Alaska Division of Geological & Geophysical Surveys

ANNUAL REPORT 2022

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
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DEPARTMENT OF NATURAL RESOURCES
John Boyle, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
David L. LePain, State Geologist and Director

Publications produced by the Division of Geological & Geophysical Surveys (DGGS) are available to 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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DGGS publications are also available at:

Alaska State Library,
Historical Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99811

Alaska Resource Library and Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

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Front cover. Alaska Volcano Observatory and Alaska Division of Geological & Geophysical Surveys crews work at site BAW above the Barry Arm landslide in Southeast Alaska. Photo: Malcolm Herstand, DGGS.

Back cover. DGGS geologist Marwan Wartes examines the contact between the Upper Cretaceous Seabee and Tuluvak Formations at Umiat Mountain. This outcrop is part of a series of intermittent exposures along the west bank of the Colville River that provide unique insight into important source rock and reservoir intervals that are targeted in exploration of the North Slope subsurface. Photo: Trystan Herriott.

MESSAGE FROM THE DIRECTOR

Greetings,

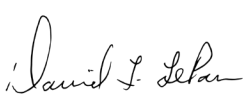
I stepped into the role of State Geologist in March 2022 after 20 years with the Division. During that time, I was aware of the wide range of projects pursued by its talented staff, but it has only been since entering into this position that I have truly come to appreciate the expansive scope of our work and its vital importance to the State of Alaska. The work ethic and creativity exhibited every day by Division geoscientists and GIS, IT, and administrative staff propels the survey forward to deliver outstanding, actionable science that promotes stewardship and prudent development of our natural resources, and a better understanding of the geologic hazards that threaten infrastructure and public safety.

2022 was another busy year for the Division and field activities marked a return to near-normal operations following the disruptions wrought by the COVID-19 pandemic. Division staff conducted field campaigns throughout the state, including the North Slope, eastern interior, western and southwestern Alaska, southeast Alaska, and the Aleutian Islands, responding to the needs of Alaskans for high-quality data on Alaska's geology-hosted natural resources and geologic hazards.

In August 2022 the University of Alaska Fairbanks hosted a Critical Minerals Summit, bringing together professionals from state and federal agencies, Native Corporations, the University of Alaska, and the mining industry, to discuss the urgent need to develop domestic sources of critical minerals and rare-earth elements for economic and national security reasons. Division geologists participated in this summit, outlining work underway by the Mineral Resources and Energy Resources sections to characterize the resource potential of Alaska's critical mineral belts and coal deposits, respectively. Work in Alaska's mineral belts is a collaborative effort with the U.S Geological Survey and is dramatically increasing the areas covered each year by airborne geophysics and bedrock geologic mapping. Work to characterize the critical mineral potential of Alaska's coal deposits, in cooperation with the University of Alaska Fairbanks and funded by the U.S. Department of Energy, is breaking new ground and could result in Alaska's vast coal deposits taking on new, strategic significance.

Numerous landslides, a dangerous rockslide in Skagway that impacted the cruise ship dock, a snow avalanche in Eagle River that came within feet of hitting a home, and a major storm in western Alaska kept Division staff in the various geologic hazards programs very busy. These events serve as reminders of the risks posed by Alaska's dynamic, mountainous, and geologically active landscape, and the storm-related flood hazards increasingly impacting long stretches of low-lying coastal areas where many communities are located.

The pages of this annual report summarize the Division's activities in 2022. I invite you to take some time to peruse it. I am impressed with and proud of Division staff and the important work they do for Alaska. I think you will be too. I encourage you to visit our website (dggs.alaska.gov) and look at the reports, maps, and data sets that we published in 2022. As always, do not hesitate to contact us if you wish to learn more about our programs or have questions about our work. We'd love to hear from you!



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State Geologist | Director, Alaska Division of Geological & Geophysical Surveys

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Geologist III (LTNP)

Geologist I

Geologist II/III

Geologist I

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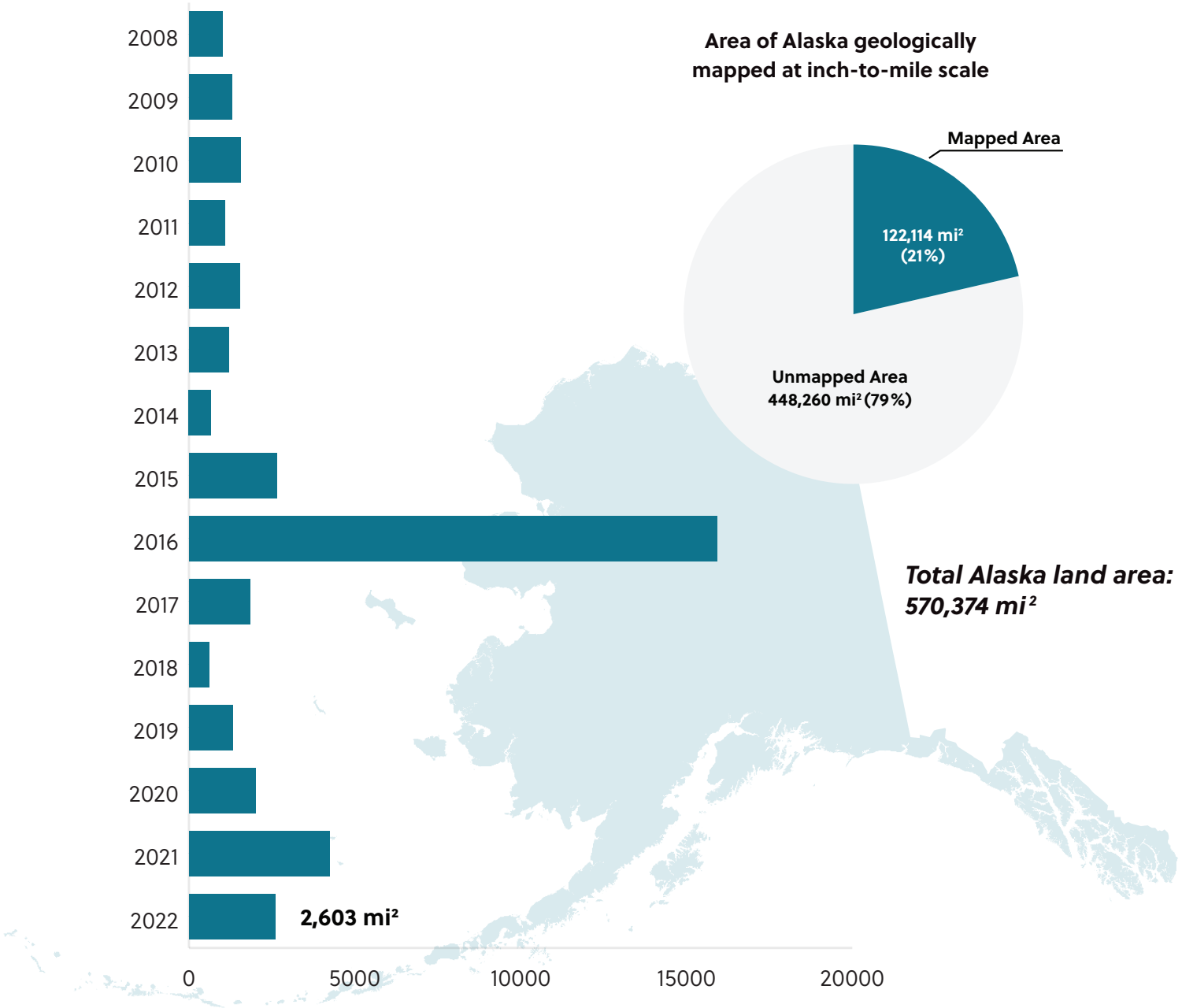
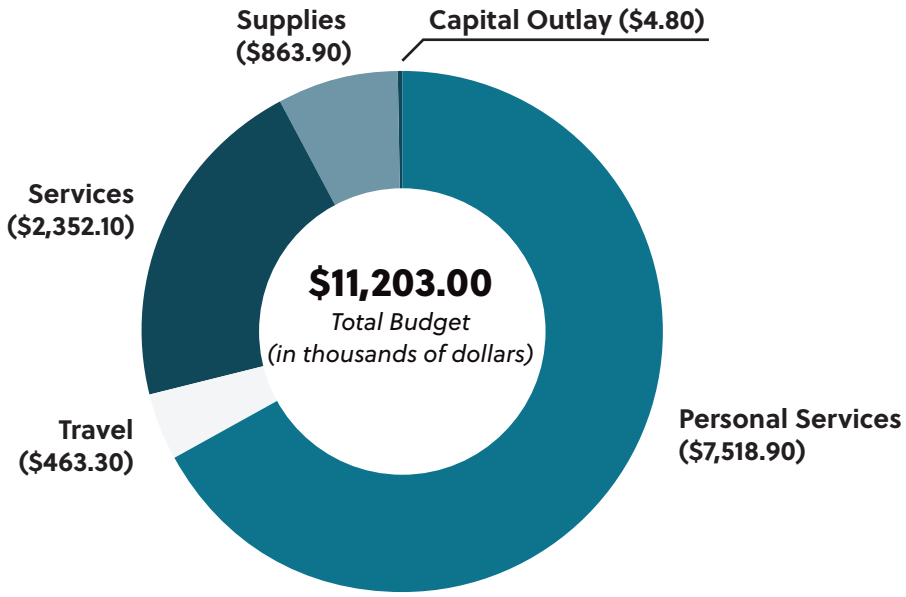
This is a vacant position

Geologic Mapping

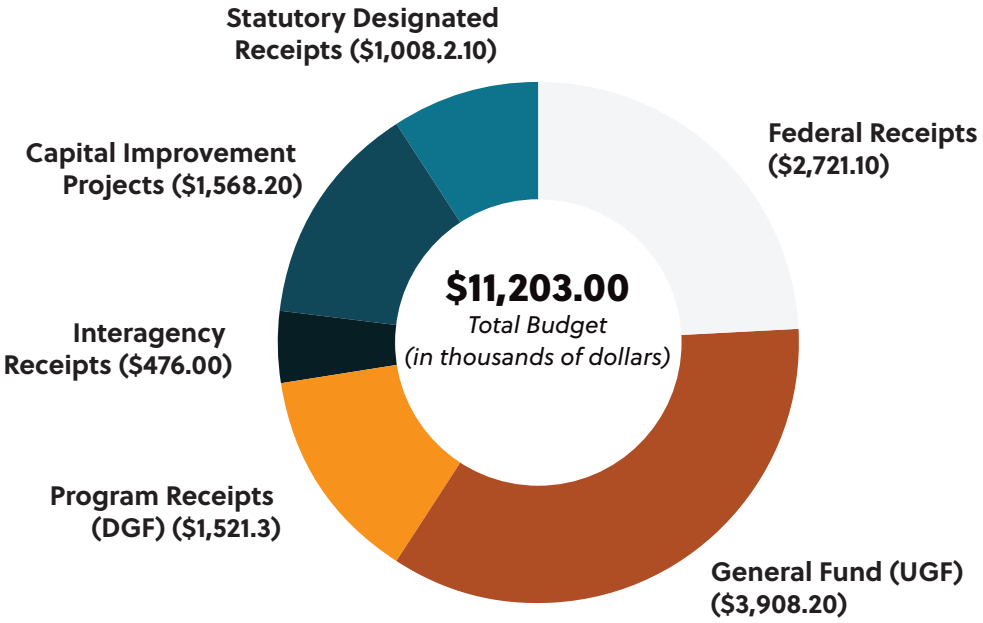
Detailed geological and geophysical maps of Alaska at scales needed for resource exploration, land-use management, and geologic-hazards assessment are currently available for only about 20 percent of the state, but our field programs are increasing this coverage gradually each year. DGGS prioritizes 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 FY2022 DGGS published **geologic mapping for a total of 2,603 mi²** of Alaskan lands. Over the past 10 years, **DGGS has published an annual average of 3,144 mi²** of peer-reviewed geologic mapping.



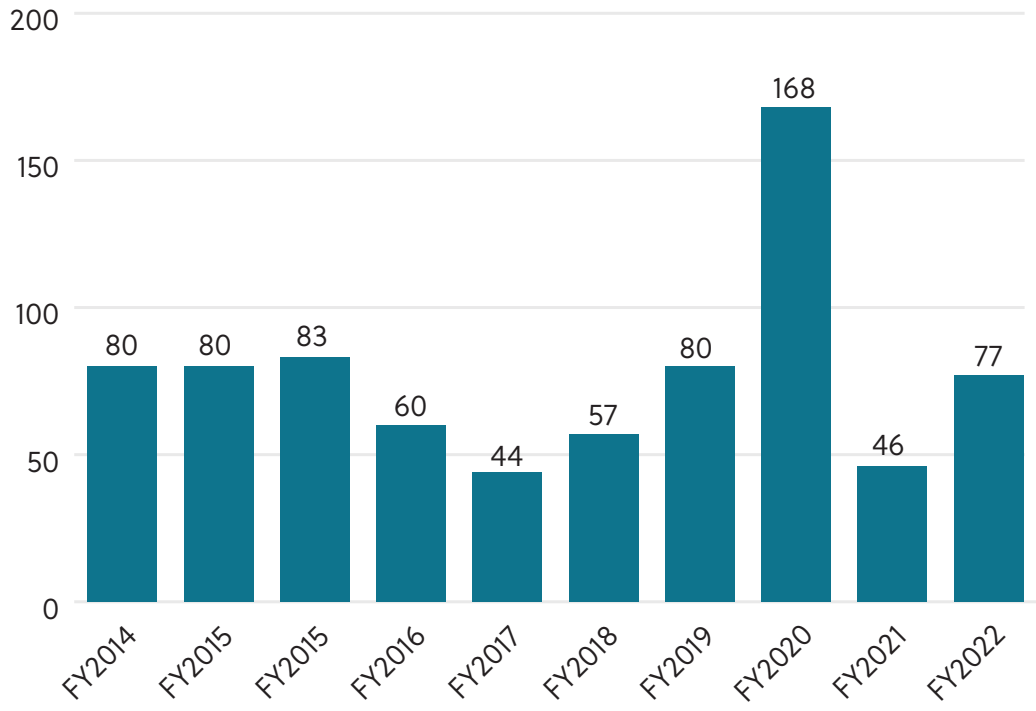
FY22 Authorized Budget



FY22 Funding Sources

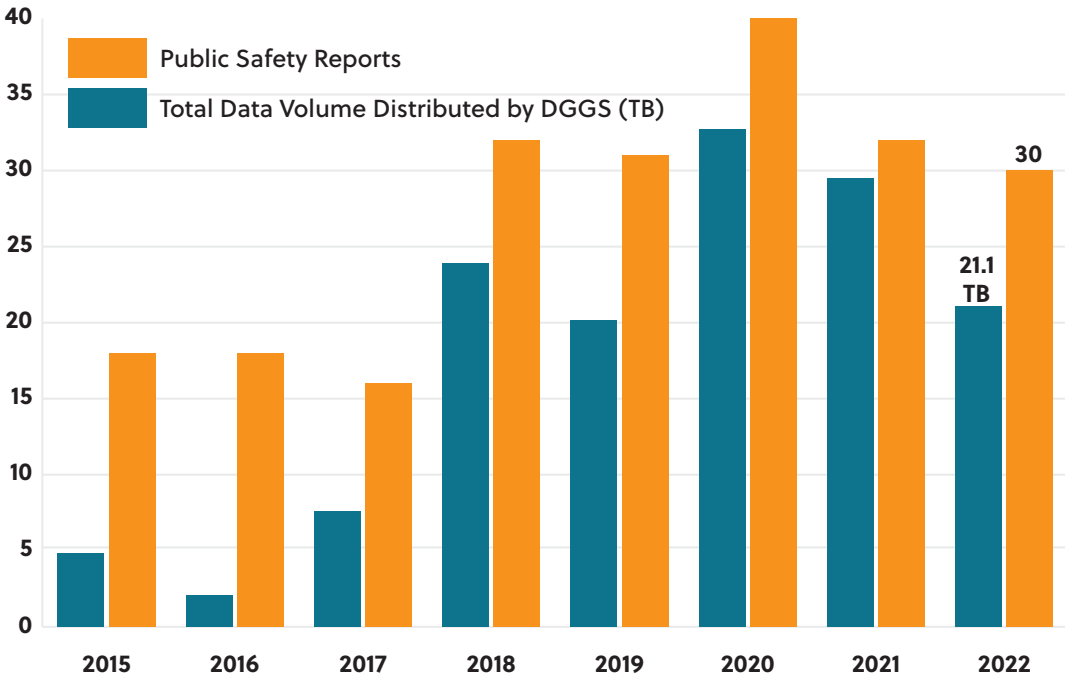


Published Reports



2022 included 45 GeMS-compliant conversions of previously published geologic maps. These time-consuming and essential projects are not included in the "official" publication numbers. For more information about these conversions, see the GIC section.

Data and Public Safety Reports Distributed



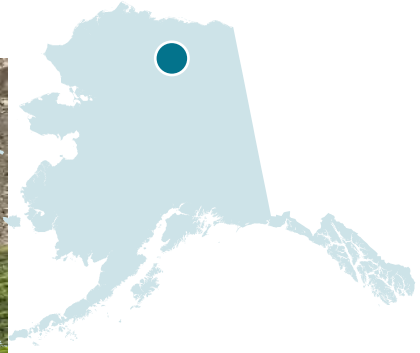
ENERGY RESOURCES

The Energy Resources Section generates new geologic information about Alaska'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) and other academic and government agencies to integrate outcrop and subsurface data in the analysis and interpretation of complex depositional and tectonic settings to better understand hydrocarbon systems.

FIELDWORK

Applied energy research on the North Slope is supported by the U.S. Geological Survey (USGS) STATEMAP program, the State of Alaska, and our long-running industry-supported Sponsor's Program. In June and July 2022, the DGGS team conducted 31 days of helicopter-supported fieldwork across northern Alaska, including the completion of a multi-season geologic mapping effort spanning more than 500 square miles on the central North Slope. Additional new mapping was begun along the front of the Philip Smith Mountains where unique exposures of the bottom of the Colville sedimentary basin are exposed. We also conducted a variety of topical studies to evaluate petroleum systems relevant to exploration on state lands, the National Petroleum Reserve-Alaska (NPRA), and the Arctic National Wildlife Refuge (ANWR). This work included the collection of several detailed measured sections of potential Cretaceous source rock and reservoir units, including the Nanushuk Formation, which is among the most prospective onshore exploration targets in North America.

The Energy Resources Section continues to modernize its field data collection and collaborated with the Geologic Information Center to hone digital field data capture methodology using tablet devices, including integration of varied software into the data collection workflow. With the help of colleagues at the Texas Bureau of Economic Geology, we collected numerous high-resolution *GigaPan* images and drone-based photogrammetry of important outcrops. These data aid in visualization and quantitative assessment of potential reservoir geometries; efforts are underway to distribute this digital data in a format that can be used by industry in their reservoir modeling.



DGGS geologists traverse across tundra to access outcrops of the Nanushuk Formation at Slope Mountain. This locality is a valuable analogue for recent major oil discoveries on the North Slope. Photo: Jada Parkinson.

Fieldwork was also conducted in the Matanuska Valley area as part of the section's evaluation of the hydrocarbon potential of frontier regions of the state. Reconnaissance mapping, stratigraphic observations, and strategic sampling of Cenozoic rocks is improving our understanding of the evolution of the nearby Susitna Basin, which shares many features with Cook Inlet and is prospective for oil and gas.

STRATIGRAPHIC TEST CORES

A major collaborative project with the USGS to drill stratigraphic test cores on the North Slope has been re-initiated. Planning and permitting efforts are underway to potentially collect two cores, strategically targeting important Brookian source and reservoir intervals. Aspects of this work are supported by the Arctic Strategic Transportation and Resources Project (ASTAR)—a multi-programmatic effort to strengthen North Slope community infrastructure and access to economic opportunities and resources (see the Engineering Geology Section for more information about the ASTAR Project).

UNCONVENTIONAL CRITICAL MINERALS

DGGS is co-leading an effort with the University of Alaska to assess Alaska's potential to provide critical minerals and rare earth elements from an unconventional feedstock, such as coal. These minerals are essential components in many modern products, yet the United States lacks sufficient domestic sources, resulting in economic and national security risks due to potential major supply-chain disruptions. This project is funded by the U.S. Department of Energy and includes a diverse team of private and Native partners. Work is underway to screen cores at the Geologic Materials Center in Anchorage with a hand-held X-Ray Fluorescence instrument for composition. An important goal of this project is the establishment of a critical minerals technology innovation center to help nurture the development of this key industry in Alaska. These efforts began in January 2022 with a well-attended stakeholder outreach meeting at the GMC in Anchorage that included participation from the Alaska delegation.

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. Important progress continues on creating a division-wide energy resources geodatabase that will eventually allow industry and the public to search for relevant geologic

Dramatic outcrop of folded lower Brookian rocks exposed in the northern foothills of the Brooks Range. This region is generally regarded as gas-prone, but we've discovered many indications of oil across the region, including notable petroliferous odor in parts of this outcrop. Photo: Trystan Herriott.

data throughout the North Slope, Cook Inlet, and other Alaska frontier basins.

The Energy Resources Section has a long record of applied research that draws attention to underexplored plays, such as the section's important work on the Nanushuk Formation on the North Slope. This unit is now the host reservoir for the largest onshore conventional oil discoveries in North America in more than 30 years. In recognition of DGGS' expertise, we were invited to submit a paper summarizing the controls on Nanushuk reservoir quality to a special issue of the international journal *Marine and Petroleum Geology* (www.sciencedirect.com/science/article/abs/pii/S0264817222003555).

Progress was also made on geologic maps, including the submission of a completed deliverable draft map and cross section for the Rooftop Ridge area on the central North Slope to the USGS for the STATEMAP program. This map includes a number of important outcrops of the Nanushuk Formation, some of which are lightly oil-stained. Final publication of this map awaits integration of seismic data in collaboration with USGS colleagues.

DGGS also co-chaired an oral and poster session on the geological evolution of northern Alaska at the annual meeting of the Geological Society of America. This gathering brought together diverse experts, included two presentations from DGGS, and resulted in fruitful discussions of the latest applied research on the geology of northern Alaska.

The section continued reconnaissance evaluations of non-producing frontier regions of the state. This ongoing work 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, Nenana, and Copper River basins. Recent results from this effort include a co-authored paper, published in the journal *Geosphere*, that analyzes sedimentary basins to better understand the tectonics of Southcentral Alaska. This type of work is building the framework needed to explore in areas with oil and gas potential but limited available subsurface data.

Finally, the team released important data for Cook Inlet, taking advantage of our expertise developed over many field seasons investigating the region. We published a major milestone Professional Report that highlights 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.

SELECTED ENERGY SECTION 2022 PUBLICATIONS

PIR 2022-1 | doi.org/10.14509/30871

Measured stratigraphic section, lower Nanushuk Formation (Albian), Slope Mountain (Marmot syncline), Alaska

PR 125 v. 1.1 | doi.org/10.14509/30554

$^{40}Ar/^{39}Ar$ and U-Pb geochronology of Cretaceous-Paleocene igneous rocks and Cenozoic strata of northwestern Cook Inlet, Alaska: Linkages between arc magmatism, cooling, faulting, and forearc subsidence

DGGS geologist Marwan Wartes taking notes on an outcrop of the Nanushuk Formation in northern Alaska. Observations and data from these exposures provide key clues to reservoir potential in the subsurface. Photo: Trystan Herriott.

GEOLOGIC MAPPING IS CHANGING HOW WE LOOK AT THE COOK INLET BASIN

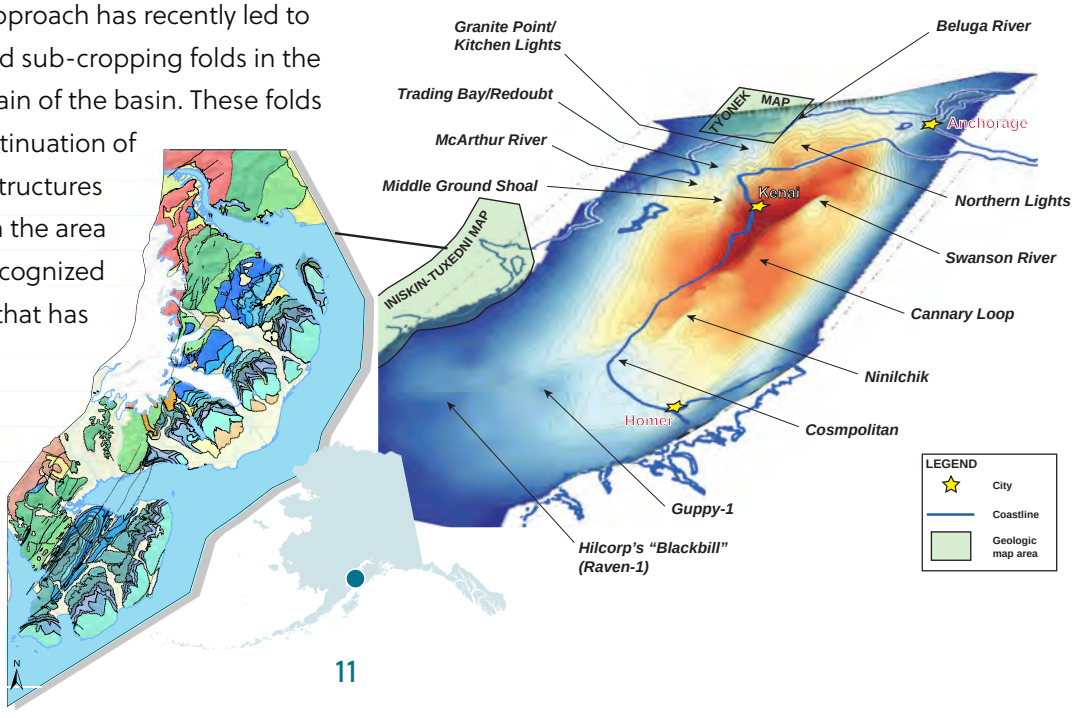
Cook Inlet basin natural gas is the principal energy source for Southcentral Alaska, having produced 8 trillion cubic feet since 1957. The DGGS Cook Inlet basin analysis program was implemented in 2006 to address deliverability shortfalls in natural gas projected to occur due to declining production. The program is a collaboration with the Alaska Division of Oil and Gas, USGS, University of Alaska Fairbanks, and other universities and aims to collect new geologic data to improve the understanding of the petroleum system. This information can spur exploration interest and ultimately increase hydrocarbon production.

Our holistic approach to studying the basin includes detailed stratigraphic investigations into petroleum reservoir and source rock deposition and has led to findings about the development of structural hydrocarbon traps, the age and evolution of basin formation, and petroleum system characteristics such as reservoir quality, organic richness, and hydrocarbon seal capacity of its rock units.

Geologic mapping allows us to bring all these pieces of information together into a single, coherent picture. To date, we have mapped over 1,700 square miles of geology along the western margin of the Cook Inlet basin where important components to the basin's petroleum systems are exposed in outcrops. Where possible, we use public and proprietary subsurface data to project the well-characterized outcrop trends into the producing subsurface. In the upper Cook Inlet, this approach has recently led to the first mapping of unexposed sub-cropping folds in the prospective western coastal plain of the basin. These folds appear to be the northern continuation of a system of major producing structures offshore. A concurrent study in the area has revealed a previously unrecognized transtensional structural style that has been masked by more recent contraction. Learning more about this area could be instrumental in predicting positions of locally thicker hydrocarbon reservoirs.

Geologic mapping in the lower Cook Inlet has revealed that a major fault defining the western basin margin loses offset toward the northeast. This observation is important because it has implications for how the basin deformed regionally and may shed light on the distribution of structural hydrocarbon traps and why they become larger to the northeast.

The geologic map of upper Cook Inlet and accompanying report are slated to be released in 2024 and a geologic map of lower Cook Inlet is anticipated to follow in 2025. These data products are some of the first of their kind to be released publicly for the Cook Inlet basin. Continued geologic field work will build on these recent findings, lead to important new insights about the basin's petroleum systems, and reduce future exploration risk. The characteristics that facilitated the accumulation of vast quantities of natural gas in the Cook Inlet basin also make it an excellent candidate for other types of storage, such as CO_2. As Cook Inlet oil and gas fields mature and deplete, data products and interpretations about the basin's hydrocarbon systems can be applied to understanding its storage potential as well.



Digital elevation model of the Cook Inlet basin with the sediment removed, revealing the basement structures that form the producing hydrocarbon traps. Also shown is a draft geologic map of the basin periphery that provide windows into hydrocarbon-producing regions in the basin subsurface.

MINERAL RESOURCES

DGGS conducts geological mapping and geochemical and geophysical surveys of the most prospective Alaska lands that are open for resource development to attract interest in mineral exploration and to support responsible development of Alaska's mineral endowment. Since 1993 the data products of the Airborne Geophysical/Geological Mineral Inventory (AGGMI) program have been an important component of successful resource exploration programs. DGGS 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.

DGGS performs Alaska's portion of the critical-minerals-focused Earth Mapping Resources Initiative (Earth MRI), 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, allows DGGS Mineral Resources geologists to create and disseminate geophysical and geological map products. These types of products have historically 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 (began in 2019) funded at greater than $10 million per year. The USGS received an additional 5-year $70 million annual increase through the Infrastructure Investment and Jobs Act (IIJA) bill. In federal FY2022, Alaska received $6.75 million in federal funds under this program.

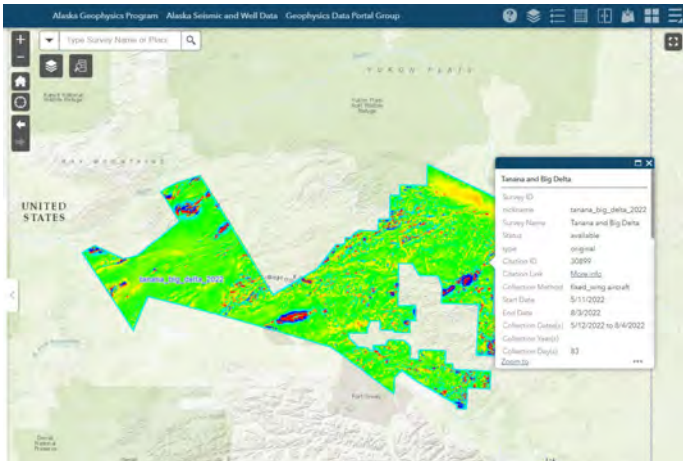
DGGS geologist Rainer Newberry at work in the field. Photo. Dave Szumigala, DGGS.

GEOPHYSICAL SURVEYING

From May 14 to August 4, 2022, DGGS collected new data for the Tanana River and Big Delta airborne magnetic and radiometric geophysical survey (doi.org/10.14509/30899). Funded by the USGS Earth MRI program, this survey covers parts of the Big Delta, Charley River, Circle, Eagle, Fairbanks, Kantishna River, Livengood, Mount Hayes, and Tanacross quadrangles near Fairbanks and Delta Junction, Alaska.

These data will be used for improving the understanding of the geology and mineral potential, promoting resource exploration, and be a part of the continuous regional magnetic data coverage of the Yukon Tanana Uplands.

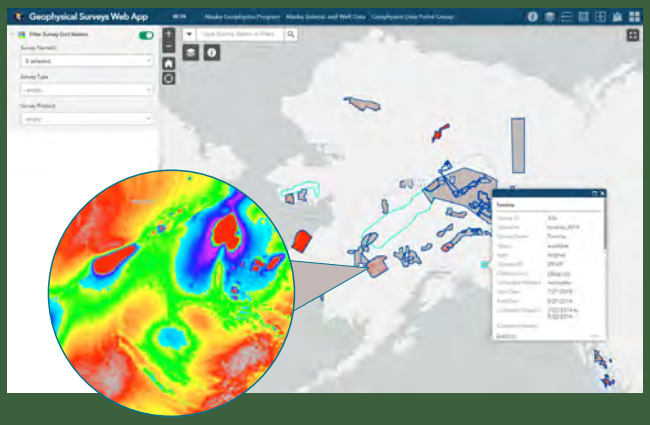
SCAN TO READ MORE:
GPR 2022-1
TANANA RIVER AND BIG DELTA AIRBORNE MAGNETIC AND RADIOMETRIC SURVEY



NEW IN 2022

Geophysics Web App

A new, interactive web map to explore geophysical survey distribution, availability, and data.



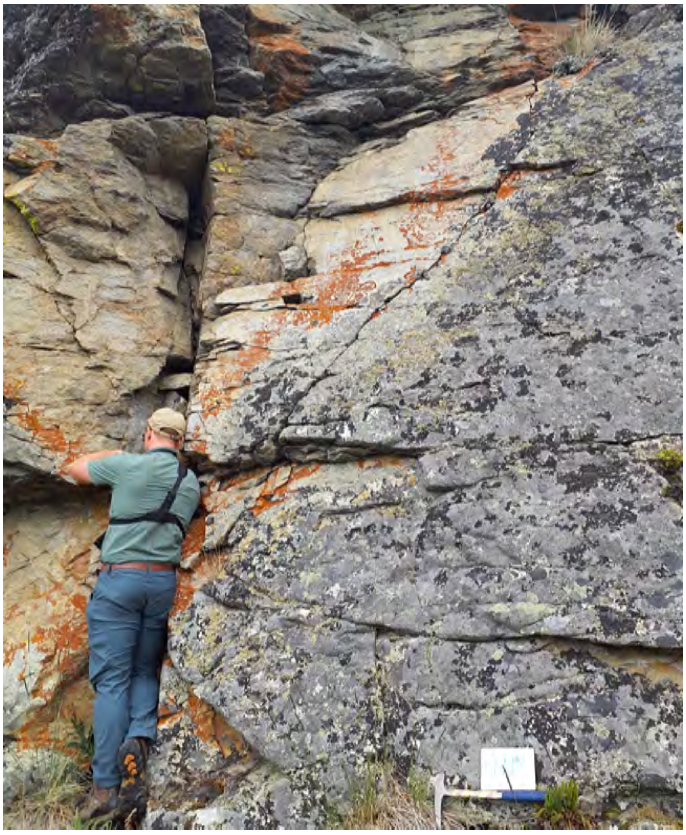
maps.dggs.alaska.gov/gp

GEOLOGIC MAPPING

During 2022, DGGS Mineral Resources geologists mounted their largest geologic mapping campaign in recent memory, fielding 12 geologists for 460 person-days of work in June, July, and August. The expanded mapping program is part of an ongoing effort to complete detailed mapping of the mineral-rich Yukon-Tanana Upland and was funded by the base budget, supplemental IIJA appropriations to the USGS for the Earth MRI program, and a State of Alaska CIP. The 2022 field program finalized two mapping projects began in 2021, both of which will be published in spring 2023. Geologists also began work on a 3,100-square-mile area north of Delta Junction. The 2022 Mount Harper geologic map area lies just south of Pogo mine and includes the Naosi, Mon, and LMS gold deposits, the Healy, Eagle, and Democrat gold prospects, and the Mount Harper area tungsten and molybdenum prospects. Mapping for this project area will be finalized in 2023 and published in 2024.

As part of the Earth MRI program, DGGS selected ~4,000 historical USGS stream-sediment pulps from across the Yukon-Tanana Upland for re-analysis with modern techniques, including a full suite of elements. The published data is available for download through the USGS website: doi.org/10.5066/P9WHRLXH; DGGS website: maps.dggs.alaska.gov/geochem; and for viewing through the DGGS Exploration Geochemistry Web App: dggs.alaska.gov/maps-data/interactive-maps.html.

DGGS geologist Travis Naibert on traverse in the Mount Harper area.



DGGS intern and UAF graduate student David Harvey measures structure in the Mount Harper area.

ALASKA MINERAL INDUSTRY REPORT

The Mineral Resources Section is in the process of finalizing Alaska's Mineral Industry 2021, 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.

COMPILING A GEOLOGIC MAP OF ALASKA

One of DGGS' long-term goals is to create a seamless 1:100,000-scale geologic map of the state. Mapping at this scale (level of detail) optimizes the detail needed by researchers and resource developers while allowing geologic mappers to cover a reasonable area each year. Although about 80 percent of the state remains unmapped at this scale, DGGS is laying the groundwork for a statewide map compilation by standardizing digital geologic data from new and legacy mapping and making it accessible from a single database. By January 2023, DGGS will have published approximately 52 maps in the new standard (see the Geologic Information Center section for more information). Also in January, DGGS will finalize an initial compilation project in the Yukon–Tanana Uplands, designed to begin development of a dynamic process that geologist compilers can harness to iteratively build a statewide compilation map with unified geologic unit descriptions and connecting unit boundaries.

Mineral Resources Section 2022 Publications

GEOLOGIC MAPS

RDF 2022-11 | doi.org/10.14509/30884

Bedrock geologic map of the eastern Moran area, Tanana B-6 and C-6 quadrangles, Alaska

PIR 2022-2 | doi.org/10.14509/30891

Bedrock geologic map of the northern Fairbanks mining district, Circle Quadrangle, Alaska

RI 2020-3 | doi.org/10.14509/30424

Geologic map of the Styx River area, Lime Hills C-1 Quadrangle, Western Alaska Range, Alaska

YUKON-TANANA UPLAND DATA

RDF 2022-2 | doi.org/10.14509/30837

Field station locations and magnetic susceptibility data collected in 2021 for the Taylor Mountain project, Tanacross and Eagle quadrangles, Alaska

RDF 2022-3 | doi.org/10.14509/30838

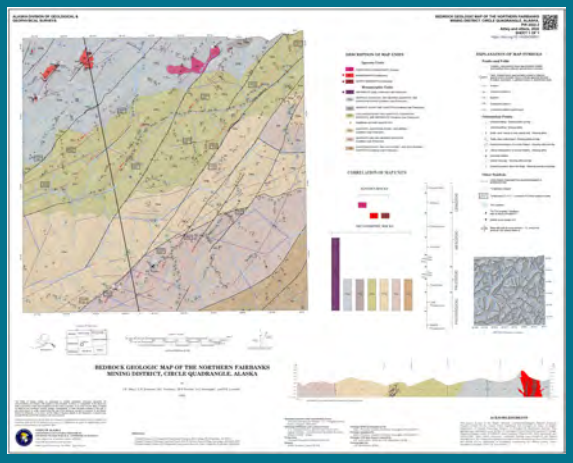
Field station locations and magnetic susceptibility data collected in 2020 and 2021 for the Western Tanacross project, Tanacross and Eagle quadrangles, Alaska

RDF 2022-4 | doi.org/10.14509/30843

Geochemical data from samples collected in 2021 for the Taylor Mountain project, Tanacross and Eagle quadrangles, Alaska

RDF 2022-5 | doi.org/10.14509/30844

Geochemical data from samples collected in 2020 and 2021 for the Western Tanacross project, Tanacross Quadrangle, Alaska



PIR 2022-2, a bedrock geologic map of the northern Fairbanks mining district, is an example of a GeMS-compliant map published in 2022. Read the whole report: doi.org/10.14509/30891.

DGGS intern and UAF student Serena Fessenden collects a sample in the Mount Harper area. Photo. Dave Szumigala, DGGS.

GEOLOGIC HEALTH HAZARDS

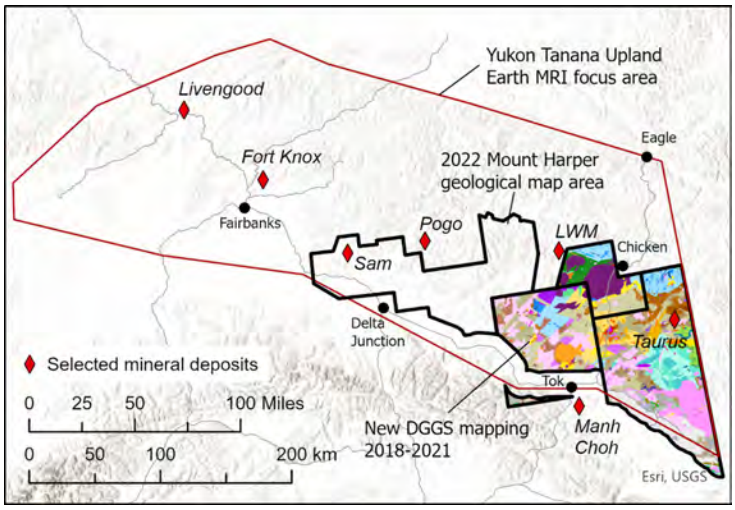
2ND ANNUAL RADON POSTER CONTEST WINNER

Naturally occurring, radioactive radon gas is the leading cause of lung cancer among non-smokers and accounts for 21,000 deaths in the United States per year. Radon is an under-recognized health risk in the state. DGGS runs the Alaska Radon Program in cooperation with the University of Alaska Fairbanks Cooperative Extension Service. Federal Environmental Protection Agency (EPA) funding for this work through the State Indoor Radon Grant comes to DGGS from the Alaska Department of Environmental Conservation's Division of Air Quality. Alaska's radon program provides education and outreach about radon to the public and organizations related to housing and health, as well as free radon testing for homes. The program distributed 665 free test kits to Alaskans in FY2022 and educated, reached, or contacted an estimated 36,534 residents through events, press releases, and social media.

Poor groundwater quality in Alaska affects many homes and neighborhoods with private wells. With EPA funding, DGGS is collecting groundwater quality data and creating statewide maps of natural contaminants like arsenic and nitrate. The project will also develop online tools to help the public better understand the water quality data they receive from the laboratory and to visualize natural contaminant distribution around the state. The first tool "Be Well Informed" created through this project is now available to the public at bewellinformed.info. DGGS also provides geologic expertise to other Alaska agencies that respond to or regulate water quality issues.

Minerals Resources Section geologists completed 460 person-days of fieldwork during the summer months of 2022, much of it helicopter-supported.

MAPPING THE YUKON TANANA UPLAND



Alaska's Yukon-Tanana Upland (YTU), the region in the Interior between the Tanana and Yukon rivers, is a vital center for Alaska's mining industry. The region's rich historical placer mines and currently operating large hard-rock mines have produced 24 million ounces of gold; an additional 32 million ounces have been discovered but not yet mined. Gold in the region may have brought mining to the Interior and founded Alaska's second-largest city, Fairbanks, but the YTU also has high potential for **critical minerals—high-tech metals essential to modern life and often sourced from outside the United States. These include tin, tungsten, antimony, bismuth, tellurium, rhenium, and rare earth elements.**

While the YTU is resource-rich, it's geology is still not well understood. Prior to 2019, large areas had only widely spaced, pre-GPS geophysical surveying, "reconnaissance" geologic mapping with insufficient levels of detail to guide geologists, and numerous "semi-quantitative" geochemical analyses with no measurements of many important critical minerals.

At the direction of DGGS' Geologic Mapping Advisory Board, the Mineral Resources Section has been upgrading these three key geoscience datasets (geophysical data, geologic mapping, and geochemical analyses) for the YTU through the USGS's Earth MRI project. When Alaska received an influx of additional Bipartisan Infrastructure Law funding through Earth MRI, DGGS geologists rose to the challenge by mapping larger areas without sacrificing data quality; **the 2022 program logged 460 person-days in the field, a 44 percent increase over the 2021 program**.

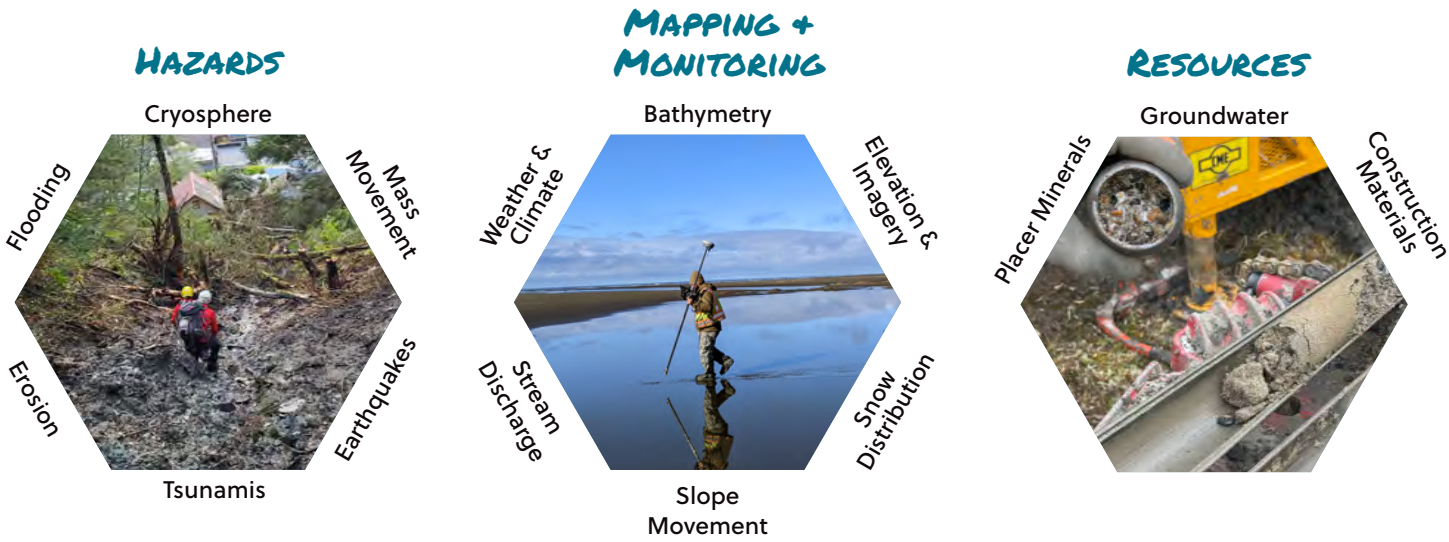
DGGS also marked an important milestone in 2022 when it completed airborne magnetic coverage of the YTU. When the geological and geochemical datasets are completed for the region, scientists and exploration companies will have modern, detailed, and internally consistent geoscience datasets from which to understand the mineral-resource potential and make new mineral discoveries in Interior Alaska.

Background. DGGS geologist Michelle Gavel on traverse in the Mount Harper area. Inset. DGGS geologist Alec Wildland digs to find bedrock in the Delta Junction area. Photo. Evan Twelker, DGGS.

ENGINEERING GEOLOGY

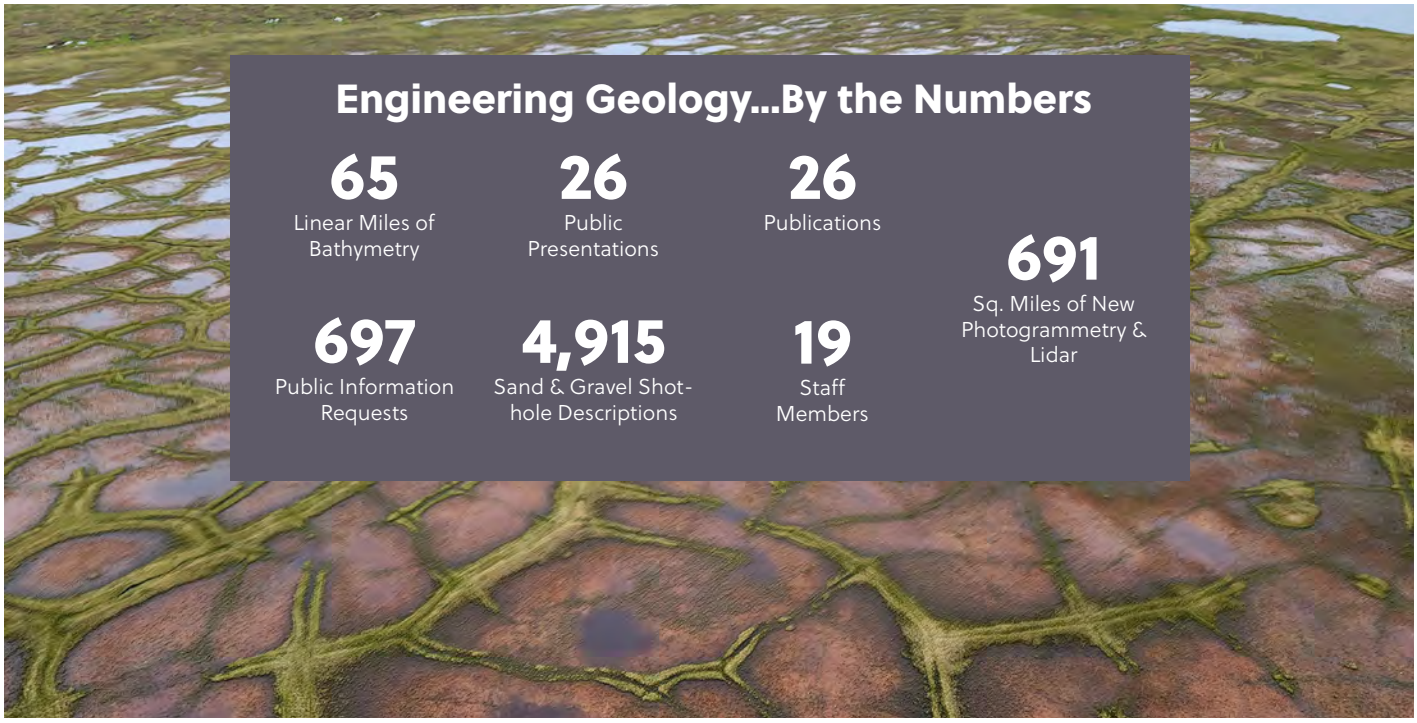
The Engineering Geology Section works to understand the engineering considerations of geologic materials, hydrology, and geologic hazards for society. Engineering geologists identify where geologic processes are most likely to have an adverse impact on humans and the structures we build and assure that the geological factors relevant to the location, design, construction, operation, and maintenance of engineering works are recognized and accounted for.

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 hazard mitigation planning for natural hazards and disastrous events. We develop baseline data, monitoring systems, and provide maps or tools to assist in these efforts.



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

Going forward, the Engineering Geology Section is splitting its functions into two new sections to better accomplish our statutory mission: a Hydrology & Surficial Geology Section emphasizing water resources, construction materials resources, and surficial-geologic mapping, and a Geologic Hazards Section focusing on geologic processes threatening lives and infrastructure.



MAPPING WITH LIDAR

The Engineering Geology Section continues to implement the power of lidar (light detection and ranging) elevation mapping in response to strategic mapping priorities across the state. Our system can collect many square miles of centimeter-accurate airborne survey information in just a few hours of flying. The entire section relies on high resolution elevation data, often over multiple time epochs, to assess geologic hazards and interpret landscape features.

This year we collected 100 square miles of lidar on the North Slope to support hydrological assessments for water resources and road planning and conducted two surveys totaling more than 100 square miles in the Haines Borough for landslide hazard mapping. An additional 100 square miles of snow-on lidar were collected at Cordova for snow avalanche modeling and will be paired with bare earth lidar to be collected in summer 2023 for landslide hazard assessment. In partnership with the U.S. Forest Service, we also collected 117 square miles of elevation data in the Twentymile watershed near Girdwood for trail planning and management and geologic hazards assessment. Multiple small, focused surveys were completed for landslide and snow avalanche hazard assessments in Southcentral and Southeast Alaska, including the Barry Arm unstable slope in Prince William Sound, Columbia Glacier, Portage Glacier, Grewingk Glacier, Turnagain Arm, Seward Highway, Turnagain Pass, and the Juneau and Whittier areas.

DGGS scientist Ronnie Daanen collects ground control points for a lidar survey during 2022.

CONSTRUCTION MATERIALS

This year, construction materials mapping continues to focus on the North Slope as part of the Arctic Strategic Transportation and Resources Project (ASTAR) Sand and Gravel Resource Assessment to support communities and stakeholders by providing information about sand and gravel resources. We met with community and regional stakeholders and gave presentations to the North Slope Borough, several communities, and regional and local native organizations to update them on our progress. An important project objective is to provide information that supports community needs and infrastructure opportunities and enhances the quality of life in the region. This starts by communicating with the people who live there to understand their needs.

After almost three years of work, in 2022 we completed a database of seismic shot-holes that will make near-surface and subsurface geologic data from more than 26,000 sites within the National Petroleum Reserve–Alaska (NPR–A) easily accessible (see ASTAR highlight article for details). We also collaborated with the Alaska Department of Transportation and Public Facilities (AKDOT&PF) and contractors to conduct a month-long field season. Our objective was to fill in data gaps in sand and gravel resource information and collect additional field data to inform resource potential that would support a proposed road connecting the communities of Atqasuk, Wainwright, and Utqiagvik. We visited more than 110 sites where we made observations of outcrops and surface landforms and used a small power auger to drill holes 10–15 ft deep. We described and characterized surface and near-subsurface materials and collected samples for more detailed description and analysis post-field season. AKDOT&PF was able to drill 24 holes 30–50 ft deep using a helicopter-supported drill rig. They completed a geotechnical report on this work late in 2022, including drill hole logs, analysis, and recommendations. We will use data from this report in our regional sand and gravel resource analysis.

During ASTAR project fieldwork, we visited 241 field sites and collected 153 samples between Wainwright, Atqasuk, Utqiagvik, and Nuiqsut. We continued to work on populating databases with geologic information and descriptions and anticipate that these will be published early in 2023. The database containing sample descriptions includes links to photos of the individual samples described.

The shothhole data and field data are essential components for achieving ASTAR project goals and objectives. These data are not only vital for regional sand and gravel resource analysis, but provide critical baseline data for planning, analysis, and any potential development.

A helicopter-supported drill rig was used during fieldwork by partner agency AKDOT&PF to collect surface and near-surface samples as part of the ASTAR project.

DGGS geologists made observations and collected samples from more than 110 sites on the North Slope.

ARCTIC STRATEGIC TRANSPORTATION AND RESOURCES PROJECT (ASTAR) SHOT-HOLE DATA

In 2022, DGGS completed a digital database of seismic shot-hole samples as part of ASTAR project. The database compilation makes lithologic descriptions, shallow subsurface information, and photos of sediment samples and field drill cards from more than 26,162 sites within the National Petroleum Reserve–Alaska (NPR–A) readily accessible without requiring a visit to the Geologic Materials Center (GMC) in Anchorage.

While conducting seismic surveys between 1944 and 1982 in NPR–A, the U.S. Geological Survey drilled ~98,753 holes along more than 12,000 miles of seismic lines to emplace charges. Field drill cards and samples collected between 1970 and 1981 at ~35,650 drilling locations are stored at the GMC. The GMC does not have samples at every shot-hole drill site location and multiple boxes were sometimes necessary to store all samples collected along a seismic line, making it challenging to find an individual shot-hole sample and develop an inventory.

Location of seismic shot-lines and shot-hole samples contained within the database.

DGGS staff entered information written on sample boxes, sample bags, and drill cards into a Microsoft Access database to facilitate easier public access to the data and make a more complete and accurate inventory. In addition, staff entered information about the material type and character because drill cards with that information were sometimes missing or inconsistent with the archived samples. A photo of the sediment sample and drill card, if present, was taken and later uploaded to the DGGS photo database. Data were then exported to a GIS database so users can access the data in tabular form and see the relationship between shot-lines and shot-holes. DGGS used the shot-hole data to help identify data gaps and plan fieldwork in 2019, 2021, and 2022. The data will be a critical component in an overall North Slope sand and gravel resource assessment report.

DGGS staff entering data from shot-hole samples into the Microsoft Access database at the GMC. Screenshot of the Microsoft Access database showing information collected by project staff.

The completed shot-hole database includes geotechnical information, scans of field drill cards, and links to photos of selected samples. Our database is a subset of the entire shot-hole collection. We focused on areas closer to communities and existing or potential infrastructure to support the ASTAR initiative to prioritize community needs and infrastructure opportunities that offer the most cumulative benefit and best enhance the quality of life for the North Slope region. Now in digital format, and expected to be formally published in 2023, this large and important dataset has been revitalized and is more easily accessible to communities and other stakeholders.

HYDROLOGY

The DGGS Hydrology Program has been working on a wide range of water-related projects, from landslides to permafrost degradation and road construction. These projects contribute to understanding hydrological effects on hazards, construction effects on flooding, and the impacts of permafrost loss on groundwater behavior, which will change future stream, river runoff, and flooding behavior.

The program is building the capacity to observe changes in groundwater behavior in steep terrain and is actively working to understand the causes of landslides in the Barry Arm and Haines areas. The deadly 2020 Beach Road landslide in Haines exposed a gap in long-term weather observation that is critical to assess the severity of weather conditions on the landscape. DGGS operates a real-time-reporting weather station in Haines to help monitor conditions that may lead to severe landslide hazard potential. We are also coordinating with the Landslide Program to take in new data streams and data storage from a subsurface monitoring network installed by contractors at the Haines Beach Road landslide. The program is helping the U.S. Geological Survey and other partners study landslide dynamics at Barry Arm by installing and maintaining a weather station network. We have also added 17 new hydrology observation stations in the understudied region of the Northwest Arctic as a part of the ASTAR road corridor studies.

The program has many ongoing projects to assess permafrost across northern Alaska. With funding from the National Science Foundation (NSF), we assisted in hydrological studies of ice-rich Arctic tundra soils near Prudhoe Bay and Point Hope. During spring 2022, we collected snow surface elevation data for the project using high-density lidar over an area directly north of the airport in Deadhorse. The very high-resolution elevation datasets collected in 2021 and 2022 provide valuable information on the snow accumulation in the area, which will help the University of Alaska study the relationship between snow depth, vegetation, and ice wedge degradation and aggradation. We have National Science Foundation funding to use WaSiM, a hydrologic model, for the project to assess the consequences of ice-wedge degradation on future hydrological conditions. Alyeska Pipeline Service Company funded a second year of study of Frozen Debris Lobe A (FDL-A), a slow-moving ice, soil, and rock mass that forced the state to move the Dalton Highway and threatens the Trans-Alaska Pipeline System. We are participating in ongoing efforts to better define movement characteristics of FDL-A by drilling two boreholes and installing soil movement sensors, as well as continuously monitoring existing sensors.

Left. A helicopter transports equipment necessary to collect hydrology data on the North Slope. **Right.** DGGS hydrologist Ronnie Daanen installs soil temperature sensors on the North Slope as part of the ASTAR project.

CLIMATE & CRYOSPHERE

A researcher measures snow water equivalent on Orca Mountain outside of Girdwood.

The Climate and Cryosphere Hazards Program works with a diverse group of partners and local stakeholders to assess, monitor, and predict the impacts of a changing cryosphere on communities, infrastructure, and resources in Alaska. In 2022 we continued to facilitate and conduct actionable science in snow distribution, snow avalanche, and glacier- and permafrost-related hazards research.

During the winter of 2022, the program continued snow distribution and snow avalanche research; conducting fieldwork, including aerial lidar surveys in multiple locations in Southcentral and Southeast Alaska; and working with partners from Alaska Railroad Corporation, UAF, Alaska Energy Light & Power, AKDOT&PF, and Alaska Department of Fish and Game. In February and March, we used aerial lidar techniques to map the dangerously unstable snowpack along the Seward Highway near Girdwood and gathered metrics on natural and artificially generated (mitigation) snow avalanches following storm events. These metrics help to validate the program's regional-scale snow avalanche simulation and mapping data and improve the efficacy of mitigation efforts by Alaska Railroad Corporation and AKDOT&PF.

In 2022, the Climate and Cryosphere Hazards Program continued small- and large-scale snow avalanche modeling and mapping. We began a new study with partners from the Swiss Institute for Snow and Avalanche Research and the UAF Climate Adaptation Science Center to evaluate future changes in snow avalanches in southeast Alaska. In October, we finalized a two-year study in partnership with the Alaska Railroad Corporation assessing the placement of proposed remote avalanche control systems using lidar-derived snow maps and dynamic avalanche modeling.

The Community Snow Observations project continues to deliver critical snowpack information to scientists and managers. This year, with the help from crowd sourcing, we gathered more snow observations in Alaska and logged more observations for the project than ever before and developed the first near-real-time operational snow distribution product in Alaska (see mountainsnow.org).

Changes in glaciers and mountain permafrost continue to be important topics for Alaska. We continue to monitor glacier-dammed lakes and glacial lake outburst floods in several locations in the state. In 2022, the program continued to participate in the multi-agency effort to characterize, assess, and monitor the Barry Arm landslide (see landslides section). The Climate and Cryosphere Hazards Program continues to work with partners on several other glacier-related landslide hazards in Alaska, including Grewingk Glacier, Portage Glacier, Maynard Mountain, Serpentine Glacier, and Columbia Glacier.

Barry Arm fjord is located in Southeast Alaska

COASTAL FLOODING & EROSION

DGGS geologist Autumn Poisson collects coastal data in Kwigillingok.

The DGGS Coastal Hazards Program works collaboratively with state, federal, tribal, academic, public, and private institutions to map, monitor, and model flood and erosion hazards in Alaska's coastal communities. We provide technical guidance and decision-making tools to local and state leaders working to plan for, mitigate, and adapt to hazardous conditions in the coastal zone. In 2019, the Denali Commission found that 187 communities are impacted by one or more of the environmental threats of flooding, erosion, and permafrost degradation, yet minimal data and reporting are available to those communities.

To aid in this work, the program develops community-specific hazard exposure assessments and has ongoing erosion and flood monitoring programs in collaboration with communities. We are currently focusing on two types of publication, covering erosion and flooding, to help communities understand exposure to these hazards. With funding from the National Coastal Resilience Fund in partnership with the Alaska Native Tribal Health Consortium, flood reports are currently being made available for many communities to aid in flood exposure mapping (dggs.alaska.gov/pubs/id/30573). The program continues erosion monitoring in communities with the assistance of community members using measuring tape and measurement rods along with time lapse cameras. In 2022, monitoring sites were installed in Saint Michael and Chefornak and baseline data were collected in several communities including, Kwigillingok, Kipnuk, Saint Michael, Stebbins, and Chefornak.

The Coastal Hazards Program helps coordinate the Alaska Water Level Watch through support from the Alaska Ocean Observing System, which monitors flood events using photographic evidence of storms as well as through a real-time water level sensor network (water-level-watch.portal.aoos.org). This year we installed and/or repaired sensors in Kivalina, Kotzebue, Kwigillingok, Kipnuk, Homer, and Tununak. These water level sensors help close the gaps in the National Water Level Observation Network within Alaska.

Alaska remains on the forefront of national initiatives to map our shoreline and the nearshore. Our efforts provide the opportunity to fill major data gaps for Alaska communities facing flood, erosion, and permafrost threats. This fall, western Alaska experienced the impacts from Extra-Tropical Cyclone Merbok (see Alaska Geospatial Office highlight), which energized a large-scale group data collection effort in the most impacted communities. This event helped promote additional data collection in communities and established working connections that will continue long after the storm has passed

DGGS geologist Zachary Siemsen walks past a fish hut in Kwigillingok while on a field trip to collect coastal data.

EARTHQUAKES & TSUNAMIS

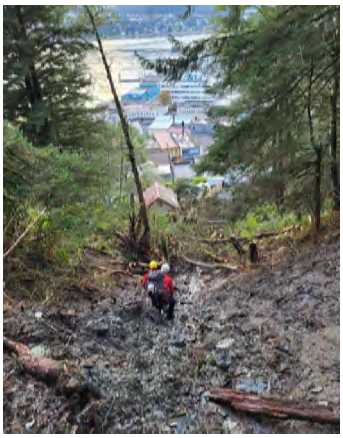
The Earthquake and Tsunami Hazards Program at DGGS is focused on reducing the impact of future earthquakes and earthquake-induced geohazards such as tsunami events and slope failures. A major component of this effort involves working directly with Alaskans—emergency management, law enforcement, community officials, and residents—to help them become more resilient in the face of ever-present geohazards through education, planning, mitigation, and response. Fundamental to resilience is hazard assessment, and DGGS continues to assess relative seismic and tsunami hazards posed to communities, statewide infrastructure, and planned future projects and collaborates on the state, federal, and international level to advance understanding of neotectonics (active faulting) in Alaska and to increase seismic resilience in the Arctic and Subarctic in the face of a changing climate.

DGGS administers the Alaska Seismic Hazards Safety Commission (ASHSC; seismic.alaska.gov). Earthquake and Tsunami Hazards Program manager Barrett Salisbury represents DNR and is the current Chair of the commission—a diverse panel of professionals that provides information to the public after significant earthquakes, promotes public education and legislative policy to reduce the state's vulnerability to earthquakes, and amplifies results of earthquake engineering resilience studies in Alaska. This year the commission received National Earthquake Hazard Reduction Program funds to begin a multi-year effort to improve seismic building code adoption and enforcement in Alaska.

DGGS manages the DNR portion of the federally funded National Tsunami Hazard Mitigation Program, increasing earthquake and tsunami hazard awareness across the state. Working closely with the University of Alaska Geophysical Institute, this year DGGS published or updated inundation maps and reports depicting areas that could be affected by future potential tsunami events at Karluk, Larsen Bay, Seward, Cordova, Seldovia, and Pasagshak (dggs.alaska.gov/pubs/tsunami). DGGS also works with the Division of Homeland Security and Emergency Management, and this year conducted two Tsunami Operations Workshops for representatives from 27 Aleutian Islands and Bristol Bay communities.

Top. Earthquake and Tsunami Hazards Program manager Barrett Salisbury engages with community members and stakeholders in Hope to discuss tsunami hazards.
Left. Tsunami inundation maps for Karluk (shown) and Larsen Bay, Alaska were published in 2022. Read the full report on our website: doi.org/10.14509/30892.

LANDSLIDES



DGGS geologist Mort Larsen responded to the Gastineau Ave. mass wasting event in Juneau in late September, 2022.

After hiring two full-time geologists in 2022, DGGS' Alaska Landslide Hazards Program (ALHP) is now fully functional and no longer relies exclusively on borrowing geologists from other programs. Although workflows are still being developed, goals of the ALHP include creating an inventory of known landslides in the state, improving our working knowledge of concepts and considerations for areas affected by steep terrain and unstable slopes, assessing the potential risk from landslide hazards, providing expertise and guidance during a landslide/mass wasting event (see the landslide response highlight article for events to which DGGS staff responded this year), and developing a network of weather stations that may be used as part of early warning systems.

The program works closely with federal entities and others within DGGS on both new and ongoing projects to evaluate unstable slopes across Alaska. Funding from a Cooperative Agreement with the USGS is an integral part of the Barry Arm and Prince William Sound monitoring and research program. With funding from the Federal Emergency Management Agency (FEMA), we are generating landslide susceptibility maps for the Haines Borough, which was impacted by unprecedented rainfall and landslides in late 2020. These maps will assist Haines with slope stability assessment and decision making regarding future development. The processes developed for this project will be used as a template for future analyses in other high-risk communities in the state, and the geodatabase will serve as a starting point for the statewide Alaska Landslide Inventory. We have laid the groundwork for a DGGS landslide inventory that will be integrated with the U.S. Landslide Inventory database. The Alaska Landslide Inventory will incorporate on-going and previous landslide studies and will provide landslide information to the public through an on-line interactive map and data portal.

Highlight

Landslide Hazards Program – Landslide Response

The ALHP has an array of funded projects and initiatives to support its mission to map and assess landslides, understand and quantify landslide hazards, and improve geologic hazard communication and coordination with other agencies and communities.

The Engineering Geology Section responded to multiple landslides in 2022 that impacted communities or major infrastructure, and we continued to research the Barry Arm unstable slope and the greater Prince William Sound area in collaboration with the USGS. The ALHP is devoted to improving and developing long-term relationships and collaborations with agencies and communities that are affected by landslides. Read on to learn more about the work we did in 2022.

Barry Arm landslide monitoring is a multi-agency collaborative effort. Regular, informative updates are available on our website: dggs.alaska.gov/hazards/barry-arm-landslide.

Barry Arm Unstable Slope

DGGS and USGS, together with the National Tsunami Warning Center and the Alaska Earthquake Center, continue robust research on the Barry Arm landslide—a major, potentially tsunamigenic slope in the Barry Arm fjord. The multi-agency effort focuses on improving our understanding of the controls and potential effects of landslide movement through field-base and remote sensing observations, including repeat aerial lidar and satellite- and ground-based synthetic aperture radar acquisition and analysis, passive seismic and acoustic sensing, surveying, and detailed geologic mapping. In 2022, monitoring in Barry Arm showed an acceleration in landslide movement that began in late August and returned to normal background levels by early November. The Barry Arm unstable slope remains a hazard to recreationalists, marine traffic, infrastructure, and important natural and cultural resources in the northwestern Prince William Sound and DGGS remains committed to the ongoing interagency efforts on behalf of Alaskans.

Seward—Lowell Point Road Landslide

The City of Seward and Kenai Peninsula Borough (KPB) requested assistance from DGGS through the State Emergency Operations Center (SEOC) to evaluate the safety and stability of the Lowell Point Road landslide that occurred on May 7, 2022, on the flank of Bear Mountain south of Seward. Response activities included early and ongoing consultation and advisement to the City of Seward, analysis of drone photography and video footage, deployment of a geoscientist for ground investigations, and analysis of lidar elevation data. An estimated 40,000 cubic yards of debris slid down the mountain and blocked the road to Lowell Point from Seward. This landslide was unusual because we can rule out the most typical landslide triggers, including prolonged or heavy rainfall and shaking from an earthquake. There was a rapid increase in temperature in the timeframe leading up to May 7 with the highest temperatures of the year thus far occurring on the day of the landslide. Rapid snowmelt, melting of ice-filled fractures in the rocks, and day-night temperature changes are potential causative factors. No injuries were reported. Governor Mike Dunleavy issued a State Disaster Declaration on May 13. KPB provided water taxi service to the Lowell Point community and workers during the road closure. The road was re-opened to the public on June 10.

Skagway—Cruise Ship Dock Rockslide

On August 24, 2022, DGGS geologists met with Municipality of Skagway (MOS) officials, Skagway Traditional Council representatives, private stakeholders, geotechnical engineers, and colleagues from AKDOT&PF and DHS&EM to examine and discuss rock instabilities that are an ongoing threat to the Skagway White Pass & Yukon Route Railway dock. The "North Slide" has been active for many years, but a new "South Slide" occurred on June 23, 2022, wherein large boulders were released and landed on the dock, damaging the deck and causing minor damage to the Discovery Princess cruise ship. No injuries were reported. Several rockslides impacted the dock and it was closed for the rest of the summer. MOS hired a geotechnical firm to develop and execute mitigation strategies for slope stabilization. Governor Mike Dunleavy declared a disaster emergency for Skagway in response to the rockslides.

Denali Village—Denali Education Center/Yanert Road Landslide

On August 31, 2022, DGGS geologists met with personnel from the Denali Education Center, the National Park Service, and AKDOT&PF for a site visit and discussion of a landslide that occurred on August 14 that was partially blocking an access road to the Denali Education Center. The ground failure likely started mid-slope where groundwater pressure pushed out of the slope face at the contact between porous river gravel and underlying fine-grained lake mud. There is a known natural spring at the site of the slide and the amount of water exiting the slope was elevated at the time of the landslide and in the days afterward. Headward erosion of the slope occurred via slumping of the loose gravel layer. Continued activity is likely to eventually undercut the road. AKDOT&PF completed a geophysical survey along Yanert Road to locate the depth of groundwater and frozen ground. This road is intended as an emergency egress from the crowded village during the summer tourist season. Currently, there is discussion regarding future activities, ongoing issues, recommendations, and mitigation responsibilities.

Juneau—Gastineau Avenue Mass Wasting Event

On September 26, 2022, a mass-wasting event occurred on Gastineau Avenue in Juneau that damaged three homes, knocked out power, and cut off road access. No injuries were reported. A DGGS geologist arrived on site where he met with Capital City Fire Rescue and City Borough of Juneau officials to assess the situation, discuss site conditions, and evaluate the stability of the slope. The event was a shallow, channelized landslide that scoured down to bedrock with very little soil and bedrock involved, mostly large woody debris and trees. Significant rainfall over a short period of time, high winds coupled with the steep terrain, and a thin soil mantle over bedrock were contributing factors for the slope failure.

Landslide Emergency Response Team

Recognizing the critical responsibility we have to provide science response to landslide disasters, the ALHP is investing in the future by developing a more structured and formal DGGS Landslide Emergency Response Team (LERT). The purpose of LERT is to provide rapid aid and services to communities impacted by landslide events. LERT members will fill specific roles, duties, and responsibilities, and ensure proper emergency communication and coordination in the event of a damaging or deadly landslide. LERT scientists will have specialized experience and draw from a wide range of expertise including field-based geologic hazard mapping, lidar interpretation and modeling, landslide susceptibility analysis, slope stability assessment, surface and groundwater modeling, remote sensing, and earthquake hazards.

Impacts of the Gastineau Ave. mass wasting event in Juneau in late September, 2022.

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 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 about impending hazardous volcanic activity.

Volcanic hazard information is communicated to local, state, and federal officials through formal interagency operation plans, and to the public through volcano alert messages (volcanoes.usgs.gov/vns), social media, and AVO's website (www.avo.alaska.edu). In addition, a weekly radio program (AVO Radio) summarizing volcanic activity in Alaska, is currently airing on 10 public radio stations across the state.

AVO field operations with Cleveland Volcano in background. Photo: Malcolm Herstand.

FIELDWORK AND EQUIPMENT MAINTENANCE

The Volcanology Section works with our AVO partners to maintain a robust network of volcano monitoring instrumentation across the Aleutian Arc. Monitoring instruments include seismometers, infrasound arrays, GPS instruments, web cameras, and power systems to support the incoming data and digital telemetry. The 2022 season marked the completion of AVO's four-year plan to upgrade all monitoring sites from analog to digital instrumentation (see A2D highlight). The A2D mission was completed with the upgrade of networks at Aniakchak and Veniaminof volcanoes and at the MREP repeater within the Makushin Volcano network. In addition to the completion of A2D, Edgecumbe volcano in Southeast Alaska received its first seismic monitoring station, and new webcams were installed at Aniakchak, Veniaminof, Pavlof, and Cleveland volcanoes. AVO receiver facilities in Amchitka, Port Heiden, Perryville, and Nikolski were also repaired, overhauled, and upgraded. A joint ship-based program between AVO and Lamont-Doherty Earth Observatory at Columbia University installed new monitoring and receiver equipment at sites on Cleveland and Okmok volcanoes. Routine and critical maintenance were also carried out on sites in Cook Inlet, on Unimak Island, and at Katmai Group and Pavlof volcanoes.

Wyatt Mayo installs a seismometer at MREP station at Makushin volcano. Photo: Taryn Lopez.

GEODIVA

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.

Malcolm Herstand works on station maintenance at Makushin's station EIDR. Photo: Taryn Lopez.

MAPPING

Volcanology Section geologists are working on a variety of research projects to advance understanding of active volcanic systems. Geologic maps of Okmok and Shishaldin volcano are presently en route to publication and are expected to be released in 2023. Digitizing and re-publishing previously published geologic maps of Alaska volcanoes, including Edgecumbe volcano, and GIS conversions to the new State (and National) Geologic Mapping System (GeMS) standards are also in-process. See the Geologic Information Center section for more information about GeMS conversions.

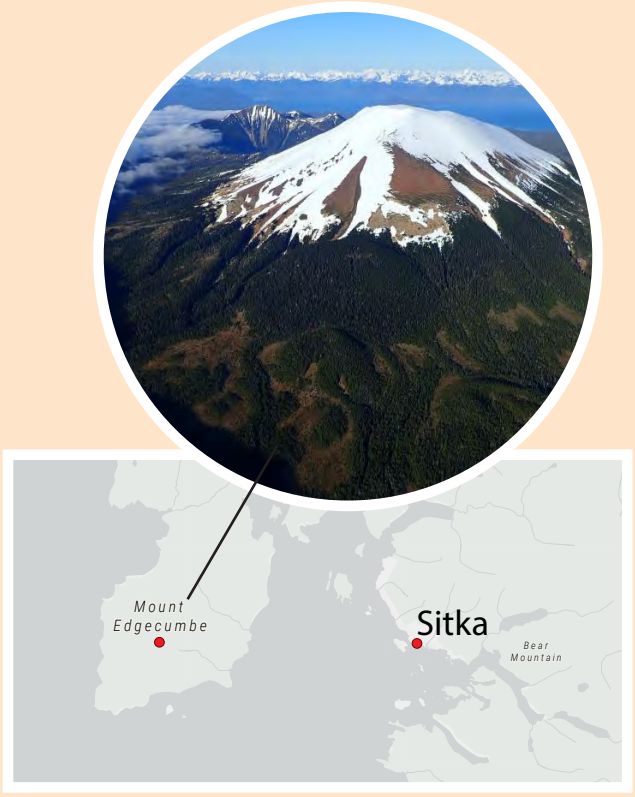
AVO ANNUAL SUMMARIES

As part AVO, 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 avo.alaska.edu/downloads/classresults.php?pregen=annsum.

MT. EDGECUMBE RESPONSE

AVO geologists responded to an earthquake swarm first detected April 11, 2022, at Mt. Edgecumbe, west of Sitka, Alaska. Subsequent modeling and researching suggested the earthquakes and ground deformation were caused by movement of magma rather than tectonic activity. This type of movement does not always lead to volcanic eruptions, and any eruption would likely be preceded by additional signals. Volcanologists traveled to Sitka for information and learning sessions with local residents during the spring, and monitoring equipment was installed at Mt. Edgecumbe over the summer.

AVO-DGGS geologist Cheryl Cameron visited Sitka to engage with community members following unrest at Mt. Edgecumbe.



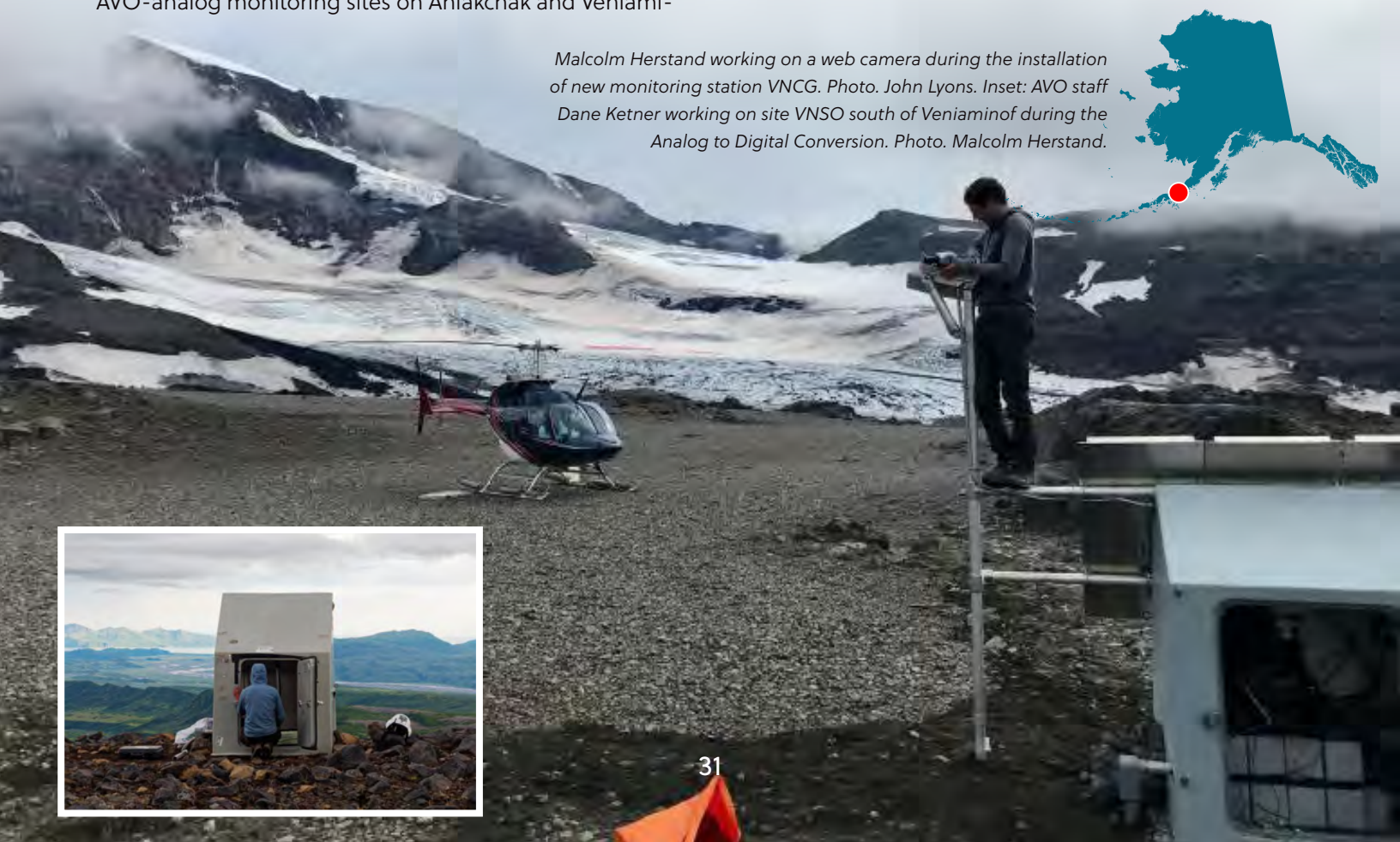
ANALOG-TO-DIGITAL CONVERSION COMPLETE!

The 2022 field season marks the completion of the Analog-to-Digital (A2D) project, a critical four-year project by the Volcanology Section and the Alaska Volcano Observatory (AVO). The project's primary objective was to install a robust system of digital data collection monitoring instruments, providing AVO scientists with advanced warning of volcanic activity in Alaska. These data allow AVO to properly warn the public of impending volcanic hazards and dangerous drifting ash clouds. The digital conversion has improved data quality, because digital data telemetry is less susceptible to external noise sources than analog telemetry, facilitating more accurate and timely forecasts of volcanic eruptions to protect life and property. In addition, the analog to digital telemetry conversion has brought AVO volcano monitoring instruments in compliance with National Telecommunications and Information Administration (NTIA) radio spectrum guidelines.

Initially designed as a three-year program, the A2D project was funded by a Cooperative Agreement between the USGS and its AVO partners DGGS and the University of Alaska-Fairbanks (UAF). The COVID-19 pandemic caused delays and huge logistical hurdles, necessitating a fourth year to complete the A2D. During AVO's 2022 field season, we completed the conversion and upgrade of the last AVO-analog monitoring sites on Aniakchak and Veniaminof volcanoes on the Alaska Peninsula, and at a receiver facility near Makushin Volcano on Unalaska Island.

Field operations were supported by both A-star and Bell 206-L4 helicopters and by a fully crewed marine vessel. The vessel was complete with heli-deck, the capacity to store more than 7,000 gallons of Jet-A fuel, berths for up to 12 AVO crew and a crane for on- and off-loading equipment. The A2D project utilized close to 300 days each of helicopter and marine vessel charters. Ninety-five monitoring stations were upgraded from analog to digital at 34 volcanoes, infrasound arrays were added to many sites as a new monitoring tool, radio repeaters were upgraded and added, and multiple new webcams were installed. The effort involved many tens of tons of equipment shipped, and hundreds of people hours that included not just field-time but planning, logistics (contracting, procuring, shipping), inventories and safety-monitoring hours as well, representing the work of more than 30 AVO and AVO collaborators.

The A2D project was a massive effort by a well-coordinated and efficient team that included DGGS Volcanology staff at the forefront. All tasks were successfully accomplished despite inclement weather, a pandemic, complex logistics and supply-chain delays.



Malcolm Herstand working on a web camera during the installation of new monitoring station VNCG. Photo. John Lyons. Inset: AVO staff Dane Ketner working on site VNSO south of Veniaminof during the Analog to Digital Conversion. Photo. Malcolm Herstand.

GEOLOGIC INFORMATION CENTER

The Geologic Information Center (GIC) provides publication, geographic information systems (GIS), and information technology support services that provide access to the geologic information related to Alaska's vast resources and support for geologic hazard response. The GIC's ability to publish, host, and distribute large volumes of data maintains collaborations with federal and other state organizations, minimizing duplication of effort and cost. The wide range of published services helps to better inform land management decisions and encourage investment, exploration, and development of the state's resources, resulting in a beneficial fiscal impact to Alaska's economy, worth billions of dollars.

The quality of DGGS' Alaska geological database, the quality and scale of maps, and the ease of access was rated number one in the Nation by the recently released Fraser Institute's 2021 Annual Survey of Mining Companies.

This year the GIC facilitated the publication of 50 new geologic reports, maps, and datasets, including 700 square miles of new geologic mapping. We served over 25 Terabytes of digital geologic data and information from the DGGS website (dggs.alaska.gov) and geoportals. The GIC also manages DGGS' public outreach efforts, which include 4,500 followers on Twitter, 530 subscribers to the division's news feed, over 1,700 followers on its Facebook page, and responding to hundreds of in-person, phone, and email information requests.

To continue to provide critical cutting edge support to a growing division, the GIC will be adding a number of new positions in 2023. As our GeMS Geologic Map production increases so does the need for a dedicated Quality Assurance position. As a result, we will be hiring a GIS Analyst 2 as part of a USGS grant. We have also identified a gap in programming capability to support all the requirements in DGGS. To begin addressing this issue, we will be hiring a Programmer/Analyst 3 to support a newly funded renewable energy program as well as provide much need programming support. In addition, we are hiring a Programmer/Analyst 2/3 at the Geologic Materials Center in Anchorage to support their new multispectral scanner project. We look forward to introducing the sure-to-be highly qualified and dedicated professionals filling these critical roles in next year's annual report.

GIC AT WORK

PUBLICATION STAFF

(Sue Seitz, Simone Montayne, and Kristen Janssen)

Always working hard at a diverse set of core tasks to ensure that:

- Our publication database is up to date
- Our website provides easy access to the division's vast array of geologic information
- All published data includes robust metadata
- Field and safety equipment is properly maintained and distributed to field crews
- The publications workflow and approval process runs smoothly
- Public outreach efforts are managed effectively
- Illustration support for publications is available

IT STAFF

(Christopher Ramey, Oralee Nudson, and Tom Cerny)

Build, manage, and maintain the critical IT infrastructure required by everyone at DGGS. Some of their core tasks include:

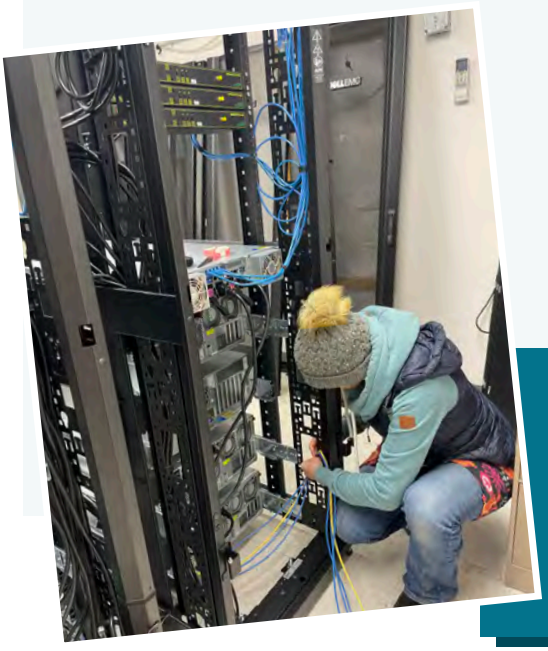
- Maintaining fast and reliable network capability
- Server design, operation, maintenance, and monitoring
- Database development and maintenance
- Software development, maintenance, and support
- Backup and disaster recovery planning
- New hardware and software support and documentation
- Desktop computer and printer support
- Coordinating with State of Alaska Office of Information Technology

GIS STAFF

(Mike Hendricks, Amy MacPherson, and Pedro Rivera)

The GIS group provides a number of core tasks:

- GIS and cartographic technical support and information dissemination
- GIS training and support that includes weekly GIS Tips and Tricks classes
- GIS administration of DGGS geoportals
- Geoportal web app development
- Technical support for AK GeMS single- and multi-map development and production
- Quality control/quality assurance for AK GeMS production
- Technical oversight of the Alaska elevation and imagery data storage and distribution



THROUGH ALL THEIR HARD WORK AND EXPERTISE, THE ENTIRE STAFF WITHIN THE GIC PLAY AN INTEGRAL ROLE IN DGGS BY PROVIDING ACCESS TO VALUABLE GEOLOGIC INFORMATION THAT HIGHLIGHTS ALASKA'S RESOURCES AND HAZARDS.

A LOOK INSIDE PUBLICATIONS

RI 2022-5 is just one example of the many products published in 2022.

The GIC oversees the publication and distribution of DGGS' numerous maps, reports, and data releases. Publications include everything from handouts on the dangers of radon to technical reports on coastal erosion and geologic maps. At any given time, there are dozens of publications in the works, each of which require different review and editorial needs, depending on the publication series. Numerous hours of review, layout, GIS work, editing, and metadata writing go into each, and that does not count the time authors spend conducting fieldwork, preparing and analyzing data, and writing the reports! GIC staff are continually looking for ways to improve the efficiency of our publication process to ensure data releases are timely, while maintaining rigorous scientific standards. Some of our recent implementations include drafting and improving templates for authors to use for frequently published data release types, writing scripts to easily compile metadata, and hosting teaching sessions on illustration and cartography so authors can confidently create their own figures and maps.

GIC staff created an online dashboard in DGGS' geoportal to track publications through the multi-step review process, as well as keep track of regularly requested publication statistics.

SELECTED GIC 2022 PRESENTATIONS

Poster presented at AGS
doi.org/10.14509/30864

Alaska DGGS geologic mapping system

Presentation given at DMT2022
doi.org/10.14509/30872

AK DGGS' hardware solution for collaborative field data collection

Presentation given at DMT2022
doi.org/10.14509/30890

Contracting out geologic map digitization and attribution using the GeMS standard

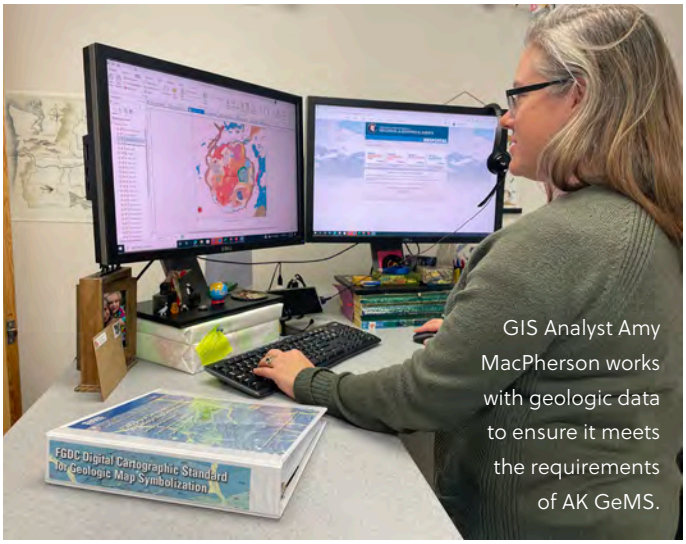
FIELD COMMUNICATION AND SAFETY

Fieldwork is the heart of DGGS' 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 50 staff and up to five distinct projects engaged in simultaneous fieldwork. In addition to providing equipment support for this year's fieldwork, GIC leads an annual collaborative review of the division's Field Operation Safety Manual and field safety outcomes.

The Alaska Geologic Mapping System

GIC staff critical to developing and maintaining DGGS' AK Geologic Mapping System, which produces standards-based, GeMS-compliant geologic maps and data for publication. The system controls the process of collecting, producing, converting, packaging, publishing, and sharing geologic map data and includes hardware, GIS software, data standards (Geologic Mapping Schema—GeMS), and well-defined organizational procedures that includes a 16-phase workflow to ensure high quality products are created and shared. Over 50 standards-based geologic map databases have been created and shared through this system with an expected 50 more to be published within the next two years.

This highly efficient mapping system is based on two primary published standards: AK GeMS Symbology: A description of the AK GeMS Style File (doi.org/10.14509/30584) and AK GeMS Data Dictionary: A description of the AK GeMS database schema (doi.org/10.14509/30669). Our AK GeMS standard extends the USGS' GeMS basic standard by placing greater focus on modeling geologic features and adds advanced capabilities. AK GeMS supports our single-map production processes while also allowing for multiple maps in a modern enterprise relational database. With our AK GeMS standard in place, we have increased our ability to efficiently create, store, and distribute meaningful geologic data for visualization and analysis. GIS staff are working with DGGS geologists to publish and implement version 2.0 of these standards in 2023.

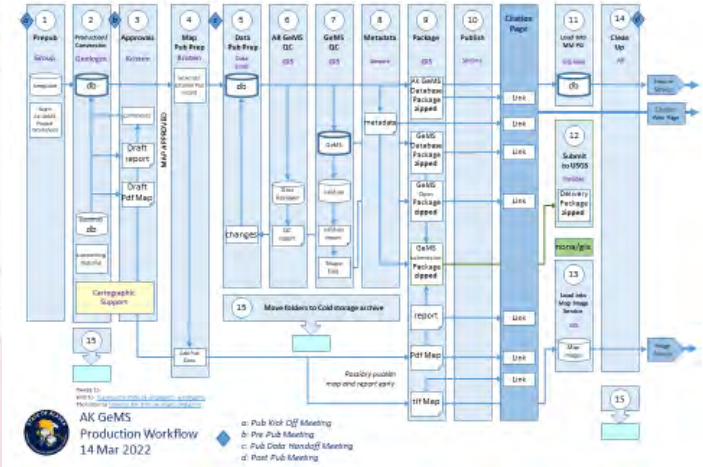


GIS Analyst Amy MacPherson works with geologic data to ensure it meets the requirements of AK GeMS.

Another critical component of this successful system is our comprehensive AK GeMS Production Workflow and Task List that illustrates production phases and includes a detailed task and responsibilities list. Using this workflow, GIC staff efficiently perform data quality control checks, metadata creation, data packaging, and distribution of published data.

GIC staff also developed and implemented a comprehensive, semi-automated quality control process that has dramatically improved data quality. Building on this success, we are leveraging support offered though our ESRI advantage program to modernize our quality assurance/quality control (QA/QC) processes and data schema, which we plan on integrating into our updated standards.

GIC staff, specifically Pedro Rivera, work on our multi-map geodatabase and development of multi-map services and web apps. We continue to update scripts automating the ingestion of single-map AK GeMS databases into our multi-map database schema, and have added more than 40 map databases into our multi-map PostgreSQL database. This past year we developed a robust AK GeMS MM DB Architecture that supports replications of data to increase speed and security. This upcoming year we plan to work on symbolizing and creating web services of this data as well as developing a web app for public viewing.



The GeMS workflow includes several steps to ensure each release distributes meaningful and accurate geologic data.

THE DGGS GEOPORTALS – EASY ACCESS TO DATA AND APPS

Over the years GIC personnel have built and now maintain a suite of geoportals where we host and share hundreds of geologic, elevation, and imagery datasets as well as interactive web apps for both the public and Alaska decision makers. These geoportals allow users to share, discover, and access geologic data, maps, and interactive applications and is part of the State of Alaska Spatial Data Infrastructure managed by the Alaska Geospatial Office.

DGGS Geoportal

The GIC staff has worked hard increasing the quality and quantity of data and web apps on the division's geoportal (geoportal.dggs.dnr.alaska.gov). Amy Macpherson expertly functions as our geoportal primary administrator, working hard to add numerous improvements as well as increasing integration with the Alaska DNR ArcGIS Online Portal and the State of Alaska Hub site (gis.data.alaska.gov). We also conducted a successful GIS Architecture review with ESRI technical experts; our geoportal's capability to efficiently host and share geologic data is greatly improved.

NEW content!

Alaska Geophysical Surveys Web App
Allows users to view boundaries and additional information, filter, and view raster grid products from published DGGS geophysical surveys.

maps.dggs.alaska.gov/gp

Exploration Geochemistry Web App
Presents a visualization of the elements of economic interest for Alaska stream sediment samples.

maps.dggs.alaska.gov/geochem

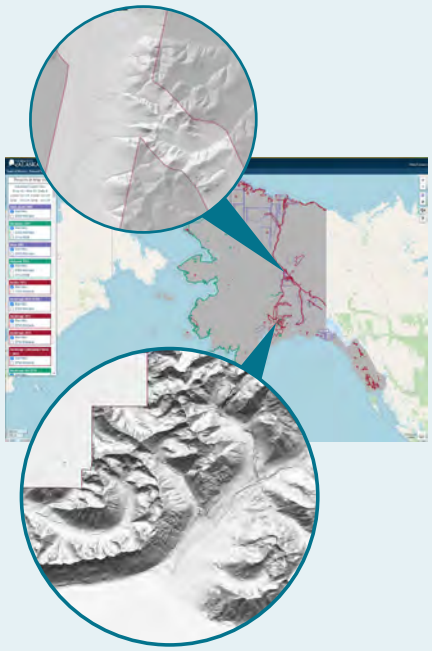
DGGS Field Geoportals

The GIC's IT and GIS staff worked to provide DGGS geologists upgraded capabilities for long-term, multi-user field GIS data collection in areas without internet access. We developed a set of rugged, mobile field geoportals that run an installation of ArcGIS Enterprise on a lightweight mobile server that can be disconnected and transported to remote field camps. These field portals allow geologists to use mobile data collection apps such as ESRI's Collector or Field Maps and upload, share, review, and backup their daily work while operating in remote locations anywhere in Alaska. DGGS can also deploy these field portals for hazard response events and still collect, combine, and analyze data even if internet connectively is not available.

DGGS intern David Harvey uses a mobile tablet to collect data and record observations in the field.

Alaska Elevation Portal

The GIC continues to work in partnership with the Alaska Geospatial Office to consolidate public domain elevation data for the state. Roughly, 11 TBs of point cloud, raster elevation models, and ortho-rectified imagery data is downloadable from our web app at elevation.alaska.gov. Additional data can be accessed from more than two hundred image services on our geoportal.



elevation.alaska.gov

IT SUPPORT

The GIC's IT staff provides critical infrastructure and support to the Division's geologists, scientists, and engineers. Our team of highly skilled IT professionals provide effective, timely, and low-cost solutions to address a host of complex problems. They work closely and directly with domain experts, rapidly respond to issues, and develop cost-effective storage and processing solutions that support DGGS and many others throughout the state.

The DGGS website (dggs.alaska.gov) is an integral component in meeting our mission. This mission includes providing not only timely and accurate data related to Alaska's natural resources, but also for the systematic collection, evaluation, archiving, and distribution of geologic hazards data. The importance of this shared resource can be seen by the fact that our website distributed over 24 terabytes of data in 2022.

The IT staff shared their expertise with others at a number of different venues this past year including the Digital Mapping Techniques conference, NGGDPP Data Preservation Workshop, the Alaska ArcGIS Users Group, and multiple groups from the government of Greenland. In addition they have been heavily involved with the GMC in the technical aspects of the purchasing process for a new hyperspectral scanner (see highlight in the GMC section).

2022 IT SUCCESSES

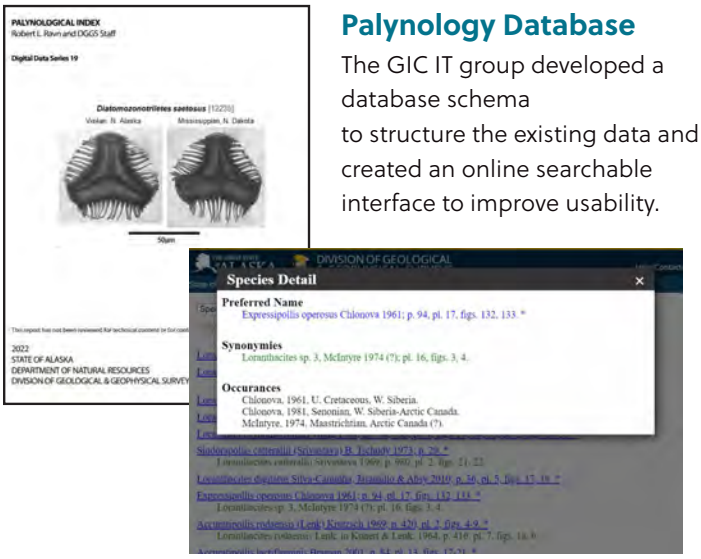
- Closed 551 support/help tickets
- Deployed over 40 new PCs
- Deployed new processing node, adding a significant amount of resources to our processing pool
- Migrated core Fairbanks network to redundant 10Gb ethernet
- Upgraded geoportal and field portals to ArcGIS Enterprise 10.9.1
- More than doubled A/C capacity in Fairbanks server room
- Expanded presence at UAF's Butrovich Data Center, adding several new servers and additional services
- Vastly expanded available virtual machines for remote and offsite workers
- Added three new handheld inventory devices used by GMC warehouse staff
- Improved wireless coverage of the GMC warehouse, especially for visitors
- Alaska Mapping Conference support

Right. Oralee Nudson, Systems Programmer, works in the Fairbanks server room.

Below. GIC Section Chief, Mike Hendricks, discusses DGGS' IT infrastructure and unique needs with Acting DNR Commissioner Akis Gialopsos in the DGGS Fairbanks server room.

PROGRAMMING SUPPORT

Led by Chris Ramey, the GIC IT staff provide essential programming support for a wide range of projects within DGGS, while also maintaining multiple databases, including the publications, photo, and geochemical databases. This in-house programming support allows us to release and maintain unique databases, tailored to the specifics required for the data (for example, the Palynology Database, DDS 19; doi.org/10.14509/30900). Chris and the GIC IT group have also added three new weather stations (Mount Doran, Barry Arm East, and Barry Arm West), expanded functionality for AGDI, and expanded the GMC database's functionality.

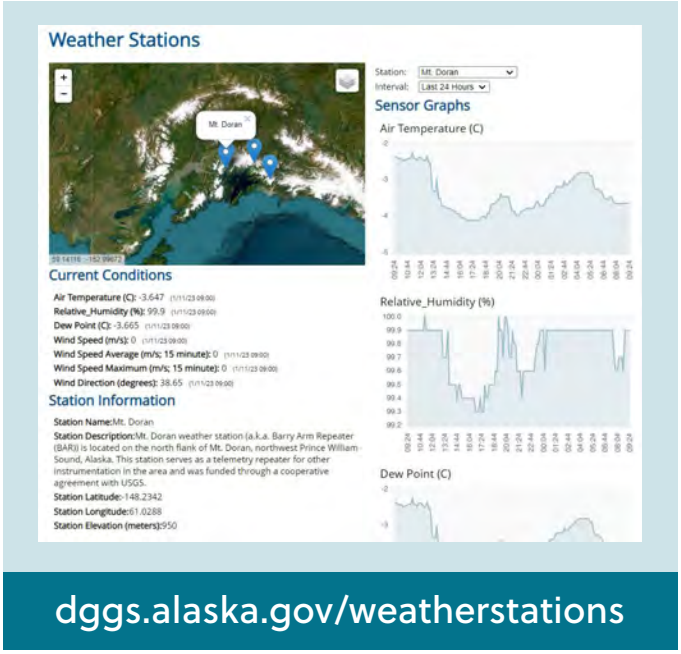


Palynology Database

The GIC IT group developed a database schema to structure the existing data and created an online searchable interface to improve usability.

Pedro Rivera, a GIS Analyst, has been working hard this past year writing scripts and tools to support the Alaska Geologic Multi-Map Database, where we now host the data for more than 50 geologic maps.

The need for programming support continues to grow and we are in the process of hiring two Programmer/Analyst positions. One will support the GMC Hyperspectral Scanner Project and the other will focus on a project to collect and analyze baseline data critical for evaluating the potential for hydro-electric (in-river) power generation throughout Alaska.



dggs.alaska.gov/weatherstations

CONGRATULATIONS!

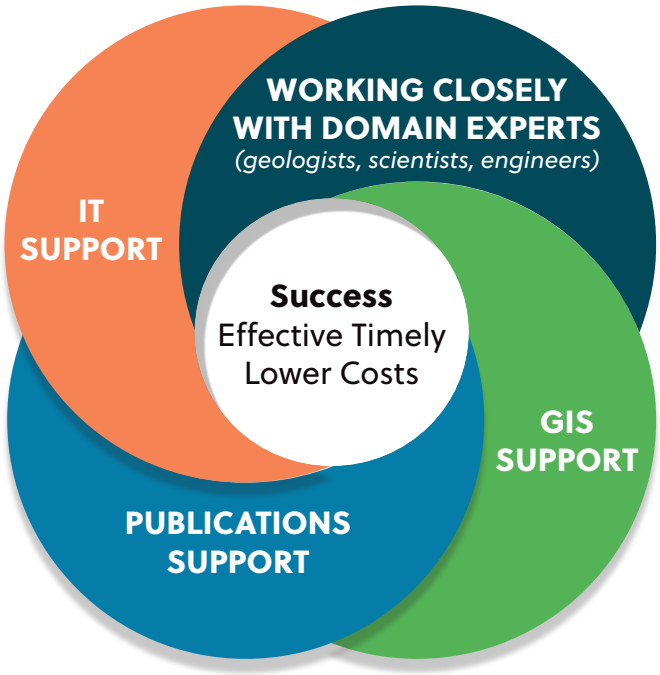
Chris Ramey, the lead of the GIC IT group, was promoted to Data Processing Manager 1 to better represent the complexity and scope of all that he accomplishes.

Chris has been instrumental in planning, organizing, and prioritizing every major data processing project for DGGS, the GMC, and the State's Geospatial Information Office (GIO) for many years. He has developed division-wide data processing policies, led major data processing programs, and managed data processing staff successfully during this time. Some examples of complex data processing projects that Chris has worked on include: Geologic Data Storage, Elevation and Imagery Processing, Geologic Map Production, Weather Stations Reporting, GMC Inventory system, and Field Portal Systems. Congratulations, Chris!

EMBEDDED AND INTEGRATED IT & GIS SUPPORT

The GIC successfully supports the state's geologists, scientists, engineers, and decision makers with effective, timely, and low-cost solutions to complex problems. **This is only possible by having our team of highly skilled professionals embedded and integrated in the division.** This allows GIC staff to (1) work closely and directly with domain experts, (2) rapidly respond to issues, and (3) develop cost effective storage and processing solutions that support the division and many others throughout the state.

Dedicated & Embedded IT Support *at the Division level is absolutely critical*



Integrated Team *Essential to publishing, hosting, and distributing large volumes of data and services*

THIS INTEGRATED TEAM CREATES SUCCESSFUL SOLUTIONS

Lidar
Weather Stations
Cameras

Geologic Publications

Remote Desktop Servers

IT & GIS Support to AGO Imagery Portal — GIC provides critical IT & GIS support to the Alaska Geospatial Office's Imagery Portal

Field Safety Equipment

General IT Support

Massive Low-Cost Data Storage — Ability to maintain a robust IT infrastructure is the critical backbone to DGGS' ability to support Alaska

Field Portals

DGGS Geoportals — Hundreds of geologic, elevation, & imagery datasets and web apps

DGGS Website — An intuitive, up to date, and information-packed website is the "go-to" site for geologic information

AK Geologic Mapping Systems

Alaska Elevation App

GMC Inventory Management

Remote Sensing Equipment Support

Web Apps — Web apps, including Exploration Geochemistry, and Geophysics Web App, are developed and maintained by the GIC

24-Hour IT Support — IT staff is available 24 hours a day to support hazard response, unexpected outages, and other time-sensitive issues

Field Data Collection Support — GIC provides critical support for year-round field data collections including rugged, lightweight mobile servers

ALASKA GEOSPATIAL OFFICE

The Alaska Geospatial Office (AGO) provides strategic oversight of the state's geospatial technology portfolio. AGO works to advance the use of geospatial technologies as a tool for better decision-making in Alaska. We accomplish this by coordinating statewide geospatial initiatives through the Alaska Geospatial Council and managing the State Geoportal for public access to the data, resulting in cost-effective ways to create, access, and apply geospatial data and technology. Our goal is to ensure that current, reliable, high-quality geospatial data are available and are easily accessible to decision-makers.

AGO is tasked with coordinating, managing, and maintaining the following:

- Development of a modern and robust Spatial Data Infrastructure (SDI) for Alaska
- Facilitating inter-agency data sharing through the State of Alaska Geoportal (gis.data.alaska.gov)
- Providing enterprise-level coordination and services to state agencies
- Promoting and supporting Alaska's Imagery and Elevation Programs
- Administering and directing the Alaska Geospatial Council.

Overall, AGO strives to improve the quality of geospatial data in Alaska through coordination and collaboration with the larger GIS community.

THE STATE OF ALASKA OPEN DATA GEOPORTAL

The state's Open Data Geoportal continues to provide access to location-based data, maps, and applications, which makes the state's vast collection of spatial data easier for the public to locate and use. As a one-stop shop for access to spatial information in Alaska, this portal ensures decision-makers are accessing real-time data from agencies and organizations across the state, reducing time spent surfing through websites and responding to data requests. AGO continues to coordinate with data managers across the state to develop consistent standards and workflows; and to improve data quality, access, and management standards, thereby ensuring long-term viability of the state's geospatial data assets. The geoportal serves a total of 1,800 datasets and maps from 20 federal, state, and local governments across Alaska. In 2022 the State Geoportal was visited by more than 25,000 unique users, a 70 percent increase in users from 2021.

ALASKA GEOSPATIAL OFFICE IMAGERY PORTAL AND PROGRAM

Imagery is widely used throughout every level of government in Alaska to support efforts such as economic development, infrastructure management, transportation planning, public works, public safety, and emergency response. The State Imagery Portal (see Extra-Tropical Cyclone Merbok highlight) provides access to the most current statewide imagery and is the foundation for building a modern and robust imagery program for Alaska. In 2022, AGO developed a new Imagery Portal for ingesting project level data from agencies across the state. The end goal is to provide access to historical and current imagery for Alaska and effectively share resources, so that funding can be allocated elsewhere. The process not only creates a cost-savings for all state agencies, but also allows AGO to track planned and completed projects and serve as a planning tool to guide decision making when allocating resources.

In 2022, the Imagery Portal received more than 142 million data requests from 100,578 unique users—up 500 percent from 2021—and served 25,000 gigabytes of imagery covering 2.6 million square miles of data.

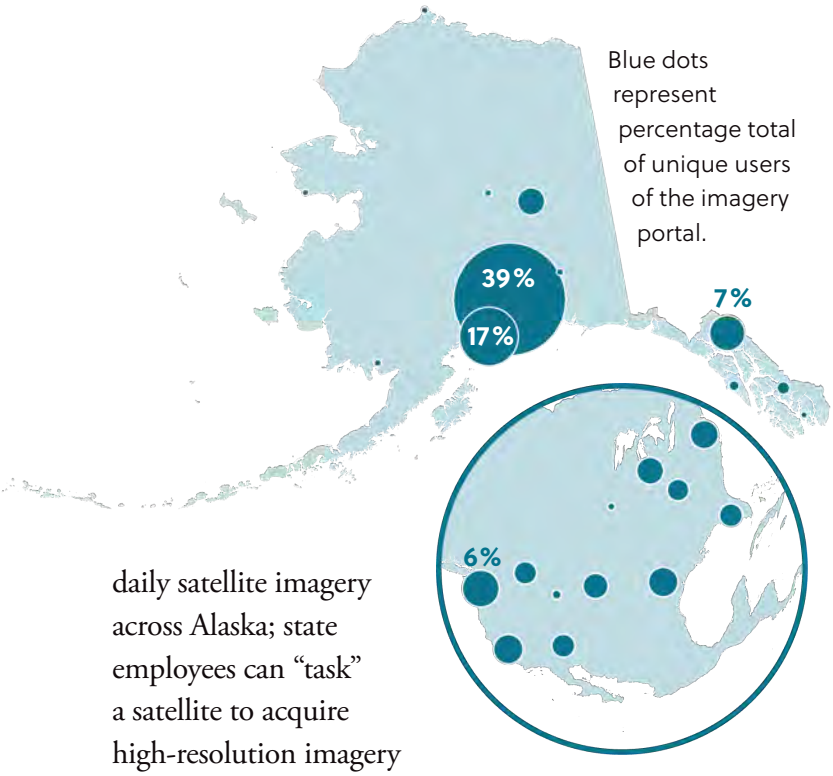
For the second year, AGO coordinated with multiple state agencies to share the cost of a pilot program with Planet Labs Inc. that provides access to

People from all over the country use our data

100,578 unique users

142,284,019 unique visits

25,000 GB of imagery downloaded covering over **2,663,039 mi²**



daily satellite imagery across Alaska; state employees can "task" a satellite to acquire high-resolution imagery over any area of interest. In 2022, the program grew from 71 to 188 users, from four DNR division, and two Department of Transportation and Public Facilities divisions. The technology is used for mining inspections, wildfire monitoring, emergency response (see Typhoon Merbok highlight), infrastructure planning, regulatory compliance, project scoping, field reconnaissance, and more, resulting in a substantial cost savings to the state.

ALASKA GEOSPATIAL COUNCIL COORDINATION

Alaska benefits from an engaged, enthusiastic, and cooperative geospatial community working in all parts of the state. The Alaska Geospatial Council (AGC) coordinates across federal, state, and local government agencies as well as university, tribal, native corporation, and private-stakeholder groups to improve geospatial information availability and use. In September 2022, AGC held the first ever Annual AGC Conference with more than 200 attendees from across the nation. To learn more about AGC and access conference presentations visit agc.dnr.alaska.gov.

Since the introduction of Unmanned Aircraft Systems (UAS) into the National Airspace System (NAS), Alaska has been in the forefront of implementing UAS technology for the benefit of the state. Alaska, through the University of Alaska, is home to one of the seven UAS Test sites authorized by the Federal Aviation Administration to provide verification of the safety of public and civil UAS operations and their related navigation procedures before their integration into the NAS. Interest in the use of UAS includes emergency response, search and rescue, mapping, photogrammetry, surveying, inspection, and natural resource management.

This year, the Alaska Geospatial Council added the Unmanned Aircraft Systems (UAS) and Drone Policy Working Group to establish safe and sustainable UAS operations across Alaska. The UAS Working Group serves as a stakeholder-based forum to provide professional guidance for implementation of UAS in Alaska; the working group will be a clearinghouse for UAS testing, training, education, and a resource for all stakeholders. This group will seek to identify and promote current and potential uses of UAS in Alaska, including cost, benefits, and potential impacts attributed to various UAS operations, and work collaboratively to develop operational guidelines and best practices.

AGO project manager Leslie Jones presents at the first annual AGC Conference in Anchorage.

EXTRA-TROPICAL CYCLONE MERBOK RESPONSE

Response Timeline

24 Hours — AGO created an efficient workflow for imagery from state, federal, and university partners to be made available through the State Geoportal

1 Week — UAS imagery was collected at several coastal communities and made publicly available on the State Geoportal

2 Weeks — Post-storm imagery for 36 communities was collected and available on the State Geoportal

In late September, Extra-Tropical Cyclone Merbok formed in an area of the Pacific Ocean where waters have historically been too cold for tropical cyclone formation. Merbok ultimately traveled across the Bering Sea, crossing the Aleutian Islands and the Bering Strait before dissipating over the Chukchi Sea. On September 15, 2022, the National Weather Service (NWS) issued a coastal flood warning, and a disaster declaration was issued by the Governor on September 17. High winds and flooding resulting from Merbok impacted 40 Alaska Native communities and more than 1,300 miles of coastline.

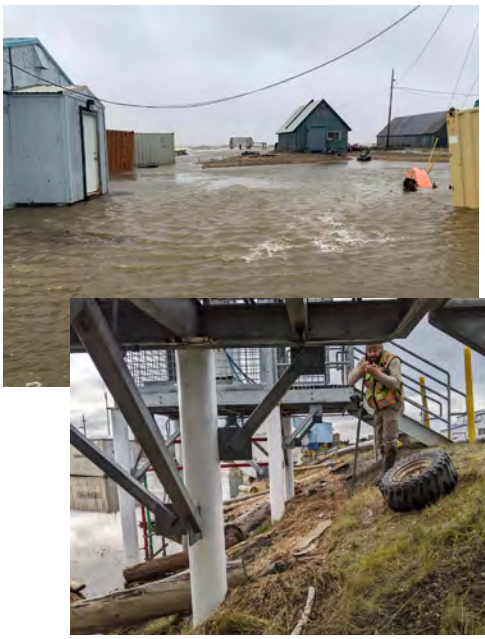
In the wake of this 100-year storm event, an interagency data collection effort was immediately coordinated to support response, recovery, and mitigation. The collaboration was a uniquely Alaskan grassroots effort leveraging known technical capacities of agencies and organizations across the state to best meet the needs of Alaskans. Coordination was led by DGGS' Coastal Hazards Program, the National Oceanic and Atmospheric Administration (NOAA), and the Alaska Geospatial Office (AGO).

High-Watermark Elevations

High-watermark elevations, which mark the peak height of water during a storm, are critical for determining storm impacts; they directly assist in the response and recovery process, and the data collected improve future NWS watches, warnings, and advisories.

Field crews from DGGS, the Division of Mining, Land and Water (DMLW), U.S. Geological Survey (USGS), University of Alaska Fairbanks (UAF) Arctic Coastal Geoscience Lab, Natural Resource Conservation Service (NRCS), JOA Surveys, and Bristol Engineering were deployed to western Alaska in the days and weeks after the storm to collect data on flooding impacts and erosion damage.

The main goals were to: (1) formally document the extent of the flooding, including high-watermark elevations; (2) measure coastal profiles to quantify storm-specific rates of erosion; and (3) collect imagery, photographs, videos, and direct-observation accounts from residents.

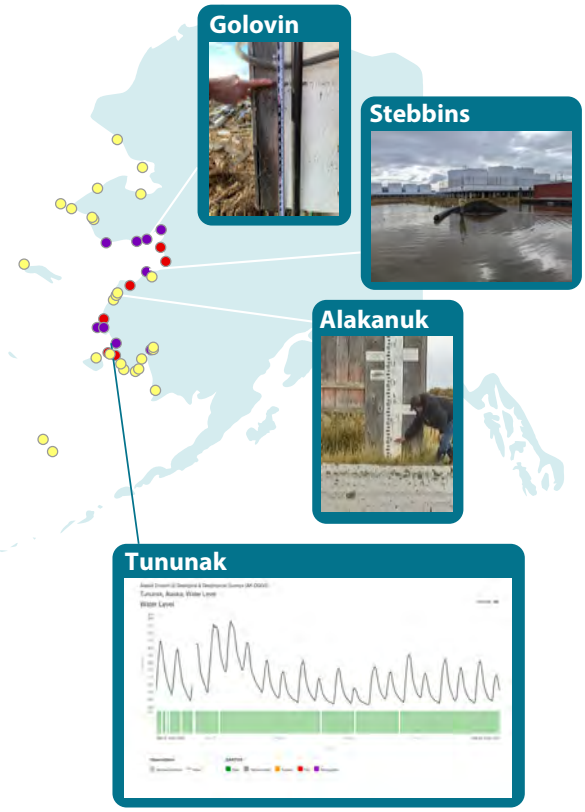


The field crews used a variety of techniques to gather high-watermark data, including measuring debris and mud lines, visible water marks on buildings, and erosion cutlines, and recording the elevations of visibly overtopped or inundated areas. DGGS visited and collected data at seven communities immediately after the storm.

Additionally, high-watermark observations from flood staffs were taken by community members in Alakanuk and Kotlik. DGGS maintains flood staffs in several coastal communities that are used for erosion and flood monitoring. These long-term partnerships are invaluable, especially when responding to these types of events. The photographs provided by residents are used to reconstruct flood inundation extents when DGGS scientists aren't able to reach the communities in person.

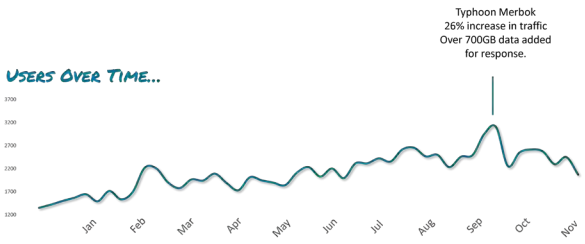
Top. Flooding in Golovin following Extra-Tropical Typhoon Merbok. **Bottom.** K.C. Horen (DGGS) collects data in Stebbins following Extra-Tropical Typhoon Merbok.

Real-time water level sensors were also used to collect peak flood heights. Between DGGS, NOAA, USGS, and other partners, 10 sensors captured flood levels of Merbok. To date, there have been a total of more than 430 high-watermark elevations recorded for 19 communities.



Imagery

Imagery was collected by helicopters, Unmanned Aircraft Systems (UAS), fixed-wing planes, and satellites over 36 communities and 5,400 miles of coastline to support situational awareness and assist with determining flood impacts to communities where high-water mark data was not collected. AGO supported imagery needs by: (1) coordinating with state, federal, and university partners to prioritize imagery collections over impacted communities during the emergency response period; (2) coordinating with partners to acquire pre-storm imagery that will be used to quantify erosion impacts; and (3) serving as a central clearinghouse for the imagery data, providing both public and restricted access to stakeholders.



Within two weeks of the storm, post-storm imagery for 36 communities was collected and available via the State Geoportal. The Geoportal saw a 26 percent increase in users during the emergency response period where a total of 5,400 square miles and over 700 GB of imagery was coordinated and hosted (gis.data.alaska.gov/pages/imagery).

Future Work and Preparedness

Flood assessments are currently being completed by DGGS for many communities in the Yukon-Kuskokwim Delta region. This work provides concise, descriptive details of community-specific flood impacts that can be used by communities to implement hazard mitigation plans, post-disaster recovery efforts, and the design of engineered mitigation solutions. Assessments have already been completed for Golovin, Hooper Bay, Napakiak, Nunam Iqua, Alakanuk, and Kotlik: dggs.alaska.gov/pubs/id/30573.

This all-hands on deck response has improved agency and organizational coordination needed for timely, efficient, and effective emergency response with definite impacts to future preparedness. For a full story on the data collection coordination and where to access the data, photographs, and images visit storymaps.arcgis.com/stories/ab19c80f9a644d3a9741e56cde5a41ab.

ALASKA GEOLOGIC MATERIALS CENTER

The Alaska Geologic Materials Center (GMC), operated by DGGS, archives 75 years' worth of geologic data consisting of energy, mineral, and geologic collections 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.

The new Anchorage repository opened on July 1, 2015, and has completed its seventh fiscal year. Fee collection began in fall 2018. There were 611 visits to the facility in CY2022. While this is about one-third of pre-pandemic client traffic, it marks a 48 percent increase from CY2020.

The GMC's database-driven search engine allows users to view real-time details of nearly 724,000 public sample items quickly and easily in the inventory before visiting the facility. This innovative and complex database and online search engine was developed in-house by DGGS staff and continues to serve user needs. There were 10,363 requests in 2022 to GMC web pages.

An overarching objective of the GMC is to physically and digitally curate its collection and expand global access to materials to stimulate exploration and development of Alaska's resources. Recent developments with automated nondestructive scanning equipment can allow digital visualization and distribution of these datasets to the global geologic community (see Virtual Rock Imaging Comes to Alaska highlight). Both 2021 and 2022 saw major strides forward regarding the funding for the Nondestructive Scanning Project with $1,880,000 in State of Alaska General Fund and Capital Improvement Project funds approved by the legislature. These state funds can serve as one-to-one match over four years for federal funds made available by the Federal Infrastructure Investment and Jobs Act. In the initial year, the GMC successfully received $614,512 in a federal matching grant to assist in the purchase of the hyperspectral scanning instrument and to support programming staff.

2022...BY THE NUMBERS

611 visitors

90,000 square foot repository

724,000 public sample items in inventory

READ MORE

Search the GMC's Inventory:
maps.dggs.alaska.gov/gmc

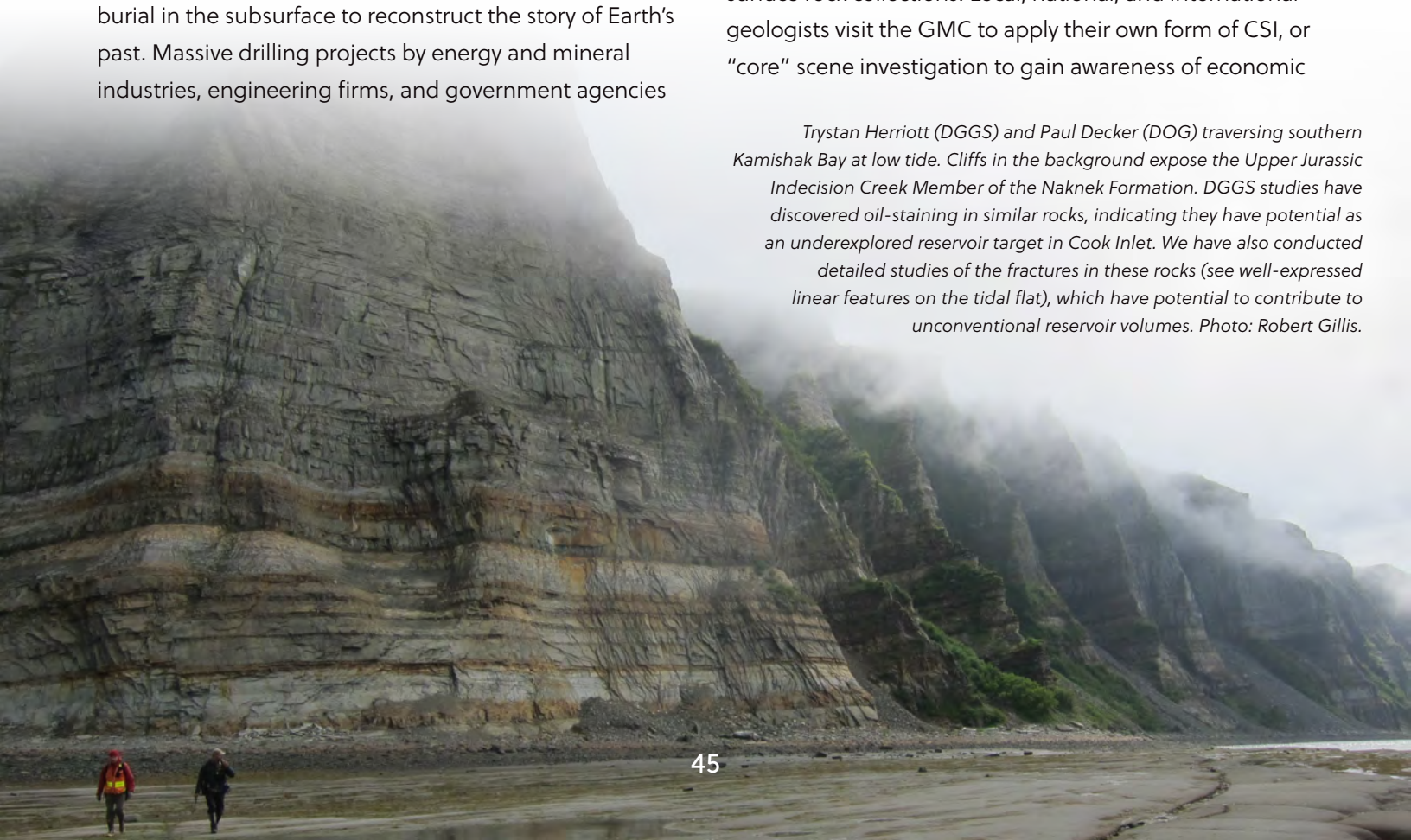
Geologists from independent and major energy companies continue to visit the GMC to sample and examine tens-of-thousands of feet of drill core and cuttings. As production declines within the mature Prudhoe Bay oil field, it is essential to diversify the oil industry in Alaska. The GMC hosted visits by major and independent oil companies, mineral companies, and government researchers operating in the North Slope, Cook Inlet, and throughout the state. These entities include Santos (purchased Oil Search Alaska), Hilcorp Alaska, ConocoPhillips Alaska, 88 Energy, Geolog Americas, Rockwash Geodata Ltd. (Great Britain), Amber Metals, Millrock Resources, South32, Yukuskokon Professional Services, Regeneration Enterprises, Greenland Geological Survey (though U.S. State Department), Alaska Mineral Producers, University of Alberta, Kansas State University, National Park Service, University of Alaska, the Alaska Volcano Observatory, and the USGS. Strong interest in the North Slope Nanushuk play continued with several industry workshops hosted at the GMC. Mining industry visits increased for the third consecutive year and involved use of GMC core samples to identify a potential critical mineral lithium deposit in Southcentral Alaska.

Highlight

VIRTUAL ROCK IMAGING COMES TO ALASKA

Popular television crime series often feature the application of scientific methods to criminal investigations. Crime Scene Investigation, or CSI, teams scour localities to reconstruct the timing of past events and establish or eliminate opportunity and motive for criminal actions. In short, CSI uses forensic science to tell a story. In a similar vein, geology requires magnitudes more exploration and analysis using evidence obscured by immense time and burial in the subsurface to reconstruct the story of Earth's past. Massive drilling projects by energy and mineral industries, engineering firms, and government agencies provide geologists unique windows into the architecture of the subsurface, greatly improving the story of past geologic events and processes. Continuing to leverage subsurface information locked in the vast collections within geologic core repositories is key to locate resources critical to an improved economy and society.

The GMC is the state's largest library of surface and subsurface rock collections. Local, national, and international geologists visit the GMC to apply their own form of CSI, or "core" scene investigation to gain awareness of economic



Trystan Herriott (DGGS) and Paul Decker (DOG) traversing southern Kamishak Bay at low tide. Cliffs in the background expose the Upper Jurassic Indecision Creek Member of the Naknek Formation. DGGS studies have discovered oil-staining in similar rocks, indicating they have potential as an underexplored reservoir target in Cook Inlet. We have also conducted detailed studies of the fractures in these rocks (see well-expressed linear features on the tidal flat), which have potential to contribute to unconventional reservoir volumes. Photo: Robert Gillis.

opportunities or overall greater geologic understanding. While the GMC is a valuable resource to these geologists, a few challenges present themselves, including the physical location of the GMC—not all geologists can travel to Alaska to view the collection, and a lack of digital data describing the rock samples limits initial assessment of materials for study. A recent GMC initiative for non-destructive digitization of repository rocks aims to address these challenges by creating a vast online virtual archive. This would provide the opportunity to build modern, Alaska-integrated analytical rock sample datasets that will be accessible regardless of physical location.

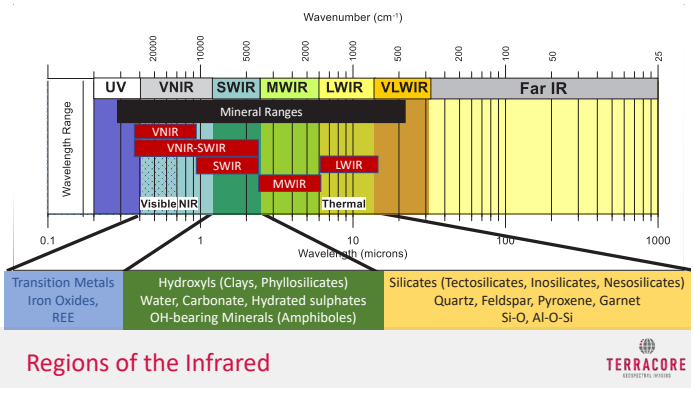
Many materials, including minerals, give off unique spectral signatures in the infrared bandwidth. A hyperspectral scanning instrument (HSI) uses visible and infrared light cameras to capture these wavelengths for rapid description of rock samples as each material's box is moved across the cameras' field of view. The resulting data can give important clues about the scanned material's mineralogy and composition.

Local access to scanning equipment will also incentivize Alaska exploration companies to share their drillcore samples with DGGS. This access would benefit the company with more detailed datasets in the short-term, and the resource industry in the long-term. Online access to hyperspectral geologic datasets will support applied industry, government, and university research to increase the understanding of Alaska's rich and complex geologic history and resource potential.

Recent combinations of state CIP and federal grant funding enables the GMC Nondestructive Scanning Project to purchase an HSI and provide multi-year support of scanning and programming staff to create Alaska-based spectral datasets. Over several years of operation, the HSI will generate tens-of-thousands of high-resolution RGB images and tens-of-billions of spectra that identify rock mineralogy and alteration patterns, along more than 500,000 feet of mineral and energy rock cores housed at the GMC.

Procurement begins in the first quarter in CY2023. Once selected, delivery of the HSI can take up to a year. In the meantime, significant changes to the GMC's geologic inventory database will need to be made to accommodate the large data products generated by the HSI. Recruitment for an Analyst/Programmer to begin work on these data-related upgrades began in early January.

This scanning project will continue to build Alaska's national and international resource profile, allow access to local, high-quality analytical datasets capable of profiling regional characteristics of energy and mineral systems, and provide new insights that potentially lead to new economic discoveries. We look to generate spectral and other analytical datasets by summer 2024.



Left. Regions of the Infrared uncover clues to rock mineralogy (Terracore, 2023).
Below. Hyperspectral scanning instrument imaging a mineral core box. Photo. Photon etc, 2022.

RELATIONSHIPS WITH OTHER AGENCIES

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

State Agencies

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

Each year DGGS works closely with:

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

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

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

Local Governments

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

DGGS works closely with local communities to help assess hazards and alternatives for mitigating the effects of erosion, flooding, and other surface processes that threaten their sustainability. DGGS also sends personnel to respond to natural disasters, such as the Sitka landslides in September 2015. Similarly, DGGS

works with rural communities to help assess potential local energy resources as alternatives to diesel fuel. During volcanic unrest and eruption, DGGS, as a partner in the Alaska Volcano Observatory, communicates with local villages—as well as with industry sectors, the aviation community, and the military—to share information and observations of volcanic unrest.

The University of Alaska

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

Federal Agencies

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

DGGS receives federal funds from matching grants for which the division must compete nationally with other organizations on a yearly basis. DGGS has been successful in securing federal funds to support mineral inventory mapping, surficial and earthquake hazards-related mapping, geologic-hazards evaluations, and studies related to oil and gas and geothermal potential. Although DGGS has historically been very successful in receiving federal grants and appropriations, the process is competitive and these funds are therefore project-specific or complementary to state-funded programs and do not replace state general fund support. Federal funding is pursued only for projects that advance and serve the division's statutory mission.

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

DGGS has been successful in receiving cooperative agreements from the National Geological & Geophysical Data Preservation Program (NGGDPP) and the National Cooperative Geologic Mapping Program. The NGGDPP, funded by the USGS, has supported several DGGS projects to preserve and make geologic information publicly available. STATEMAP funds provide a stable source of federal funding for geologic mapping in the state. Both of these programs require a 1:1 match in state funding.

ALASKA GEOLOGIC MAPPING ADVISORY BOARD

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

2022 members of the board are:

James Jones, Chair

U.S. Geological Survey, representing the federal government, mineral resources, and mapping interests. Jamey Jones is a geologist in the Anchorage office of the USGS Geologic Division, specializing in mineral resources and geologic mapping.

Curt Freeman

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

Tom Homza

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

Dr. Nicole Kinsman

Alaska Regional Advisor, NOAA/NOS/National Geodetic Survey.

Mitchell McDonald

Regional Engineering Geologist, Alaska Department of Transportation & Public Facilities.

Jamie Marunde

Vice President of Lands, Doyon, Limited. Ms. Marunde manages Doyon's ANCSA land, mineral exploration project partnerships, and oil and gas exploration across 12.5 million acres in Interior Alaska.

Paul McCarthy

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

Rob Retherford

President, Alaska Earth Sciences. Mr. Retherford has decades of experience managing mineral exploration and geoscience projects in Alaska.

Russ Kirkham

Manager, Coal Regulatory Program, DNR Division of Mining, Land and Water. Mr Kirkham has extensive experience with Alaska's coal resources and regulatory issues surrounding mining and represents the State of Alaska.

DGGS MISSION AND HISTORY

Mission Statements

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

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

History

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

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

Leadership

Eleven qualified professional geoscientists have served as State Geologist:

- Jim Williams, 1959–1971
- William Fackler, 1971–1973
- Donald Hartman, 1973–1975
- Ross G. Schaff, 1975–1986
- Robert B. Forbes, 1987–1990
- Thomas E. Smith, 1991–1995
- Milton A. Wiltse, 1995–2002
- Rodney A. Combellick (Acting), 2003–2005
- Mark D. Myers, February–October 2005
- Robert F. Swenson, 2005–2013
- Steven S. Masterman, 2013–2022
- David L. LePain, 2022–present

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

ORGANIZATION

DGGS is one of seven divisions and six offices in the State of Alaska Department of Natural Resources. Under the overall administration of the Director's Office, the DGGS is organized into five sections and the Geologic Materials Center and Alaska Geospatial Office (see organizational chart on pages 4 and 5). The Division also administers the Alaska Seismic Hazards Safety Commission.

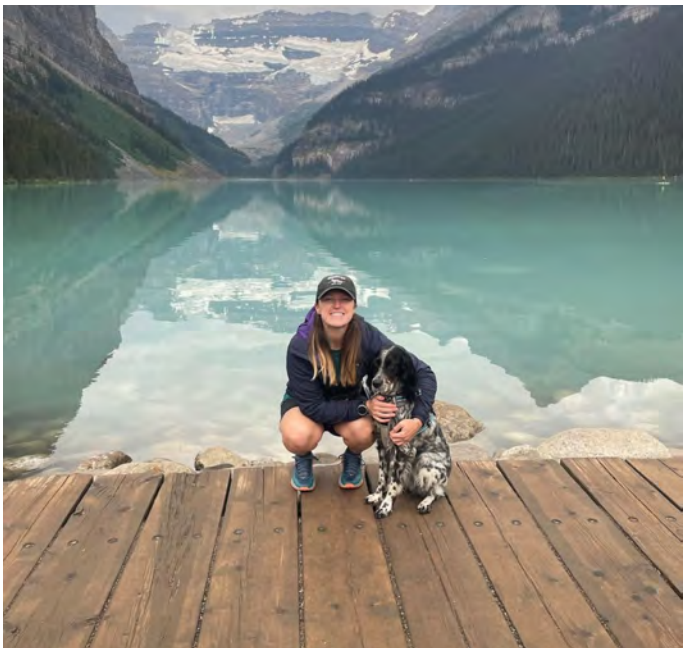
WELCOME!

WELCOME, DIRECTOR DAVID (DAVE) LEPAIN

Dave LePain took over as Division Director for Steve Masterman on March 1, 2022. No stranger to DGGS, Dave proudly served as the division's Energy Resources Section Chief since 2014. A highly experienced geologist, his work in Alaska has focused on the North Slope, including the northeastern Brooks Range, Cook Inlet, and several Interior sedimentary basins. LePain began working for DGGS in 1998 before leaving in 2003 to work at the Wisconsin Geological and Natural History Survey, then returning to DGGS in 2006. In 2012, LePain spent two years in Dhahran, Saudi Arabia, working for Saudi Aramco before returning, yet again, to DGGS to serve as Petroleum Geologist and Energy Resources Section Chief.

Since being in his new role, Dave has quickly learned the tricks required to get through a very energetic day and his careful, humble, and judicious approach to leading the division is appreciated by staff and coworkers. Although keeping busy focusing on the survey's future, Dave always finds time to "talk shop" about geology; his eyes begin to light up when waxing poetic about hyperpycnites and reminding staff that sedimentary rocks are perfect and far superior to their "messy," metamorphosed brethren. Welcome, Director LePain...We look forward to your leadership for years to come!

No stranger to fieldwork, Dave samples the Nanushuk Formation on the east bank of the Kanayut River.



AUTUMN POISSON

Autumn joined the DGGS Coastal Hazards Program and moved to Alaska in June 2022. Autumn is originally from the state of Michigan where she studied environmental science at the University of Michigan earning a BS in environmental science and mathematics and an MS in ecology. Autumn then spent a few years working in the natural resource field with experiences in environmental education and communication with Michigan Sea Grant, watershed management as a coral reef management fellow in the Commonwealth of the Northern Mariana Islands, and project management at Michigan State University. She later attended North Carolina State University earning an MSE in coastal engineering with a focus in hurricane storm surge modeling followed by a brief stint in Florida with the U.S. Geological Survey St. Petersburg Coastal and Marine Science Center working in coastal erosion modeling before making her way to Alaska. Autumn has an interest in coastal modeling of storm surge and erosion along the vast Alaska coastline and hopes to incorporate this into the Coastal Hazards Program and their work on flooding and erosion monitoring in communities of Alaska.

Outside of the office you can find Autumn exploring Alaska with her dog, Dakota, or hitting the weights at the gym. Autumn enjoys spending time hiking and backpacking and hopes to learn how to fish during her time in Alaska. She also has a big passion for Olympic weightlifting and is happy to teach anyone the skill if they're interested to learn.

JILL NICOLAZZO

Jill is excited to have joined DGGS in August 2022 as a geologist in the new Landslide Hazards Program. Prior to coming here, she worked at the Alaska Department of Transportation and Public Facilities as a geotechnical engineering assistant designing bridge foundations and was part of the Asset Management team in charge of the unstable slopes program. Jill is originally from New York State but has been in Alaska since 1995. She graduated from the University of Alaska Fairbanks twice, first with a Bachelor of Science degree in anthropology, and then with a B.S. in geological engineering. When not in the office, she can often be found at the rock climbing gym or hiking in the Chugach.

JUSTIN GERMANN

Justin joined DGGS in 2022. He previously worked as a North Slope Natural Resource Specialist for the Division of Mining Land and Water where he gained experience conducting field work and interacting with communities and commercial operators in the arctic. Prior to moving to Fairbanks in spring 2021, Justin completed his Master's degree in Planetary Geology and Bachelors in Geology in 2017 at the University of North Dakota. His research background lies in hydrated minerals, planetary evolution, and cold climate geomorphology. He is currently working to support the Arctic Strategic Transportation and Resources Project through field work, scientific instrument deployment, and data collection, as well as GIS and data management support.

Originally from southwest North Dakota, Justin gained an interest in geology when he realized he could combine his love for being in the outdoors with his interest in natural sciences. He has previous experience as a field technician for the National Ecological Observatory Network, a laboratory research assistant studying asteroids and comets, and as an intern at NASA Goddard Space Flight Center where he helped develop a program to track blowing snowstorms in Antarctica.

MORT LARSEN

Martin (Mort) Larsen joined DGGS' Geologic Hazards Section in September 2022 as the Landslide Hazards Program Manager. Originally from southwestern Idaho, Mort earned a B.S. in geology from the University of Montana in 2001. His appetite for active tectonics, geologic hazards, geomorphic processes, and field geology landed him at Humboldt State University where he received an M.S. in geology in 2006. His dream of becoming a geologist in Alaska became a reality in 2015 when he took a position with the Alaska Department of Transportation and Public Facilities as a Senior Engineering Geologist, where he mapped and identified geologic hazards within the southcoast region. Mort has mapped and investigated geologic hazards throughout the Pacific Northwest as well as Montana and Wyoming. Aside from looking at lidar for existing and potential hazards, he enjoys his time with his wife and two kids, relishes all that goes with outdoor activities, has a passion for music, and, for an escape, coaches youth football and baseball.

JENNA ZECHMANN

Jenna first learned about geophysical mapping techniques as a student traveling over the Juneau Icefield. Afterwards, her interest in glaciers and Alaska brought her to the University of Alaska Fairbanks Glaciers Group, where she earned a Master's in Geophysics. At UAF, she studied glacial sediment evolution using active seismic surveys, ground penetrating radar, and surface elevation data from remote sensing. At the same time, she became attached to the unique environment and opportunities afforded in Fairbanks. She is very happy to be a GIS Analyst 2, especially since she gets to run lidar surveys and work with incredibly detailed point clouds of the landscape, all while living a ten-minute drive from her workplace. Her research contributions also have direct bearing on the geophysical land movement dynamics she studied as a graduate student, as they improve our understanding of evolving landslide hazard areas.

HOLLY KRIEG

Holly joined DGGS in the fall of 2022 as an Accounting Technician II to assist our Administrative Officer and future Grants Administrator. In addition to 13 years working in the finance industry, she has spent time commercial fishing in Kodiak and working as a Fish and Wildlife Technician for the Department of Fish and Game in Southcentral Alaska. Outside of work, Holly enjoys traveling to new places, hiking, biking, kayaking, painting, and photography. Her secret love for geology will no doubt ensure she fits in with the rest of the "rockhounds" at DGGS. Welcome, Holly!

LIZ SJOBLOM

DGGS was very lucky to have hired Liz in early 2022, as her professionalism while coordinating the division's travel needs is second to none. Born and raised in Fairbanks, Liz has worked in various administrative roles for non-profit organizations, hospitals, and clinics in Alaska, Florida, and Malawi, Africa. When not solving all the division's travel issues, she loves a good mystery, baking, and exploring Alaska with her family. Liz believes working at DGGS is a privilege and she always looks forward to learning knew ways she can support the team. Welcome, Liz!

SONJA ZASTROW

In search of a new challenge, Sonja Zastrow joined the DGGS team in April 2022. She transferred as an Administrative Officer II from the Office of Children's Services to DGGS and has almost 21 years of experience in the administrative world within the State of Alaska. Raised in the Mat-Su Valley, Sonja reluctantly moved to the frigid Tanana Valley in 1999 and has since made many wonderful memories fishing, hunting, and exploring Alaska. Her days are spent monitoring budgets, supporting staff, developing processes and efficiencies for administrative tasks, and ensuring the division's activities adhere to policy and procedure, bargaining unit contracts, and federal guidelines. Evenings are filled with cuddling her two pugs, Olive and Roscoe, and planning the next adventure with her husband, Tom. Together they have three grandchildren and three great-grandchildren. Hobbies that keep her out of trouble include traveling, sewing, quilting, and cheering on the Packers. Welcome, Sonja!

THERESA HARMON

Theresa Harmon came from a "galaxy far, far away." When her spaceship crashed, she realized she needed to find the right materials to rebuild it and find the fuel to get back home. What better place to crash than at the Division of Geological & Geophysical Surveys. Since starting in October 2022, she has been having so much fun in her role as Administrative Assistant that fixing her spaceship is no longer a priority. She was born and raised in Fairbanks and loves all the city has to offer. The joy of seeing a moose in her yard or Denali on the drive to work is always a thrill for her. Theresa spends her free time riding horses, hiking with her dog, biking, and watching British television or Swedish mysteries. She is grateful for the opportunity to work with such an amazing team and to be a part of the important work done at DGGS. Welcome, Theresa!

FAREWELL!

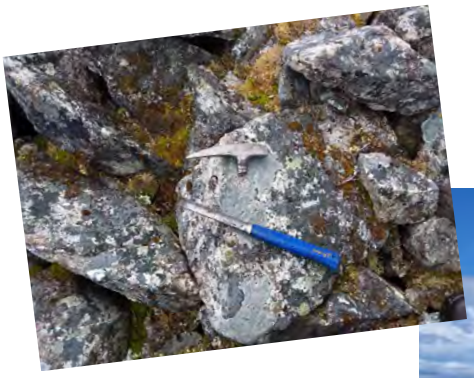
DIRECTOR STEVE MASTERMAN–HAPPY RETIREMENT!

Steve Masterman spent nine years (2013–2022) representing DGGS at the state and national level to raise awareness of Alaska's mineral and energy resource potential, sand and gravel resources, coastal erosion risks, and other geologic hazards to ensure the safety and well-being of all Alaskans. Steve also proudly represented DGGS in state, regional, and national organizations, including as president of the American Association of State Geologists.

De Anne Stevens and Marwan Wartes present Steve an apple-and-geology-themed quilt—made by the unofficial DGGS quilt club—at his farewell party.

For the first several weeks in his role, Deputy Director Ken Papp thought Director Masterman was a robot, because Steve was constantly on the phone, advocating for the survey, never witnessed him eating anything, and assumed he somehow recharged himself with small solar panels under his skin. Director Masterman was tenacious in his work ethic and always put the division first. One of Steve's favorite things to do while at work was test and search the division's Alaska Geochemistry application (maps.dggs.alaska.gov/geochem), offering suggestions to improve the application and finding potential errors in the data.

When Director Masterman wasn't leading the division, he would spend his weekends tirelessly digging hundreds of holes, planting as many as 200 fruit trees in just two days. Rumor has it, Steve grafted more than 900 fruit trees in a single season. Robot or not? We'll let you decide.



Steve even found time to put his love of geology to practice in the field... Sometimes a little too enthusiastically!

And, as a nod to his witty sense of humor, Steve's last day of state service was April 1, 2022, April Fool's Day. Director Masterman will be greatly missed. Thank you, Steve, for your inspiring guidance, professionalism, and love of life.

JANET SCHAEFER

After more than 20 years of service, Janet Schaefer retired from her position as chief of DGGS' Volcanology Section in November 2022. Originally from Washington state, Janet moved to Fairbanks in January, 1996, with her husband and 4-week-old son to begin her Master's degree at UAF. During her time in graduate school Janet worked as a research assistant in UAF's Ar/Ar dating laboratory, and after a brief hiatus while Janet worked in the mineral industry, she completed her Master's degree in 2002. Janet's Master's thesis described the stratigraphy, major-oxide geochemistry, and $^{40}Ar/^{39}Ar$ geochronology of a tephra section north of the Wrangell volcanic field. A prominent hornblende-rich tephra at the base of the section was dated at 627 +/- 47.7 ka using the $^{40}Ar/^{39}Ar$ method of single-step total laser fusion of multiple hornblende grains. The tephra was named the "Tetlin Tephra" and was shown to be a product of an explosive phase of eruptions at Mount Drum volcano.

Janet joined DGGS in March of 2000, working with Chris Nye in what would become DGGS' Volcanology Section. A geologist of many hats and talents, Janet served DGGS and the Alaska Volcano Observatory in several disciplines. She spearheaded GIS data management and mapping from the early days of command-line ARCINFO through the present ArcPro, and she was an active field geologist, mapping volcanic deposits, and doing volcano hazard assessment and tephrochronology studies at Chiginagak, Okmok, Shishaldin, and Makushin volcanoes, among others.

While juggling these roles at DGGS, Janet helped raise three tall and hungry boys, coached kids' soccer, exercised regularly, ran multiple Equinox marathons, and planned and executed adventures across Alaska, Scotland, and places in between. A favorite and relished image at DGGS is of Ms. Schaefer in her orange flight suit in the field, the suit's zipper barely fitting around her pregnant belly—she worked hard and she had fun!

Janet became chief of the Volcanology Section in 2013, when Chris Nye retired. Janet envisioned AVO and DGGS becoming a powerhouse of tephra information. Thanks to her forethought and efforts, AVO's GeoDIVA database is a global leader today in tephra information.

In the last few years of Janet's tenure at DGGS, the need to upgrade AVO's volcano monitoring networks from analog to digital became apparent. Janet ensured DGGS' critical participation in the monumental effort to transform all AVO's monitoring networks: she secured cooperative agreement funding for what would become a four-year project, hired skilled and adept geotechnical field staff and a logistics coordinator to procure all helicopter and ship contracting and undertake related logistics. Despite hurdles including the COVID pandemic, under Janet's guidance the Volcanology section at DGGS more than doubled, and the Analog-to-Digital (A2D; see AVO section) program successfully completed its mission this summer with the conversion of networks at Aniakchak and Veniaminof volcanoes.

Known for her sense of humor, her straight forward, unrestrained diplomacy, and her incredible efficiency. Janet will be sorely missed at DGGS in general and at AVO in particular.

JACQUELYN OVERBECK

Jacquelyn (Jaci) originally joined DGGS as a Graduate Research Intern in 2012, supporting the mission of the Coastal Hazards Program as she completed her M.S. in geological engineering at the University of Alaska Fairbanks. After spending the next year and a half post-graduation working with the U.S. Geological Survey studying storm-induced flooding and erosion for the National Assessment of Coastal Change Hazards, we were fortunate to have her return to DGGS in 2015 as the manager of the DGGS Coastal Hazards Program. Her dynamic leadership, drive, and ability to think outside the box greatly benefited the coastal program and DGGS as she implemented her vision of a program dedicated to fostering scientific partnerships to improve the quality and quantity of the critical coastal baseline data necessary for informed decision-making throughout the state. In 2022 Jaci moved on to an exciting and important new position as Alaska Regional Geospatial Coordinator for NOAA's Office of Coastal Management, where she is using all she learned at DGGS to positively impact coastal management for Alaskans. She still works closely with her colleagues at DGGS as we continue to call upon her expertise and insight to help sustain our Coastal Hazards Program during its transition to new leadership.

JOHN PERREAULT

John came to DGGS' Volcanology Section in late 2019, after having previously worked as a local radio host on KUAC for several years. In his position, John made beautiful GIS maps for field crews to use in the Aleutians and on the Alaska Peninsula, helped out with tasks for AVO's geologic database, and greatly expanded AVO's outreach efforts by reinvigorating AVO's Instagram account and creating AVO Radio, a 2-minute summary of weekly eruptive activity that airs on 10 stations around Alaska. Radio is an important communication tool for many Alaska communities that still face internet bandwidth difficulties. In October 2022, John accepted a Public Information Officer position with Northern Region Department of Transportation. We wish him luck in his new position!

Alaska Division of Geological & Geophysical Surveys

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