rest of the year; AVO lowered the volcano to "Unassigned" on November 20, 2020.

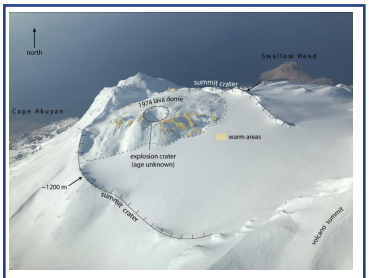
2020 NON-EXPLOSIVE UNREST AT OTHER ALASKA VOLCANOES

Volcanology Section response duties

During unrest and eruption, DGGS Volcanology staff help with AVO response duties, including the following:

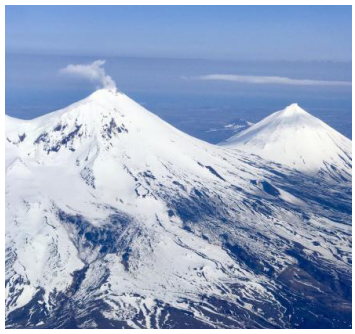
- Issuing volcanic eruption alerts in collaboration with USGS and UAF colleagues
- 24/7 seismic and satellite monitoring
- Detailed record-keeping of eruption chronologies, impacts, and response activities
- Outreach to citizen scientists
- Maintaining current information on public and internal websites, Facebook, and Twitter

Steam puffing from the summit fumaroles of Makushin volcano, as viewed from Summer Bay Cliff Rd, south side of Iliuliuk Bay. Photo: Abi Woodbridge.



Great Sitkin: Increased seismicity in February 2020; M3.5 earthquake March 6; activity declined in second half of the year

Veniaminof: Seismic tremor and earthquakes observed in June, 2020, and declining in August



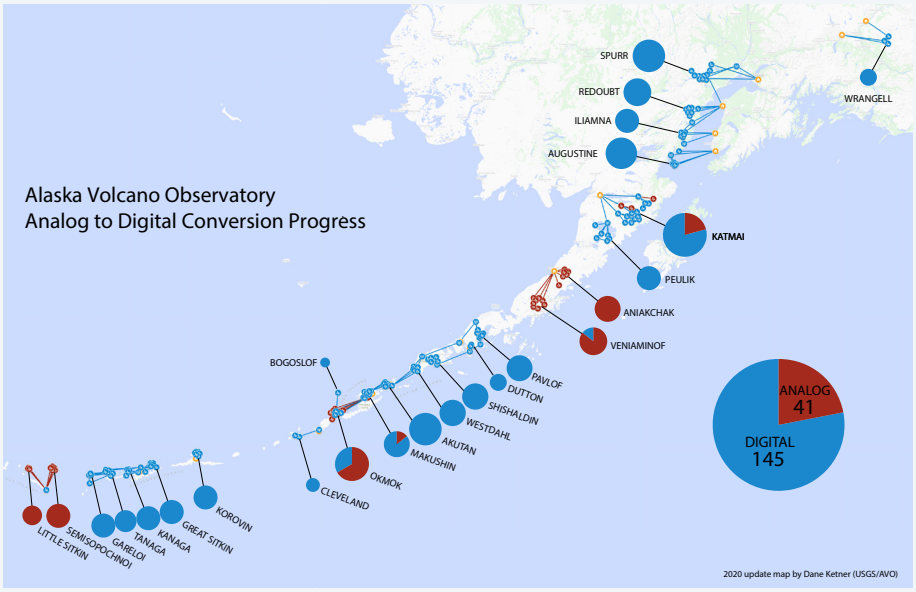
Pavlof: In late December 2019, seismicity at Pavlof increased; this activity declined in early 2020, and increased again in September 2020, followed by another decline in October

Korovin: Significant SO_2 emissions and seismicity increase in late October 2020 followed by a decline in unrest

Makushin: Earthquake swarm in June, 2020, with 2 earthquakes larger than M4, and hundreds of smaller quakes, followed by a decline in seismicity and a return to background levels by September

Helicopter landing aboard the R/V Steadfast near Akutan Island. Photo: Allan Lerner, Sept. 2, 2020

EXTENSIVE UPGRADES TO VOLCANO MONITORING EQUIPMENT PROVIDE ADVANCE WARNING OF VOLCANIC ACTIVITY – YEAR 2



In 2020, despite significant setbacks to fieldwork timelines due to the COVID-19 pandemic, AVO and DGGS field technicians completed the second year of fieldwork under a three-year cooperative agreement grant from the USGS Volcano Hazards Program established to replace old analog volcano monitoring equipment with new digitally telemetered instruments. The upgrades have significantly improved AVO's ability to provide advance warning of volcanic activity, allowing AVO to warn the public of impending volcanic hazards, including dangerous drifting ash clouds. The new digital instruments are less susceptible to external noise, which translates to more accurate and timely forecasts of volcanic events. In addition, the analog-to-digital telemetry conversion brings AVO volcano monitoring instruments into compliance with the National Telecommunications and Information Administration (NTIA) radio spectrum guidelines.

Fieldwork during the COVID-19 pandemic

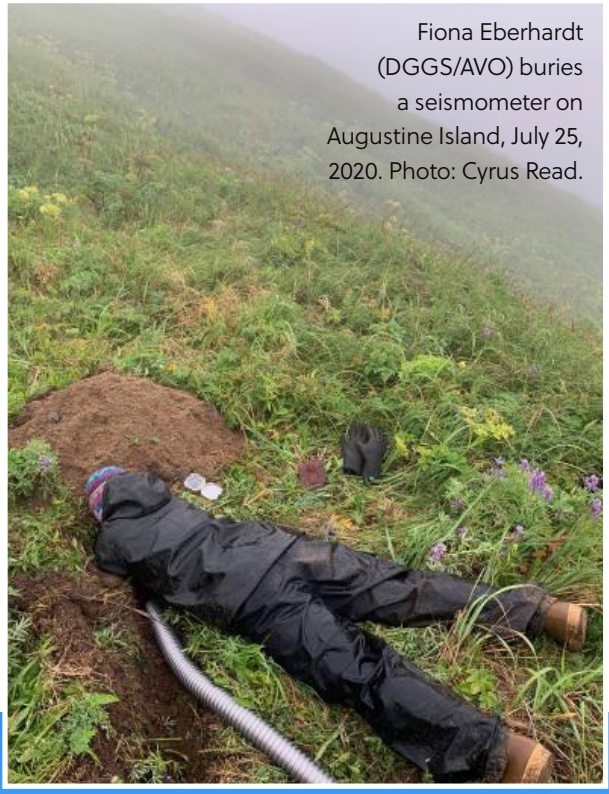
The COVID-19 pandemic resulted in unprecedented logistical feats to safely execute fieldwork objectives. The primary objective as the team prepared for fieldwork was the safety of AVO field personnel, the helicopter crew, and the marine research vessel crew, as well as the protection of remote village communities. Volcanology Section staff took the lead role in providing a COVID-safe field plan that required a strict 14-day quarantine and COVID testing of all field personnel prior to deployment ("bubble model") in addition to restricted community interactions. To prepare for the unlikely yet possible event of illness on board, the size of the field party was reduced considerably so that fewer personnel were interacting on the research vessel. The bubble model was highly effective and resulted in no illness and no positive COVID tests. Knowledge of and adherence to community regulations and restrictions allowed us to maintain a positive working relationship with remote communities and allowed for equipment and fuel caches to be safely accessed.

Field operations were conducted in two phases. Phase I work consisted of 32 days (July 14–August 13), with maintenance and upgrades at Augustine, Katmai, Peulik, Aniakchak, and Veniaminof volcanoes. Phase II work took place between August 13 and September 11 (31 days); sites visited included Shishaldin and Westdahl volcanoes of Unimak Island, and Akutan, Pavlof, and Makushin volcanoes.

To complete the analog-to-digital transition, major infrastructure overhauls and upgrades are required at repeaters and regional data acquisition sites in order to accommodate the digital data streams and collect and/or convey data to the main acquisition and processing center in Anchorage. Such necessary work

was completed this year at 5 repeater sites and 2 receive facilities. Three existing digital sites were upgraded with modern instrumentation; these digital-to-digital upgrades allow for improved communication efficiency across radio networks. Analog equipment was cleaned up and removed from 10 sites and a field staging area on Augustine Island.

DGGS staff Malcolm Herstand and Wyatt Mayo designed and helped implement several engineering solutions, including new lithium battery systems, new digital radios, and methods for adopting Transportable Array sites. New remote camera kits now include a "Mayo Mount," named for Wyatt Mayo's design.



Fiona Eberhardt (DGGS/AVO) buries a seismometer on Augustine Island, July 25, 2020. Photo: Cyrus Read.

78 marine vessel days

60 helicopter days

75 tons of equipment shipped

Monitoring Upgrades

- 142 total station visits
- 10 analog to digital site upgrades
- 3 sites received digital equipment upgrades
- 2 receive facility upgrades
- Site cleanup including removal of analog equipment and site restoration at 11 sites
- Field engineering improvements including new power systems, webcam hardware, and communications equipment

Dane Ketner (USGS/AVO) orients a radio antenna toward a site near Shishaldin Volcano, August 20, 2020. View from SE at geophysical site BRPK. Shishaldin Volcano is emitting a gas plume and the edifice is covered with debris from 2019–2020 eruption. Photo: Allan Lerner.

GEOLOGIC INFORMATION CENTER

Basic geologic information about Alaska's resources helps to inform 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. Availability of information specific to the state's volcanoes, earthquakes, landslides, tsunamis, coastal erosion, climate change, and other natural hazards helps mitigate these hazards, helping to save lives and reduce damage to property and critical infrastructure. The staff within the Geologic Information Center (GIC) design, edit, publish, and deliver division-generated geologic information as authoritative, peer-reviewed maps, manuscripts, geospatial datasets, and easy-to-use online applications.

In 2020 the section helped publish new, peer-reviewed geologic mapping of 2,015 mi^2 to help evaluate energy resources, mineral resources, and geologic hazards. The section archives and maintains more than 1 petabyte (1 petabyte = 1,000 terabytes) of digital and map-based geological, geophysical, and geochemical data in a database that drives DGGS's website (dggs.alaska.gov), which helped foster 1.04 million downloads of digital datasets and reports, totaling more than 32 terabytes (13.8 terabytes from elevation data alone) of information in FY2020, with even more data being provided via interactive maps, online databases, and geographic information system services. DGGS personnel responded to more than 2,600 geologic information requests. The section's ability to host and distribute data helps maintain collaborations with federal and other state organizations, minimizing duplication of effort and cost. It will keep playing an integral role in geospatial and digital data distribution as it develops new and maintains existing online maps, reports, and digital datasets.

DGGS Geologist Gabriel Wolken prepares to collect data for the Kensington Mine photogrammetry survey.

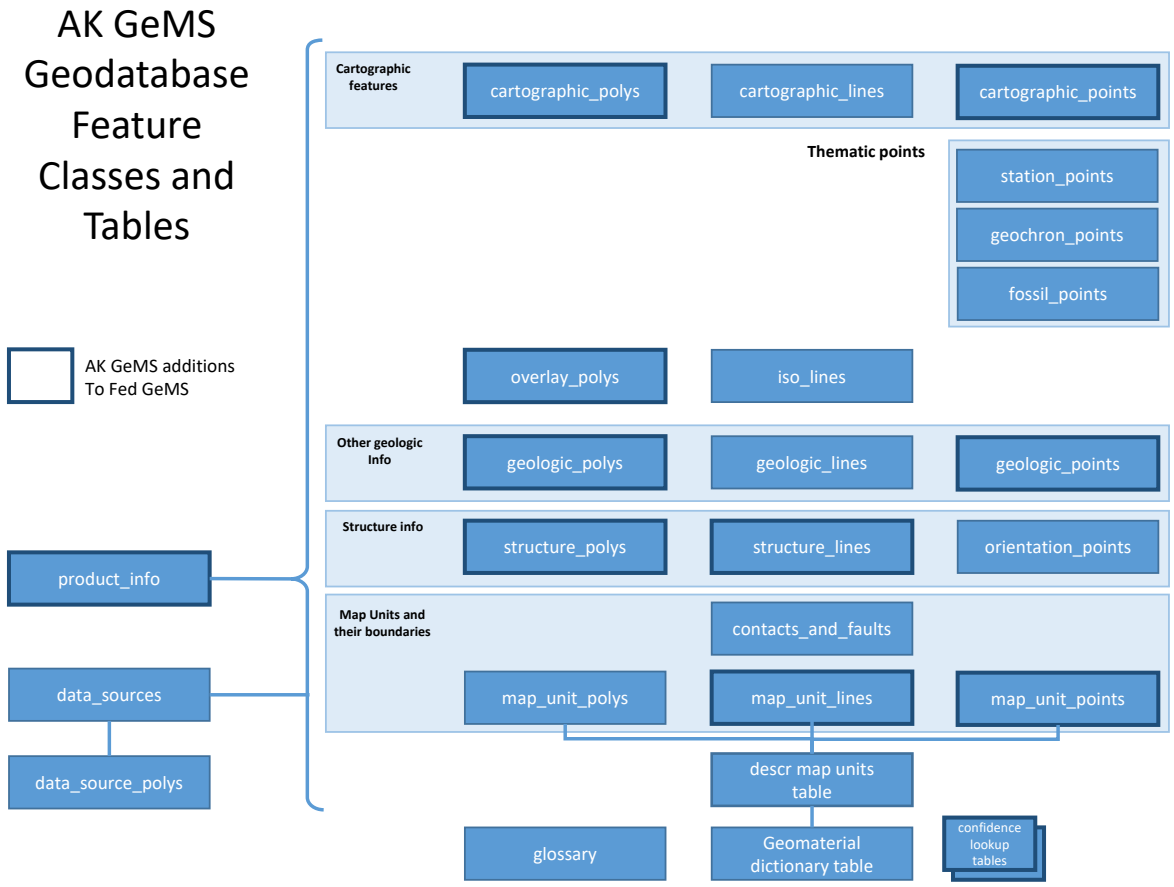
THE ALASKA GEOLOGIC MAPPING SCHEMA (AK GEMS)

This year the Geologic Information Center (GIC) has made great strides in completing our multi-year effort to modernize the division's geologic mapping support infrastructure. This modernization occurred through upgrades to our server hardware and software, a major upgrade to our mobile field geoportal, and the continued development of published standards related to geologic mapping at DGGS.

Of particular note are our efforts related to creating the Alaska Geologic Mapping Schema (AK GeMS). Our AK GeMS standard extends the USGS' GeMS basic standard by placing greater focus on modeling geologic features (instead of the outdated importance placed on a map's graphical elements). AK GeMS supports our single map production processes while also allowing for multiple maps in a modern enterprise relational database. With the AK GeMS standard in place, the division is now positioned to more efficiently create, store, and distribute to the public meaningful geologic data for visualization and analysis.

We have placed an emphasis this past year on the creation of robust documentation for AK GeMS, to increase internal efficiency and share our work with the geologic community, and are in the process of creating and publishing documentation for the following areas:

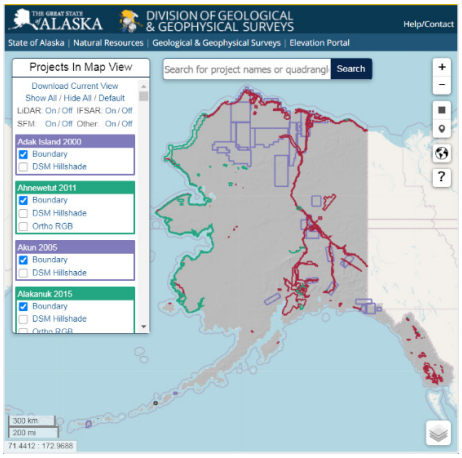
- **AK GeMS Data Dictionary:** A description of the AK GeMS database schema.
- **AK GeMS Symbology:** A description of the AK GeMS Style File.
- **AK GeMS Quality Control:** A description of the AK GeMS quality control process.
- **AK GeMS Production Workflow & Task List:** A graphical flow chart illustrating production phases, as well as an associated detailed task and responsibilities list.



THE DGGS GEOPORTAL

This past year the GIC's IT staff performed a major upgrade to the hardware and software associated with the Alaska DGGS GeoPortal. The division's GeoPortal allows users to share, discover, and access geologic data, maps, and interactive applications. Our Geoportal integrates with Alaska DNR's ArcGIS Online Portal and also shares content to the new State of Alaska Open Data GeoPortal (gis.data.alaska.gov).

SEE PAGE 37 FOR MORE INFO



THE ALASKA ELEVATION PROGRAM

GIC personnel continue to maintain the Alaska Elevation Program, which provides over 14 terabytes (1 terabyte = 1,000 gigabytes) of Alaska elevation data to users throughout the world. The program has greatly benefited from the addition of Andrew Herbst, a full-time GIS analyst focusing on elevation data at DGGS. This year also marked the completion of the statewide IFSAR elevation dataset, which was over a decade in the making. In addition to adding data to our flagship online elevation web application, elevation.alaska.gov, we continue to develop elevation data layers and applications on the DGGS GeoPortal to support various requirements.

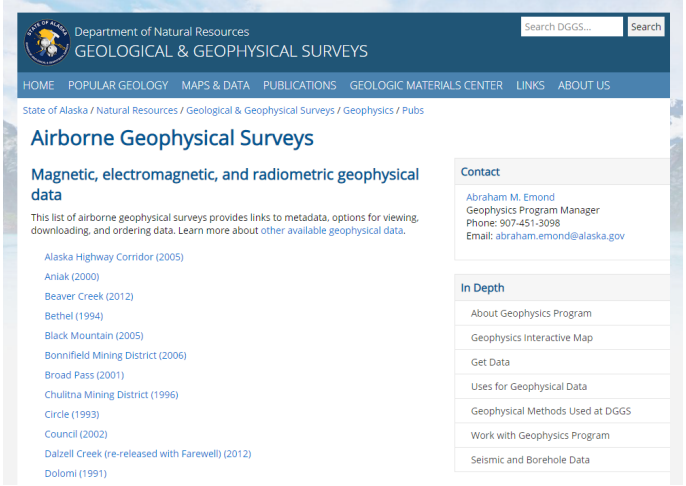
GIC SUPPORT TO DGGS' HAINES LANDSLIDE RESPONSE TEAM

GIC personnel supported the division's response in several ways, including rapid equipment deployment, assistance in preparing mobile field collection devices, and swift publication of elevation data and basemaps. Upon learning that DGGS personnel would be traveling to Haines, GIC GIS staff immediately began creating and distributing GIS datasets of the Haines area to support mobile data collection. In addition, elevation data that became available during the response was fast-tracked for inclusion in the online elevation web application and made available to the public.

UPGRADE TO HISTORICAL AIRBORNE GEOPHYSICAL SURVEYS

GIC personnel completed a multi-year collaboration with geophysics staff to archive and upgrade historical airborne geophysical surveys; 35 surveys, many formerly available only on paper, were digitally re-released during FY2020. Users can now download modern digital formats of DGGS' entire collection of modern airborne geophysical surveys.

dggs.alaska.gov/pubs/geophysics

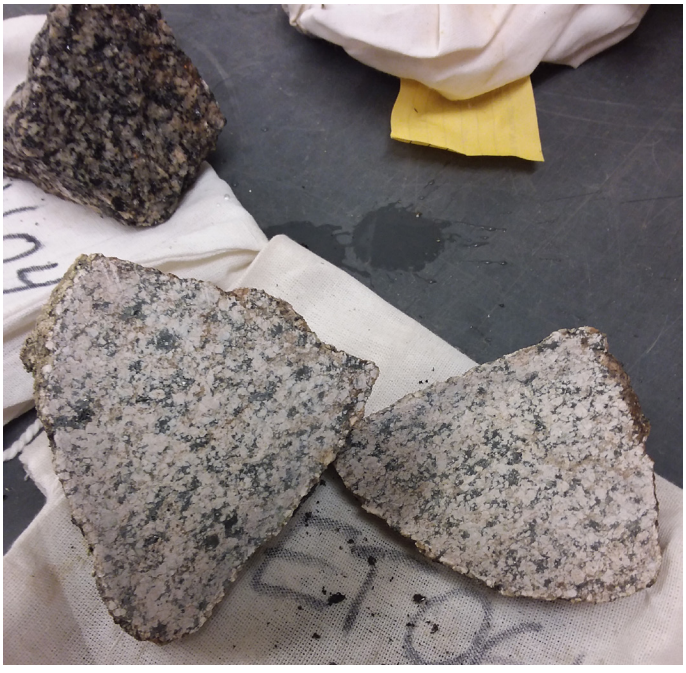


WHERE'S MY SAMPLE

Each field season, DGGS mapping teams are likely to collect 500–1,000 samples, along with copious descriptions of the sample site. Analysis of the physical and chemical properties of these samples provides essential information about the distribution, age, and resource potential of geologic units. After samples are analyzed, the Geologic Materials Center (GMC), in Anchorage, retains residual material for future investigations. Although the accompanying rock sample descriptions are carefully preserved in publications, field notebooks, individual spreadsheets, and various project databases, this information can still be difficult to find. This year, significant work to address longstanding challenges to sample metadata discoverability was completed. Using workflows developed in conjunction with previous years' federally funded data preservation projects, we centralized sample record management throughout the division. We also improved programming to facilitate data compilation, quality control, and information retrieval. Approximately 12,000 rock sample records in our enterprise database were added or upgraded. Corresponding records are available to the public through the GMC inventory catalog (maps.dggs.alaska.gov/gmc).

FIELD COMMUNICATION AND SAFETY

Fieldwork is the heart of geoscience research. GIC personnel support our scientists with training and equipment needed to operate safely in the field and respond to emergencies. Essential safety and communication equipment include helicopter helmets, radios and repeaters, satellite phones, GPS trackers, and emergency first aid bivouac kits to equip roughly 40 staff and up to four distinct projects engaged in simultaneous fieldwork. In addition to providing equipment support to late summer 2019 fieldwork and participating in contingency planning for early 2020 fieldwork, GIC leads an annual collaborative review of the division's Field Operation Safety Manual and field safety outcomes. Integrating upgraded two-way GPS trackers into emergency response communication routines and developing COVID safety protocols for 2020 field operations were key FY2020 field safety focus topics.



Granodiorite sample collected by DGGS geologist Evan Twelker.

IT UPGRADES AND BIG STATEWIDE PLANS

As many now know, teleworking has its challenges, and providing IT support for those who are teleworking can be even more difficult. While GIC IT staff answered slightly more "trouble tickets" in 2019 compared to 2020 (594 vs. 548), the complexity of issues in 2020 becomes apparent when tallying up the number of responses to those tickets: 436 in 2019 vs. 893 in 2020. IT support staff are tackling the same volume of requests, but it is requiring twice as much "back and forth" to fully address them. Despite these challenges, GIC IT support staff reduced the average response time for support tickets by 50 percent with no increase in staffing. Lastly, GIC IT staff are building a massive storage array for statewide imagery services. When complete, it will act as a centralized repository of all geospatial image data for the entire state of Alaska. The array will be composed of more than 600 networked drives split across 20 computing nodes, with a total storage capacity of approximately 10 petabytes (1 petabyte = 1,000 terabytes). That's enough to store more than 41 Libraries of Congress!

5,305
publications released by DGGS since 1903

675,000
total number of items in the Geologic Materials Center inventory*
*An average Walmart Supercenter sells 160,000 unique items

1.2PB
of digital geologic data stored at DGGS

2,015mi²
published, peer-reviewed geologic mapping

more than **166**
newly published maps and reports available at dggs.alaska.gov

3,500mi²
lidar data collected and published

GMC NETWORKING UPGRADES

Due to an increased volume of Anchorage-based projects, and the frequency of which we work with very large datasets, GIC undertook a giant upgrade to the Geologic Material Center's network backbone. The performance improvement should increase network speeds by a factor of 10, saving significant staff time otherwise spent waiting for lengthy file transfers.

DGGS Geologist Mandy Willingham using two-way handheld radio for team communication.

CONGRATULATIONS!

Mike Hendricks originally joined DGGS as a geospatial analyst in August 2014 after moving from West Point, New York, with his wife and youngest daughter, and serving 28 years in the military. As an Army Engineer and Geospatial Information Officer, he worked and lived with his family over the years in Frankfurt, Germany; Monterey, California; Columbia, South Carolina; West Point, New York; Honolulu, Hawaii; and Bangor, Maine. While in Bangor, he earned his Ph.D. in Spatial Information Engineering from the University of Maine at Orono in 2004.

Between 2004 and 2014, Mike served on the faculty of the United States Military Academy's Geospatial Information Science Program at West Point. While in that position, he taught Geospatial Information Systems (GIS) and conducted applied research in spatial-temporal analysis and land navigation education using location-based technology. While at West Point, Mike also served as the coach of West Point's Orienteering Team, a running (or cross-country skiing) sport where competitors use a compass and a large-scale topographic map to race over the terrain.

Just after four years of being with DGGS, between 2018 and 2020, Mike planned, coordinated, and prioritized major geospatial data projects and goals for both DGGS and the state, as acting Geospatial Information Officer for the Alaska Geospatial Council. As the lead GIS Analyst for the division, Mike has been managing the division's centralized digital geospatial data and infrastructure; working to increase process efficiency and mitigate workflow issues; and working to create new ways to distribute geospatial data and increase its utility to the division's data users and others, ultimately maximizing the value of the division's GIS assets.

He also oversees the archival of the division's geospatial data, provides technical GIS and cartographic design expertise, and regularly trains staff in the use of GIS software and cartographic standards. With the support of several others within the division, Mike has been the principal lead on successfully modernizing the National Geologic Mapping Schema (GeMS), in coordination with the federal U.S. Geological Survey, to better support DGGS geologic data and map production, as well as dramatically improve the distribution and accessibly of this data to the public and other agencies.

As a result of his continued hard work, dedication to helping DGGS be at the forefront of GIS technology, knowledge of the division, and consistent prudent and judicious decisions, Mike has been promoted to be the section chief of the Geologic Information Center. Mike will provide administrative, supervisory, and technical leadership for the division's centralized GIS, database, programming, and Information Technology resources. Congratulations, Mike, and we know you're going to be successful in your new role!

STATE GEOSPATIAL INFORMATION OFFICE

Timely, accurate information, easily accessed and capable of being shared across federal, state, and local political jurisdictions, is fundamental to the decision-making capability of those tasked with economic development, environmental management, education, health, public safety, human services, infrastructure management, planning, zoning, real property records management, elections and redistricting, and disaster preparedness and response.

NEW STATE OF ALASKA GEOPORTAL

The State of Alaska has launched an Open Data GeoPortal! With the knowledge that baseline mapping data underpins most projects in Alaska, the Open Data Geoportal will provide access to location-based data, maps, and applications used for analytics, making the state's vast collection of spatial data easier for the public to locate and use. As a one-stop shop for access to government spatial information, this will reduce time spent surfing through department websites or making numerous data requests. It also will create a platform for innovation, collaboration, trust, and accountability across state, local, and federal government agencies. Data is only useful if people can find it. Users can search the Open Data GeoPortal site by keyword or organization.

IMAGERY, IMAGERY, AND MORE IMAGERY

Acquisition and use of digital imagery are on the rise and government agencies are incorporating these data into daily workflows and realizing the full potential of this technology. Through coordination with the Alaska Mapping Executive Committee, the state now has a new, high-resolution, Maxar statewide imagery product. The data, a statewide, 50-cm resolution orthomosaic of visible and near-infrared images, is now available to the public and all State of Alaska agencies to support their mission objectives at soa-dnr.maps.arcgis.com/home/search.html?t=content&q=tags%3A%22Maxar%22.

LEARN MORE!
gis.data.alaska.gov

The State Geospatial Office has also received funding to build a massive storage array for future statewide imagery data and services. When complete, it will act as a consolidated repository of all imagery assets for the State of Alaska. The array will be composed of over 600 networked drives, split across over 20 computing nodes, with a total storage capacity of approximately 10 petabytes. That's enough to store over 41 Libraries of Congress!

ALASKA GEOSPATIAL COUNCIL COORDINATION

The Alaska Geospatial Council (AGC) coordinates across federal, state, and local government agencies as well as University, tribal, and private-stakeholder groups to improve geospatial information availability and use in Alaska. Since 2015 AGC has worked under the Department of Natural Resources' Division of Geological and Geophysical Surveys to eliminate redundant efforts and expenses, modernize state geospatial data holdings and hardware, acquire and make geospatial data widely available, and implement a statewide geospatial strategic plan.

Coordination efforts recently resulted in a 10-year, $70 million effort to use high-altitude airplanes to obtain full digital elevation data—from the lowlands to the mountaintops—for the entire state. Among the dataset's many applications is its ability to serve as the foundation for a new generation of topographical maps of Alaska.

AGC was also at the forefront of Alaska's response to a 2019 White House executive order calling for thorough mapping of the nation's coastline and 200-mile Economic Exclusion Zone. AGC helped develop a coastal mapping strategy, established a coastal working group to prioritize coastal mapping areas, and has coordinated with the National Oceanic and Atmospheric Association to adopt a plan that in 2021 will start producing a more accurate map of Alaska's coastline. This project is critical in charting coastal erosion and providing ships with updated hazard information.

AGC has established the following 11 Technical Working Groups and initiatives to address geospatial priorities for Alaska: hydrography, wetland, vegetation, transportation, geodetic, cadastral, administrative boundaries, enterprise GIS, coastal mapping, elevation, and imagery. To learn more, visit agc.dnr.alaska.gov.

ALASKA GEOLOGIC MATERIALS CENTER

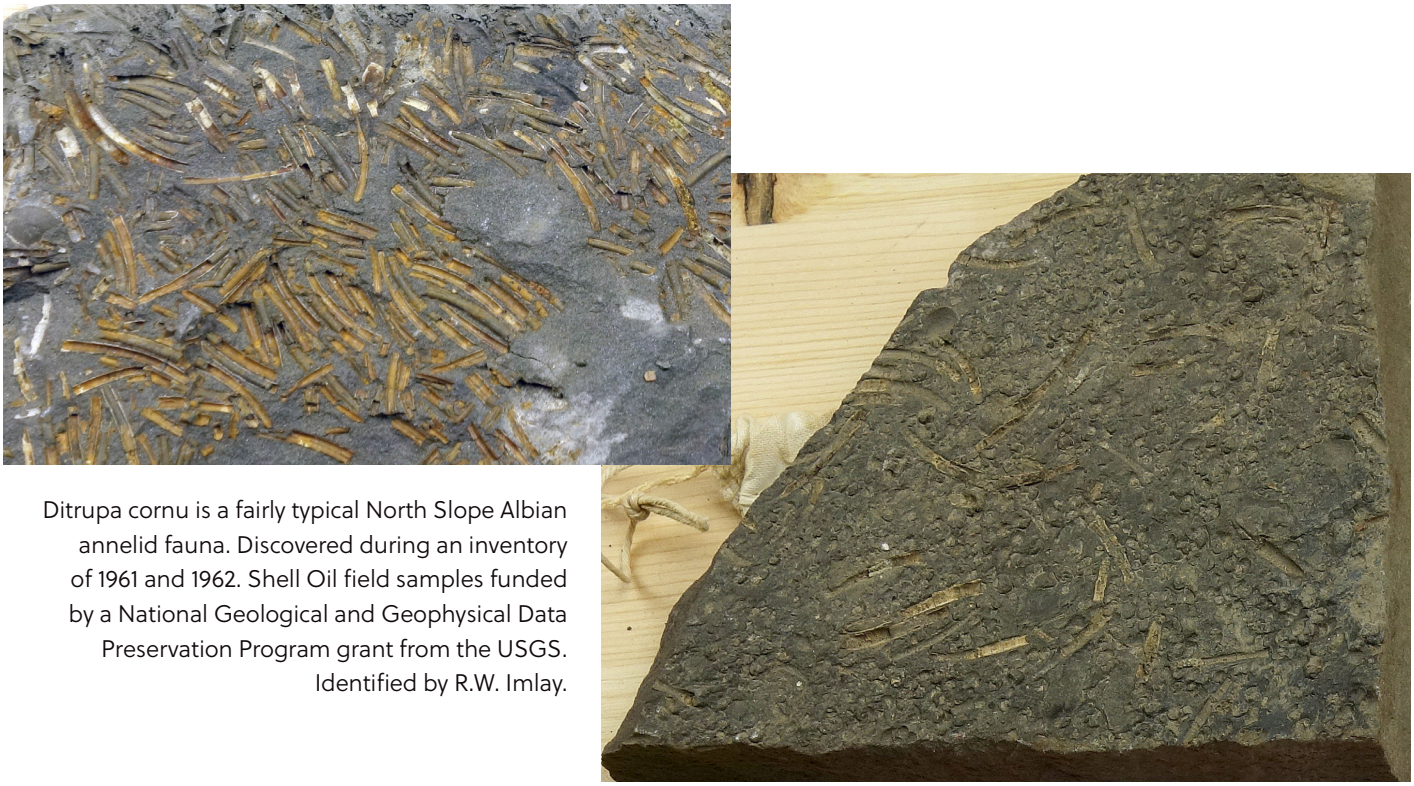
The Alaska Geologic Materials Center (GMC), operated by DGGS, archives 75 years' worth of geologic data and nearly 740,000 energy, mineral, and geologic samples with an estimated replacement value exceeding $35 billion. The facility provides a wide range of users (industry, government, academia, and public) access to samples for identifying new resource prospects and increasing our geologic knowledge of the state.

In the past, this was done under a very limited budget in a thoroughly inadequate and outdated facility with limited availability of samples due to cold storage in winter. The new Anchorage repository opened on July 1, 2015, and has completed its fifth fiscal year. Senate bill SB170, signed by Governor Walker in June 2016, allowed DGGS to "charge and collect fees for facilities, equipment, products, and services." Fee collection began in fall 2018, and the GMC is now a revenue-generating facility for the state. For FY2020, the GMC generated more than $1.4 million in fees, including distributions for tax credits of seismic datasets.

There were 1,112 visits to the facility in FY2020 (prior to the new Anchorage facility opening, the average number of visitors was 400), and the fiscal year saw several major successes for clients of the GMC. Proximity and higher visibility to the much larger population center of Anchorage have increased both institutional and public visitors to the facility. Due to COVID-19 travel restrictions, visits this year did drop

Geologic materials keep pouring into the GMC collections!

After nearly six-years in Anchorage, the 5,000+ shelves in the GMC warehouse are starting to feel full!



Ditrupa cornu is a fairly typical North Slope Albian annelid fauna. Discovered during an inventory of 1961 and 1962. Shell Oil field samples funded by a National Geological and Geophysical Data Preservation Program grant from the USGS. Identified by R.W. Imlay.

by 25 percent compared to FY2019; however, strong interest in the North Slope Nanushuk play continued. Mining industry visits remained low.

Geologists from independent and major energy companies visited the GMC to sample and examine hundreds of feet of drill core and cuttings. As production declines within the mature Prudhoe Bay oil field, it is essential to diversify the oil industry in Alaska. The GMC hosted visits by major and independent oil companies and government researchers operating in both the North Slope and Cook Inlet regions, including Oil Search Alaska, Hilcorp Alaska, ConocoPhillips Alaska, Advanced Hydrocarbon Stratigraphy, Rockwash Geodata Ltd., Chemostrat Ltd., Energy 88, Repsol, Furie Alaska, Donlin Gold, Burgundy Exploration, and the U.S. Geological Survey.

Negotiations began with Haliburton subsidiary Ingrain to leverage GMC sample materials for additional analysis. The GMC is proposing creation of a private and public Alaska resource consortium to share assets to generate digital scanning rock sample datasets. If successful, Dual Energy (DE) CT scans, thin section digitization, benchtop spectral gamma ray, XRF, high-resolution digital photography, and machine learning performed on thousands of GMC samples will enhance oil reservoir quality evaluation and core-log integration, proactively preserve valuable information from decaying GMC samples, and improve global data access, visualization, and the data marketplace. All nonproprietary datasets will become available through the GMC's fee schedule.

FY2016 saw a drastic shift in tracking client access to the GMC inventory. The former paper file inventory system was replaced by a more modern browser-based inventory search interface in January 2016 (maps.dggs.alaska.gov/gmc). The new database-driven search engine allows users to quickly and easily view real-time details of nearly 690,000 public sample items in the GMC's inventory before visiting the facility. This innovative and complex database and online search engine were developed in-house by DGGS staff and continue to serve user needs (there were 317,000 requests to GMC web pages by 28,000 visitors in FY2020) and receive positive feedback from industry.

WELCOME!

ANDREW HERBST

Andrew Herbst joined DGGS in August 2020 as a GIS Analyst I after a successful two-year internship with the division, where he demonstrated the utility of having a full-time GIS analyst to focus on elevation data. Andrew has 5 years of experience in the fields of GIS and remote sensing, and holds a Bachelor of Science degree in Geography, with a concentration in geospatial sciences, from the University of Alaska Fairbanks. Originally from Kansas City, Kansas, Andrew began his career in geography after an enlistment in the U.S. Army left him in Interior Alaska. Starting as an analyst with the Geographic Network of Alaska (GINA), he contributed to the Statewide Digital Mapping Initiative (SDMI) by performing the final round QA/QC for a continuous imagery basemap for the state, which remains one of the most ambitious mapping projects in Alaska history and is still widely used today. Continuing that ambition, he now excels as a lidar specialist and big-data manager within DGGS' GIC and Engineering Geology sections, aiming to further Alaska's geographic awareness by providing thousands of square miles of elevation data to the public.

BRANDON BROWNE

Brandon Browne joined the Volcanology Section of DGGS and interagency Alaska Volcano Observatory (AVO) in June 2020. Originally from southern California, Brandon earned a B.S. in Geology and a B.S. in Environmental Science from Oregon State University in 1998. His enthusiasm for igneous petrology, volcanology, and field geology in college led him to Alaska in 1999, where he started a M.S. project at the University of Alaska Fairbanks (UAF). He described pyroclastic density current deposits from a caldera-forming eruption in Mexico for his M.S. degree in Geology, which he earned in 2001. One of things that Brandon enjoyed most about being a graduate student at UAF was having the opportunity to collaborate with so many different AVO scientists on field mapping and sampling projects at volcanoes in Alaska and Kamchatka. He earned a Ph.D. in Geology from UAF in 2005, using geochemical, petrological, and experimental techniques to better understand the timescales and manner in which magmas of contrasting composition mingle in the shallow crust and ascend to the surface during volcanic eruptions. Brandon worked as a geology professor after leaving Alaska in 2005, first at Cal State Fullerton in southern California and later at Humboldt State University in northern California, where he enjoyed teaching a variety of geology courses to a diverse group of students and supervising the completion of nearly 40 student thesis projects on volcanoes in California's Sierra Nevada, the Cascades, and Aleutians. He and his wife Carrie (who worked at DGGS from 2000–2005) enjoy being outside and spending time with their two rapidly growing boys.

KATE BULL

In May of 2019, Kate Bull returned to the volcanology section of DGGS and AVO to apply her expertise in remote fieldwork operations to help coordinate logistics for AVO's new Analog-to-Digital instrument conversion project. In April of 2020 she accepted a permanent job as a geologist and logistics coordinator in the volcanology section. She first worked for DGGS-AVO from 2005–2012 as a volcanologist and coordinator of AVO's helicopter contracts. After leaving Alaska to join her husband in Australia, she worked as a senior geologist at the Geological Survey of New South Wales from 2014–2019, where she was a regional mapper and petrographer, focused on volcanology. Kate earned her B.S. in geology at the University of Washington in 1984, and an MS from UAF in 1988. Her MS project involved mapping and studying the ore-genesis and igneous petrology of an ore deposit hosted in an ancient intrusive-volcanic igneous complex located near Iditarod, AK. After her MS, Kate joined a small company specializing in steep-terrain mineral exploration. For the following 13 years, Kate's contracts focused on mapping, but also included managing mapping and drilling projects mainly in Alaska and Canada, which involved helicopter and camp logistics. In 2001 she switched gears and pursued a PhD in volcanology at the University of Tasmania, which she earned in 2006. Her thesis included detailed mapping, dating, and geochemical analysis of an ancient submarine volcanic complex exposed in central New South Wales. Kate relished the opportunity to work in young and active volcanic complexes in 2005 when she first joined DGGS-AVO, and was fortunate to participate in the 2006 Augustine and 2009 Redoubt volcanoes eruption responses. Kate is excited to be back in Alaska with her newly retired husband, and to be coordinating logistics and working on Alaskan geology projects for AVO.

KATREEN WIKSTROM JONES

We are pleased to welcome Katreen Wikstrom Jones to the Climate & Cryosphere Hazards Program as a permanent employee. Katreen is a cryosphere hazards and remote sensing specialist who has been working at DGGS since 2017. She has a research background in avalanche dynamics and numerical modeling of wet snow avalanches and is currently involved in multiple projects that focus on snow distribution and alpine slope instability hazards in Alaska using remote sensing techniques and citizen science and stakeholder involvement.

RICH BUZARD

Rich Buzard began studying Alaska's coastal hazards in 2015 as a graduate student at the University of Alaska Fairbanks. He worked with DGGS on several projects while filling roles of Alaska Sea Grant Fellow, DGGS Graduate Intern, and NOAA Digital Coast Fellow. It was a great relief to hire Rich as a permanent Geologist II with the Coastal Hazards Program this year. Rich received his M.S. in Geology and Remote Sensing from the University of Alaska Fairbanks (UAF), where he built community-based erosion monitoring protocols in Bristol Bay. As a Digital Coast fellow, Rich developed historical flood maps and documentation to assist weather forecasters and community planners in understanding flood risk for Golovin and Hooper Bay, Alaska. Rich's passion is collecting data, running analyses, and creating maps for areas with very little data, which is necessary for the coast of Alaska. At work and on his own time, Rich is an avid drone pilot. He takes pride in creating not only accurate, but beautiful maps of coastal communities using unmanned aerial systems. We are so happy to be able to work with this dedicated, talented, and fun individual!

LESLIE JONES

Dr. Leslie Jones received her PhD in 2016 in Systems Ecology at the University of Montana, where she was awarded both National Science Foundation and Montana Institute on Ecosystems fellowships.

Since March 2020, Dr. Leslie Jones has provided statewide coordination for geospatial data, initiatives, and policies. She plays the principal role in advancing geospatial goals of the State of Alaska and serves as the voice of the Alaska Geospatial Council. Leslie has 20 years of experience as a geospatial statistician in applied research science and advocates for open data, reproducible science, and use of GIS as a platform for data-driven decisions. In her lead position overseeing the Geospatial Information Office, she promotes the value of modernizing technologies to foster data sharing and integration to enable more effective coordination across the state.

Welcome, Leslie, and we all appreciate your energy, enthusiasm, and thoughtful insight!

CHERYL PARK

We are extremely happy that Cheryl Park has joined DGGS to be the lead Administrative Officer for the division. Cheryl has worked at, and managed funds for, Fish and Game, and then Northern Region DOT, for more than 20 years. She was one of the original IRIS/ALDER authorized developers when it first launched. Cheryl has experience overseeing an operating and capital budget of $72 million including federal airport, highway, emergency, and other funds.

Since early December 2020, Cheryl has been responsible for budget development, accounting, and financial management for the division. She coordinates and supervises all aspects of the administrative functions for the division, including personnel, procurement, travel, and inventory. Never afraid to ask the tough questions and understand the details, Cheryl brings a tenacity, a thoughtfulness, and a professionalism we appreciate on a daily basis. Welcome to the DGGS family, Cheryl!

LEE ANNE KOZIE

LeeAnne joined DGGS way back in 2005 as a Natural Resource Technician II and, for the next two years, she warmly greeted the public at the front desk and helped tackle the day-to-day challenges faced by the Administrative section. From 2007 to 2019, LeeAnne admirably worked in the Vital Statistics section within the Department of Health and Social Services. Then, after six months working for the Department of Transportation at the Fairbanks International Airport, she found her way back home to DGGS! LeeAnne now oversees invoicing, time sheets, and travel for the division. Outside of work, LeeAnne enjoys looking after her horses and spending quality time with family. Welcome back, LeeAnne…it's great to see your smiling face again!

FELISA CHILDSDRESS – WELCOME AND A SPECIAL THANK YOU!

Felisa Childsdress joined DGGS in early summer 2019 as a non-permanent Administrative Assistant to help manage invoices, procurement logistics, and budget details for the Volcanology Section within DGGS. To no one's surprise, Felisa quickly became very knowledgeable and was always willing to learn additional skills and take on new challenges. In the spring of 2020, Felisa applied for our Administrative Assistant III position, which briefly became vacant, and was easily selected as the lead candidate.

In her new role, Felisa confidently tackles personnel, procurement, invoicing, inventory, cell phone requests, and many other administrative duties. In the late summer of 2020, an unexpected vacancy in our administrative team created an opportunity for Felisa to become our Acting Administrative Officer and we quickly learned what Felisa was really made of. "Learning at the speed of light" would accurately describe her day and Felisa eventually conquered the day-to-day challenges of the lead administrative position with impressive patience and professionalism.

In the workplace, we greatly appreciate Felisa's dry sense of humor and wit; she once described hand sanitizer as "magic paper cut finder." Outside of work, Felisa is an avid reader and enjoys spending quality time with family. Welcome to the DGGS family, Felisa, and thank you for your perseverance and unrelenting dedication to the survey and its staff.

FAREWELL!

KARRI SICARD

Karri Sicard joined DGGS Mineral Resources section in 2013 and, as her first geologic mapping experience in Alaska, organized and lead the Styx River project in the remote and rugged Western Alaska Range. Karri later led the Tok River project, and she participated in the section's Tanacross and Richardson projects, not to mention an infamous 2014 project she took to calling "Raingellia." She brought a fun, safety-conscious approach to her DGGS fieldwork, and she placed a special emphasis on mentoring new hires and interns. While it's true that she's a bear magnet, she does have a quick draw.

In 2020 Karri moved on to a new career with Jacobs Engineering. Karri, we will miss your cheerful enthusiasm in the field, good luck in your new job!

LINDA NATROP

Linda Natrop joined DGGS in September 2015 as a Natural Resource Technician II. For several years, she was the warm, smiling face of DGGS, as she greeted the public at the front desk. Linda quickly became a timesheet, travel, and invoicing guru and was always willing to help others when needed.

Linda grew up in southern California and northern Nevada. In 1978, the family moved to Albuquerque, New Mexico, where she later attended the University of New Mexico. Linda moved back to northern Nevada in 1985, married, and had two children.

In 2002, Linda and her family decided it was time for an adventure and they chose Alaska as the location to transplant their roots. Linda went back to school and earned her Associate's Degree at the University of Alaska Fairbanks in 2004. Following graduation, she began her career with the State of Alaska as an Office Assistant at the Fairbanks Public Health Center and was Office Assistant II at the Right-of-Way Office with Department of Transportation & Public Facilities from 2012 until she accepted the position at DGGS more than six years ago.

Outside of work, Linda enjoys traveling with her husband, hanging out with her grandson, spending time with her son and his wife, crocheting, rubber stamping, fishing, and fitness activities. She is involved in music, church activities, and suicide prevention events.

Linda retired from state service in early Fall of 2020 and kindly chose to come into the office, for several weeks, to assist other administrative staff. Thank you, Linda, for your service to the state and your DGGS family wishes you the best as you enjoy your well-earned retirement.

SHELLY SHOWALTER – FAREWELL AND GOOD LUCK!

Shelly Showalter joined DGGS as its Administrative Officer in April 2013. Shelly spent her childhood in Lancaster County, Pennsylvania, in the heart of Amish and Mennonite country. In 1979 she met and married her husband, Russ, who promptly transported her to his hometown of Fairbanks, Alaska. She immediately fell in love with Alaska and has considered it her home ever since.

After fifteen years working with Russ to build their family business, Shelly returned to school, and by 2004 had earned an Associate Degree, as well as Certificates in Organizational and Public Management, from the University of Alaska Fairbanks. In 2001, Shelly began her career with the state as an Administrative Clerk II with the Department of Corrections and was the Business Manager for the Fairbanks International Airport from 2011 until she came to DGGS in 2013.

For seven years, Shelly worked extremely hard, always putting in many extra hours, to manage and coordinate the administrative aspects of the division. She was always willing to help others and go the extra mile to provide essential information, all the while sharing her good sense of humor with coworkers.

Outside of work, she enjoys spending time with her immediate and extended families and grandchildren, traveling, photography, fishing, camping, and scrapbooking and quilting with friends, as well as baking and knitting during the long winter nights.

Shelly is currently a Vocational Rehabilitation Assistant, with the Division of Vocational Rehabilitation and Client Services in Fairbanks, helping hundreds of Alaskans with disabilities prepare for, get, and keep great jobs. Thank you, Shelly, for your unwavering dedication to DGGS and we wish you a happy, future retirement!

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