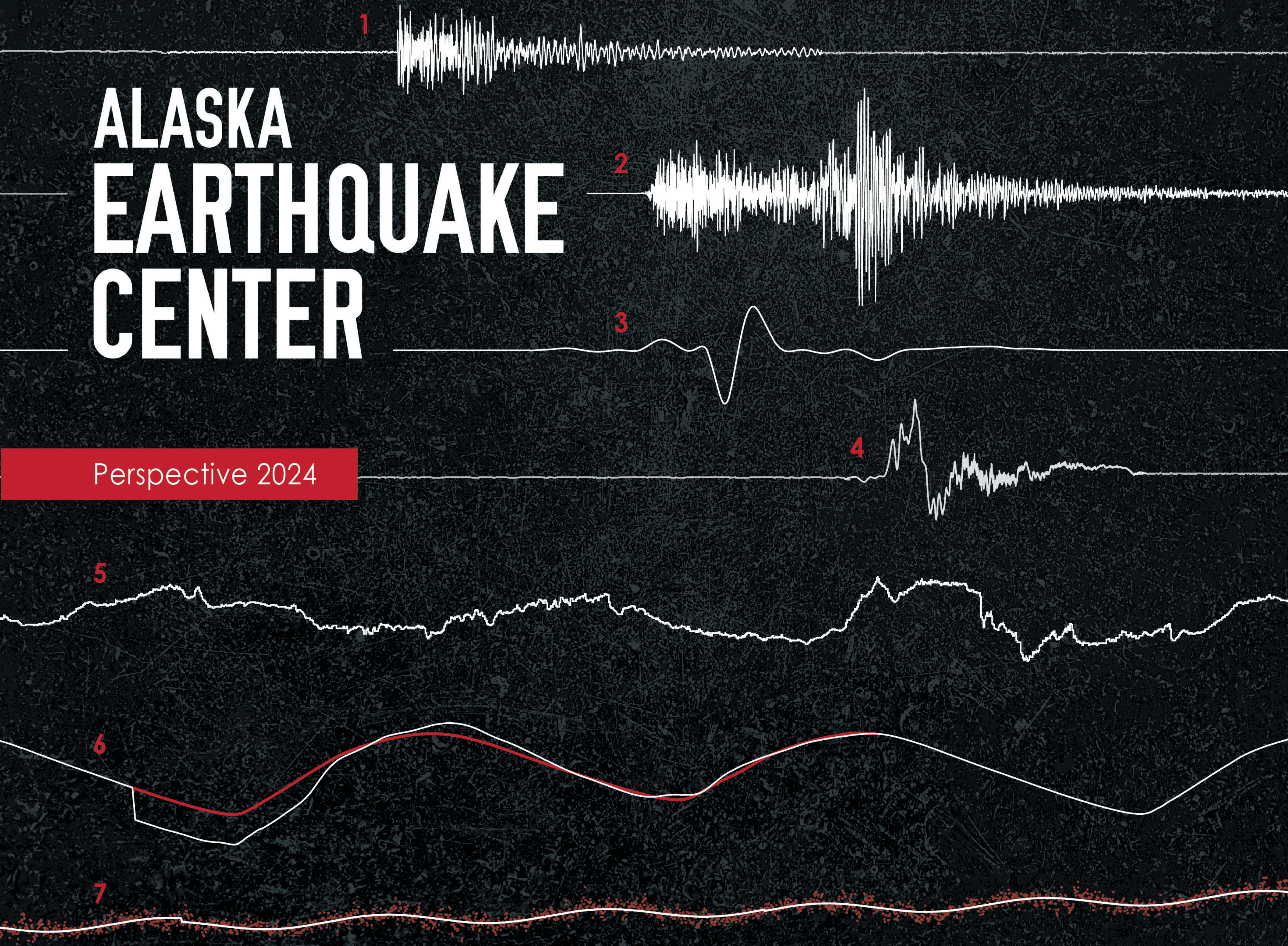
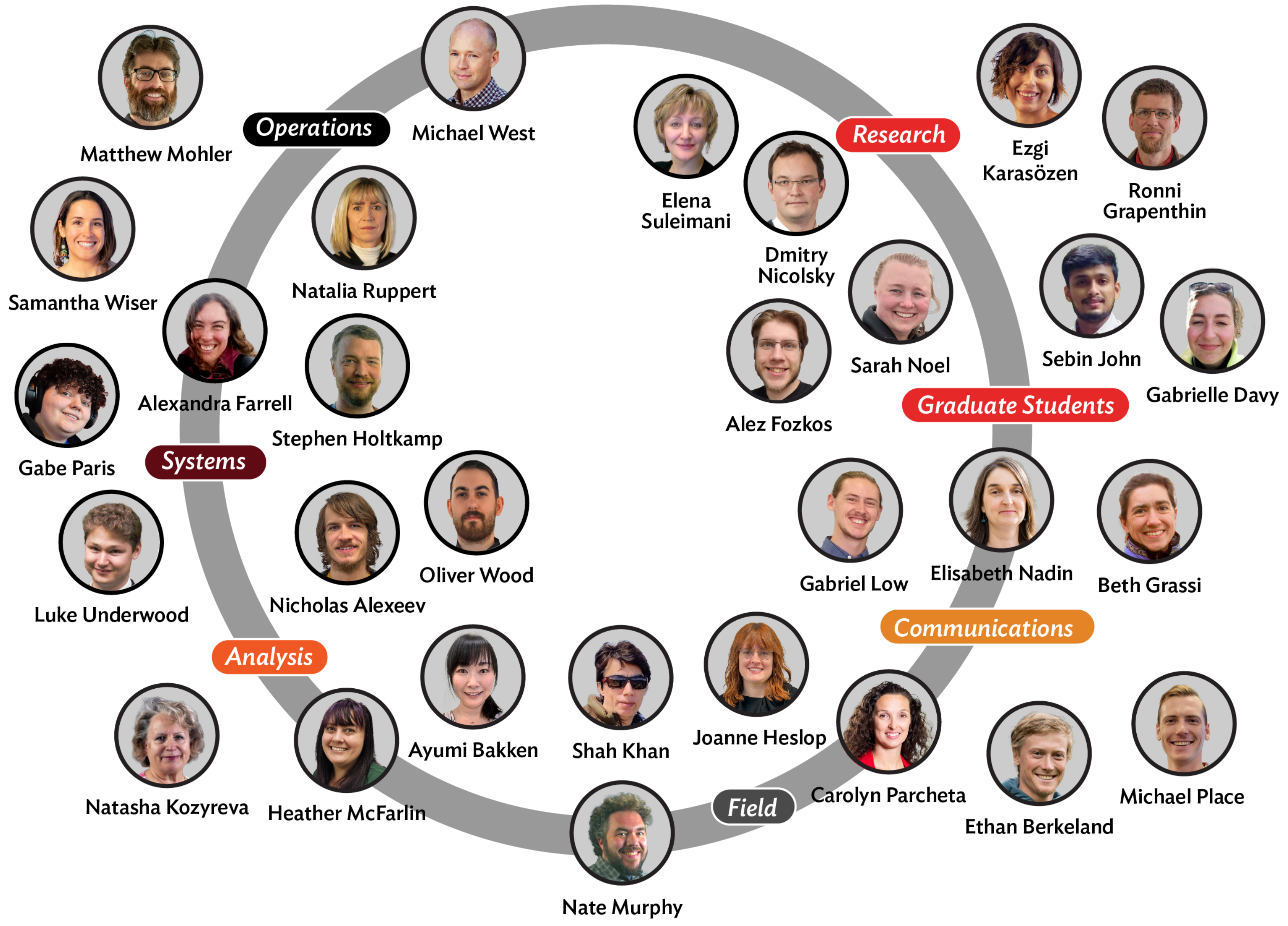
ALASKA EARTHQUAKE CENTER

Perspective 2024



Who We Are



Our mission: Advancing Alaska's resilience to earthquakes through monitoring, research, and public engagement.

Director's Note

The last few years have been a period of growth and change as we have worked to strengthen Alaska's ability to navigate large earthquakes. Expanded strong-motion instrumentation allows us to support the engineering and emergency response communities. Our tsunami hazard products now cover 60 communities. We have developed our high-rate GNSS capabilities. And perhaps most significantly, we capitalized on the National Science Foundation's USArray project to finally achieve a truly statewide monitoring capability. Along the way, we have grown capabilities that leverage our strength in real-time observation. The distributed infrasound network has proven to be a unique research asset. We offer one of the most comprehensive weather datasets in northern Alaska. And we are proud to contribute to efforts that track our environment in a changing climate—from storm systems and wildfire to landslides and permafrost degradation.

> Several new capabilities sit on the horizon. ”

We serve Alaska. We spend long hours working with individual communities. We support industry and the military with custom monitoring tools. In our public engagement, we meet people where they are, whether they are in middle school or in a scientific career. And we are proud to be a part of helping train the next generation of Alaska scientists.

Several new capabilities sit on the horizon. Whether it is earthquake early warning, landslide monitoring, or assessing tsunami risk, the foundation we have laid over the past few years positions the Alaska Earthquake Center to deliver on these services.

Michael West
Research Professor/State Seismologist

Overview of Change

	2018	2023
Seismic stations	150	252
GNSS (GPS) instruments	0	7
Weather stations	0	67
Total field days	149	311
Non-earthquake seismic events	1,548	4,032
Earthquakes felt	346	215
Tsunami inundation reports	23	37
Strong-motion instruments	72	135
Community tsunami hazard brochures	0	12
ShakeMaps	510	559
Educational seismometers in schools	0	45
Social media followers	14,000	63,000
Earth Observation Club students	0	67
Station site landowner partners	42	70

Expanding Our Network

The Alaska Earthquake Center manages more than 250 stations that make up the Alaska Geophysical Network. During 2019–20, our monitoring network expanded greatly when we added 96 sites from the National Science Foundation's short-term USArray project. A portion of these new sites expanded the Earthquake Center's network to places that previously had no seismic monitoring, especially in northern and western Alaska. This effort was made possible through strong support from the U.S. Geological Survey, the National Science Foundation, and the National Oceanic and Atmospheric Administration.

In addition to seismometers, many of these stations host other types of sensors, including weather, infrasound, soil temperature, and GNSS instruments. Through the variety of instruments at each station, we are forming new, multidisciplinary partnerships and, along with other scientists, engaging in cross-disciplinary research. All data are public and openly available, most in real time, through standard data portals.

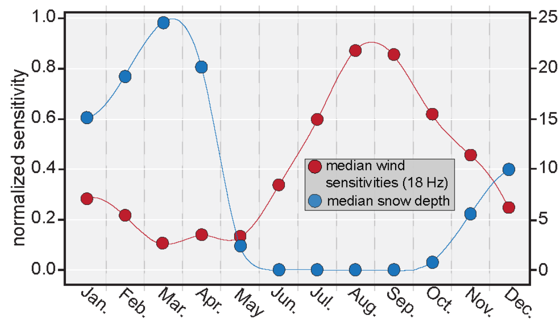
A June visit to station TGL (Tana Glacier), located in Wrangell–St. Elias National Park

Weather

The Alaska Earthquake Center's seismic stations have grown into a role serving as outposts monitoring Arctic environmental change. Thawing permafrost makes ground unstable. Shrub expansion increases available biofuel. Elevated temperatures and lightning heighten the risk for more, and more widespread, wildfires. We facilitate study of these processes with instrumentation that provides a continuous record of temperature, wind, and relative humidity in remote regions.

In adopting the instrumentation of the National Science Foundation USArray project, we now operate 67 weather sensors spread evenly throughout Alaska. Each sensor in the Alaska Geophysical Network sends data continuously to the Alaska Earthquake Center. We then make the data publicly available through established data services, for use by scientists and agencies across the country. For example, the Alaska Interagency Coordination Center uses the data to inform wildland fire forecasts and management decisions.

The pairing of weather instruments with seismometers has also yielded insight into environmental factors, such as how background seismic noise is influenced by wind speed, vegetation, storm systems, snowpack, and seasonality. Seismometers tracked Typhoon Merbok in 2022, and also detect the annual advance and retreat of sea ice. Thus, seismometers are playing their part in monitoring Arctic change.



When snow depth is high (blue), seismic noise from wind (red) is lower.

https://doi.org/10.1785/0120230097

GNSS

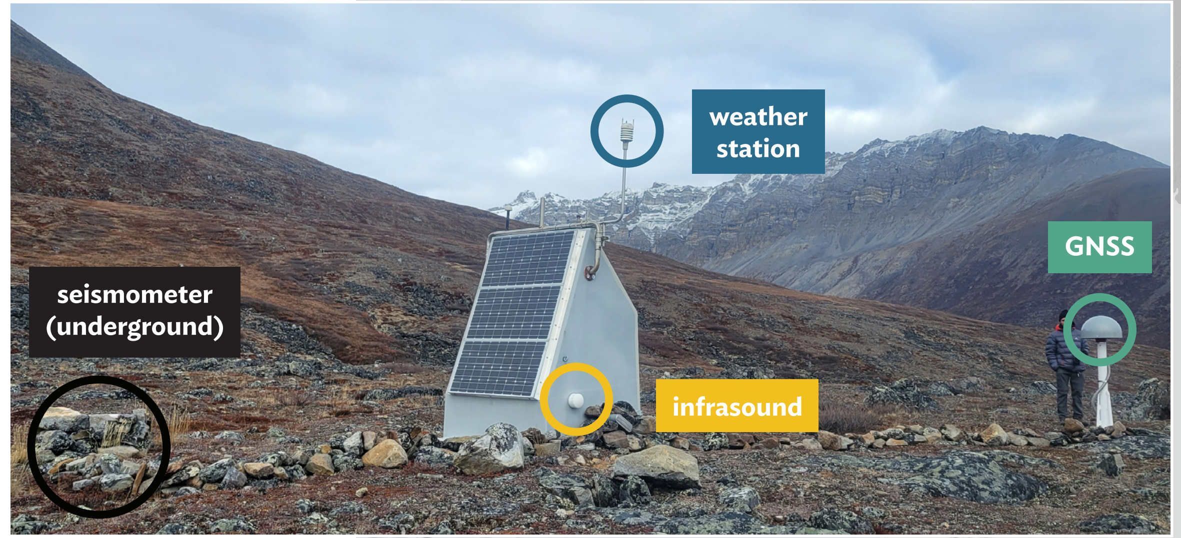
A few years ago, the Alaska Earthquake Center started installing GNSS instruments. GNSS is an expanded GPS system that uses more satellite networks for better accuracy. We've since developed real-time data acquisition and in-house processing capabilities.

Our instruments add to real-time GNSS networks hosted by other organizations in Alaska—such as the EarthScope Consortium's Network of the Americas, the Alaska Volcano Observatory, and the Alaska Department of Natural Resources' Alaska's Continuously Operating Reference Network. The Earthquake Center will continue adding sites to close gaps in the existing real-time GNSS network and lay a strong foundation for earthquake early warning.

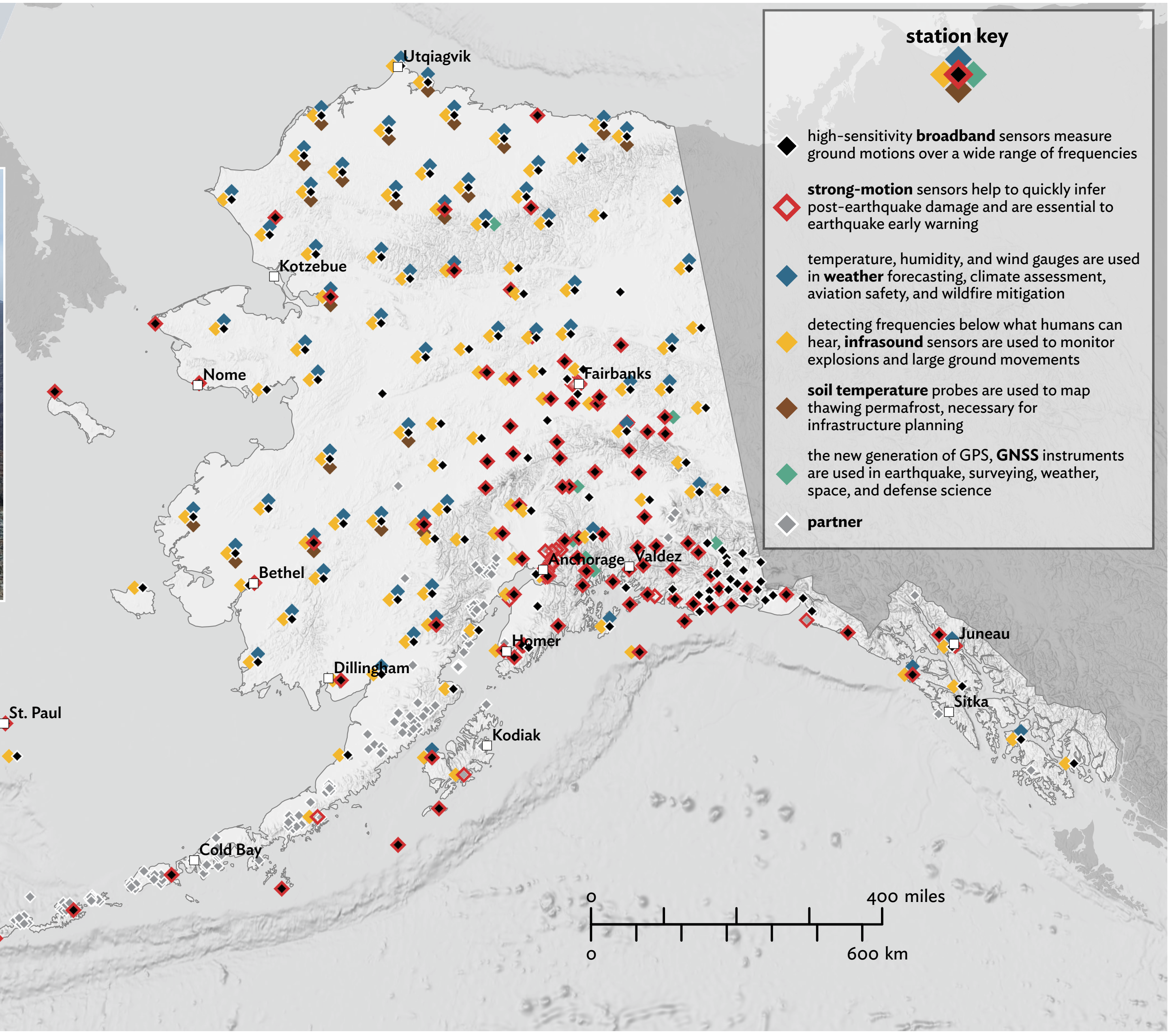
GNSS instruments complement seismometers for rapid earthquake assessment. While seismometers accurately record shaking, GNSS is superior at measuring substantial ground offsets (sometimes many feet) that occur during the largest earthquakes. GNSS instruments are excellent for measuring the extent of an earthquake rupture.

When the ocean floor moves vertically by a significant amount in a coastal region—such as along southern Alaska's subduction zone—the potential for generating a tsunami is high. A GNSS network can help reduce unnecessary evacuations by more accurately capturing plate motion during the earthquake.

Quick assessment by GNSS of significant ground motions will be important in developing our earthquake early warning system.



Station E22K, Anaktuvuk Pass



Landslides

Identifying the seismic signal of an impending landslide could help avert disaster in coastal Alaska, where the collapse of material into the ocean can trigger tsunamis. Seismic data from the Alaska Geophysical Network make it possible to detect the location and size of certain large landslides as they are occurring. Working with our partners at the U.S. Geological Survey, National Tsunami Warning Center, and Alaska Division of Geological and Geophysical Surveys will ultimately yield a warning system for landslide-prone areas.

Our focus so far has been Barry Arm in Prince William Sound, where a landmass has been creeping since the early 1900s. In this fjord, the rapid retreat of Barry Glacier has led to slope destabilization around the glacier. The largest of several landslides set in motion is more than a mile (2 km) wide. This mass—if it were to suddenly collapse into the fjord below—could generate a tsunami with wave heights peaking at more than 6 feet (2 m) in the nearby community of Whittier.

Identifying a landslide using seismic data requires methods that differ from earthquake detection. Rather than a sharp onset of seismic noise like with an earthquake, a landslide's signal starts small and grows as the mass moves. In 2023, Earthquake Center researchers used seismic data to detect more than a dozen large landslides at the time they were happening. These events were confirmed with remote sensing imagery in the days and weeks following.

Infrasound

Low-frequency sound waves, called infrasound, travel long distances and are used to detect a range of signals, including nuclear explosions and volcanic eruptions. They can also reveal details about the mechanics of a landslide. Infrasound-equipped stations in the vicinity of Denali National Park and Preserve showed that the landslide on September 13, 2023, one of the largest in Alaska that year, was preceded by two slides several minutes earlier. The precursory slides were first detected in the infrasound data.

Alaska Peninsula Earthquake Sequence

Thousands of earthquakes shake Alaska each year. Many of the largest occur where the Pacific Plate slowly moves beneath the North American Plate. Between 2020 and 2024, four earthquakes with a magnitude greater than 7.0 ruptured offshore of the Alaska Peninsula (see map).

Shumagin Gap

Between 1938 and 1965, a series of large earthquakes ruptured almost the entire Aleutian subduction zone. One notable patch, however, did not rupture—the area roughly between Sand Point and Perryville. This section became known as the "Shumagin Gap," named for the nearby Shumagin Islands. Seismologists had long debated whether this seismic gap would eventually rupture in a large earthquake.

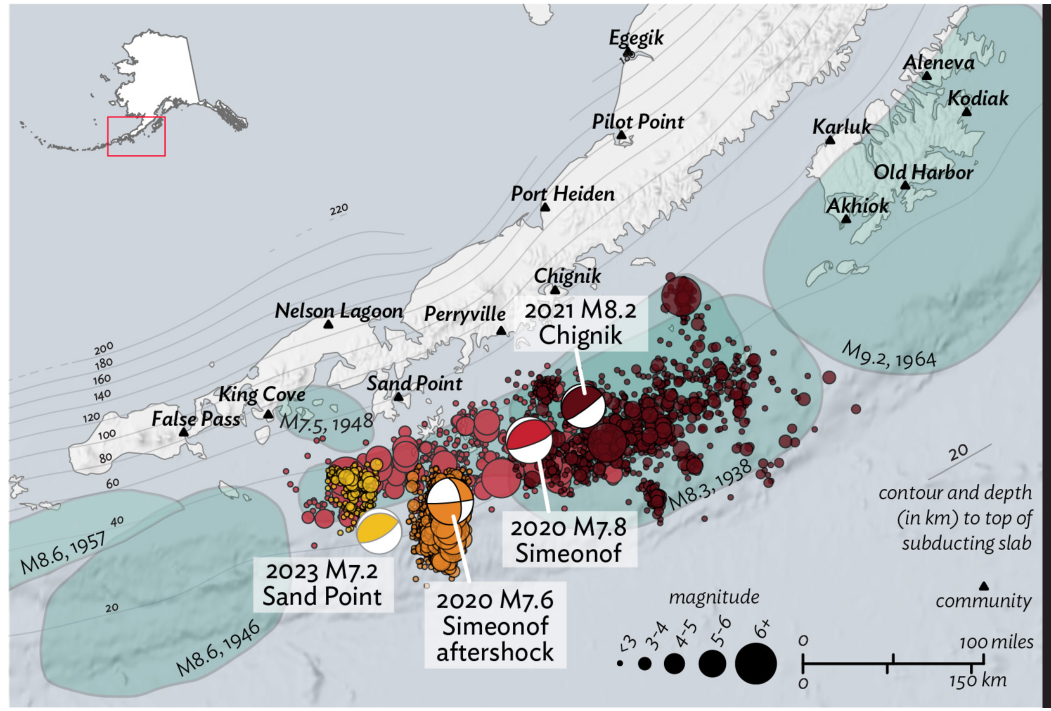
On July 21, 2020, a M7.8 earthquake struck just south of Simeonof Island, in the Shumagin Gap.

Cascading Earthquakes

Continuing this sequence of large earthquakes, on July 28, 2021, the magnitude 8.2 Chignik Earthquake, the largest U.S. earthquake in 50 years, struck offshore of the Alaska Peninsula. Then, on July 15, 2023, a magnitude 7.2 earthquake south of Sand Point occurred within the M7.8 Simeonof aftershock zone. While the M7.8 aftershock activity greatly diminished since its peak in the summer and fall of 2020, the Earthquake Center was still observing elevated levels of seismic activity within the M7.8 aftershock zone in 2023. So, the M7.2 earthquake was a late aftershock of the M7.8 earthquake, but it also generated its own aftershock sequence.

University of Alaska Fairbanks researchers examined plate motions and tectonic strain buildup in this region, as measured by a network of GNSS instruments. Their study points toward the recent earthquake sequence being a continuation of the "cascade" of large subduction-zone earthquakes that began 80 years ago. Every large earthquake releases strain along a portion of the ruptured interface, while causing increased strain along some adjacent areas, which may trigger future earthquakes. The cascading effect may take days to decades to evolve. How tightly the tectonic plates are connected controls how frequently the strain is released as earthquakes.

This decades-long sequence of large earthquakes points toward the value of continuing comprehensive earthquake monitoring in Alaska.



Four major earthquakes and their aftershocks along the Alaska Peninsula segment of the Alaska–Aleutian subduction zone since 2020, color-coded by sequence. "Beach balls" depict focal mechanisms of recent earthquakes, indicating the type of motions along the fault. Light-blue patches show ruptures from major earthquakes. Portions of the tectonic plate interface that have not ruptured are of significance because they could be the next regions to rupture.

Earthquake Early Warning

An earthquake early warning system is a lightning-quick response to a large earthquake that has already started, sending alerts that give people from a few seconds to a minute or more to take safety actions. The Alaska Earthquake Center and our partners at the U.S. Geological Survey are in the early stages of determining how to make an earthquake early warning system feasible in Alaska.

Alaska's seismic networks cover a vast area, and will need time and financial investment from state and federal agencies to develop the instrumentation infrastructure to provide earthquake early warning. Our goal is to configure the sensor network and data analysis to maximize advance notice. The Alaska Earthquake Center will be at the forefront of this effort.

Tsunami Hazard

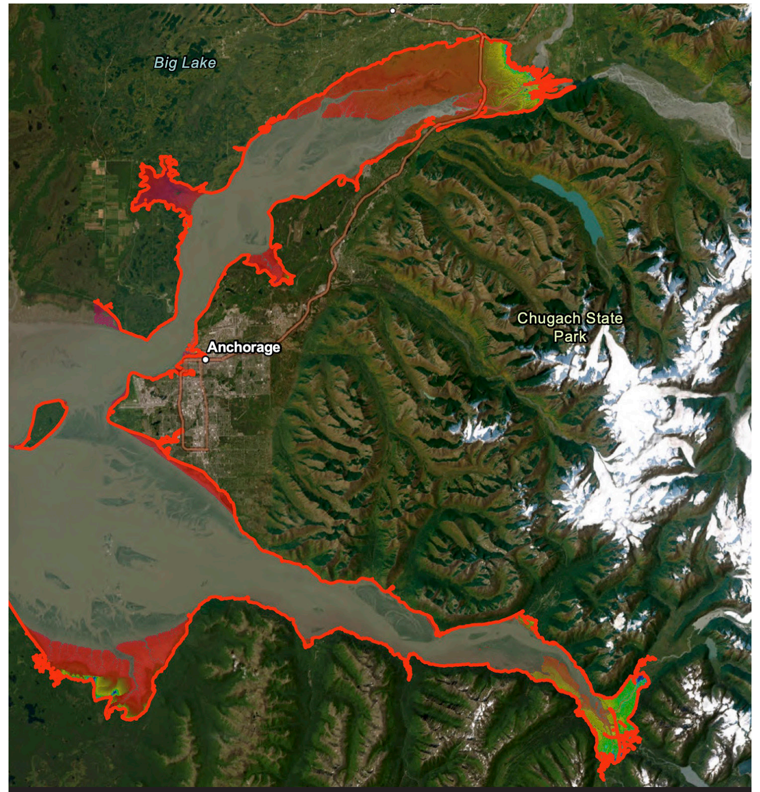
Between 2020 and 2024 there were four earthquakes offshore of Alaska greater than magnitude 7.0, which all resulted in tsunami warnings and evacuations. Fortunately, none of the resulting tsunamis turned out to be large enough to cause serious damage, due to depth, location, or mechanism of the earthquakes that produced them.

The Alaska Earthquake Center provides scientific tsunami hazard assessment products for Alaska's communities, in coordination with the National Tsunami Hazard Mitigation Program.

A New Look at Tsunami Hazard in Cook Inlet

A 2023 report by Alaska Earthquake Center tsunami researchers and our partners showed that, contrary to popular belief, upper Cook Inlet communities—including Anchorage—are at some risk from tsunamis.

On March 27, 1964, in the wake of the magnitude 9.2 Great Alaska Earthquake, there were no observations of a tsunami in Anchorage. For decades afterward, the absence of significant tsunamis in Cook Inlet supported the idea that its length and shallow waters offered protection. Since then, understanding of tsunami dynamics has increased significantly. The recent study's 1964 simulation shows a 10-foot-high tsunami did indeed reach Anchorage around 2:00 a.m., at *low tide*. Should a large earthquake trigger a tsunami that reaches the area at *high tide*, there would be flooding along low-lying areas of upper Cook Inlet.



Upper Cook Inlet tsunami hazard map

A Hidden Wave Emerges storymap

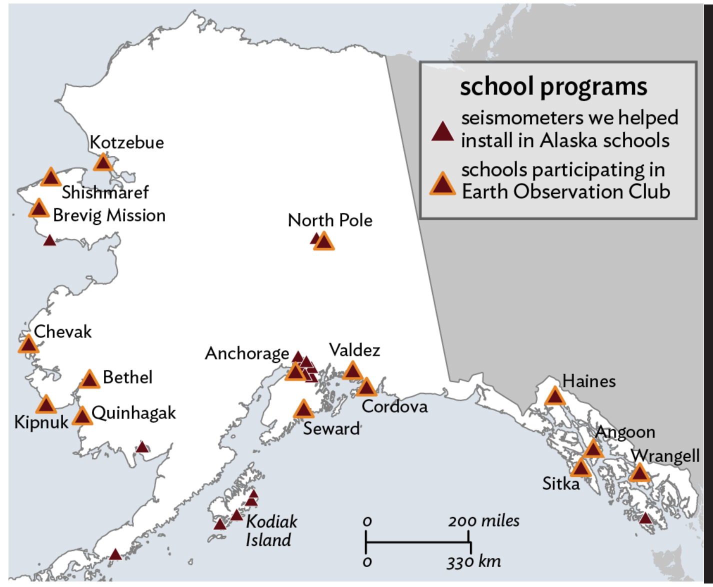
One new outreach outlet we explored in summer 2023 was the ArcGIS® StoryMap, an online tool for stories with interactive map elements. Our storymap depicts the tsunami modeling for upper Cook Inlet, and tells the history that led to the erroneous assumption that the area was immune to such risk. We then co-hosted several town halls in the area to present our findings and answer residents' questions. We continue to support communities in their tsunami planning.

In Schools

The Alaska Earthquake Center engages students across the state both in and outside the classroom, with the goals of promoting geoscience literacy, and increasing interest in and skills for geoscience careers.

We help bring earth observational equipment into classrooms across the state. Forty-five schools (and counting) host a seismometer linked to an online monitoring system. Any classroom, in Alaska or elsewhere, can view the live feeds to examine how seismic signals vary across the state.

We partner with the Alaska T3 Alliance to equip students in rural schools with monitoring tools that help them identify and address community issues. We also help connect these students across Alaska, building a cohort of young people sharing ideas as they learn about applying science to help their communities.



We support a network of in-school seismometers *that provides students the opportunity for hands-on, place-based STEM learning. This program is a partnership with T3, the National Science Foundation's Alaska Native Geoscience Learning Experience (ANGLE), the Anchorage School District, and all the individual schools.*

Workforce Development

Starting with the 2023–24 school year, the Earthquake Center refocused our after-school club program to provide students with technical, skills-based training in geophysical monitoring, particularly the technical deployment and maintenance of monitoring stations. Called the Earth Observation Club, it also includes a credentialing program that develops career skills and qualifies students for internships with the Earthquake Center.

Shake Challenge Symposium *(right). In March 2023, teams of students from seven rural Alaska schools gathered at UAF to present and demonstrate their seismic alert systems, programmed using live data from their school seismographs.*

Puerto Rico Seismic Resiliency Field Trip *(left). In April 2023, eight rural Alaska high school students journeyed to Puerto Rico for a week-long trip to foster student leadership, establish cross-cultural connections, and understand the similar challenges faced by these isolated and resilient regions. During this visit, the Alaska students helped their Puerto Rican peers install a seismometer with a live display in a local coffee shop, and presented their research projects at the Seismological Society of America conference.*

In Communities

A crucial part of the Alaska Earthquake Center's mission is communicating earthquake science and hazards in the state. We reach out in a variety of ways—publishing science news stories for our website and making quick updates on social media, working with local and state-wide media outlets, producing graphics to illustrate scientific processes and principles, engaging with the public at community events, and more.

We also host tours year-round! These happen weekly in the summer as part of the UAF Geophysical Institute summer tour series, and as special events and scheduled requests throughout the year.

If you have an idea for your community's needs, you can reach us at uaf-aec@alaska.edu or 907-474-7320. We would like to hear from you!

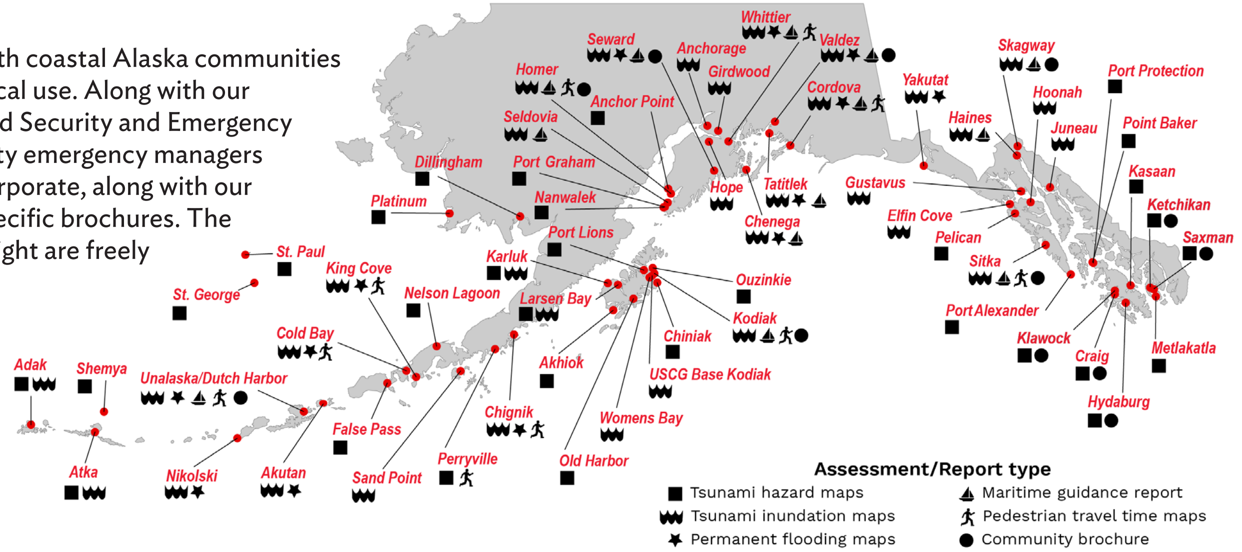
Quake Cottage *(left). We partnered with DHSEM to tour the Quake Cottage through Fairbanks. We organized first grade through high school students from 13 area schools to come to the UAF campus to experience a simulated earthquake. At several locations around town, people could climb aboard and feel the effects of strong shaking, to help them be more prepared during an actual earthquake.*

Tsunami Community Brochures

Over the past few years we have worked with coastal Alaska communities to put our tsunami hazard models to practical use. Along with our partners at the Alaska Division of Homeland Security and Emergency Management (DHSEM), we help community emergency managers determine evacuation areas, which we incorporate, along with our scientific assessments, into community-specific brochures. The tsunami information products featured at right are freely available on our website.

Online Resources

Our interactive website tool kit has grown considerably. We invite you to explore the features of the interactive earthquake map, as well as the shake maps for significant events, the tsunami hazard map tool (**tsunami.alaska.edu**), and more at **earthquake.alaska.edu**.



Tsunami hazard products available for coastal Alaska communities

We could not do what we do without extensive support—financial, logistical, and more.
We hope that these pages demonstrate that we are putting your support to good use!

Land Use Partners

Native Corporations and Village Councils

Arctic Slope Regional Corporation
Atxam Corporation
Bethel Native Corporation
Calista Corporation
Cook Inlet Region, Inc.
Dot Lake Native Corporation
Doyon, Limited
Eyak Corporation
Minto Village Council
NANA Regional Corporation, Inc.
Native Village of Nikolski
Native Village of Venetie Tribal Government
Nunamiut Corporation
Sea Lion Corporation
Sitnasuak Native Corporation
St. George Island Traditional Council
Tanadgusix Corporation
Tanana Tribal Council

Local Governments

Fairbanks North Star Borough
Matanuska–Susitna Borough
Municipality of Anchorage
North Slope Borough
City of False Pass
City of Galena
City of Gambell
City of Seward
City of Unalaska
Lake Minchumina

State Agencies

Alaska Department of Natural Resources (Northern, South-central, Southeast offices)
Alaska Division of Parks and Outdoor Recreation—Kachemak Bay State Recreation Area

Federal Agencies

Bureau of Land Management (5 offices: Fairbanks, Anchorage, Glennallen, Yukon, National Petroleum Reserve—Alaska)
Federal Aviation Administration
National Oceanic and Atmospheric Administration
National Park Service
U.S. Army—Fort Wainwright, Fort Greely
U.S. Army Corps of Engineers
U.S. Air Force
U.S. Coast Guard
U.S. Fish and Wildlife Service
U.S. Geological Survey
USDA Forest Service

Special Projects or Partner Sites

Alaska Gasline Development Corporation
Alaska Public Safety Communication Services
Alaska Energy Authority—Bradley Lake Hydroelectric Project
Alyeska Pipeline Service Company
EarthScope Consortium
National Tsunami Warning Center
University of Alaska Fairbanks—Geophysical Institute, College of Engineering and Mines

Private Landowners

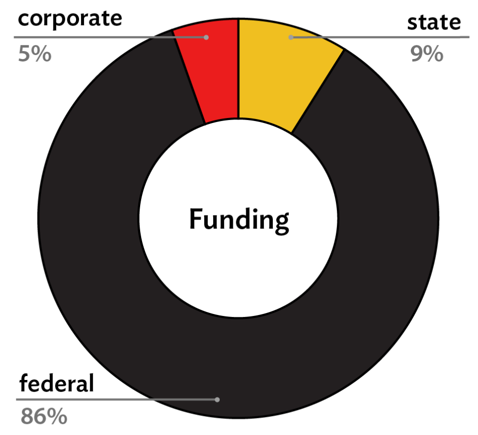
20+ sites

Station KNK (Knik Glacier) was installed in 1973 and has been upgraded over the years. The most recent addition is the GNSS instrument (dome at left) added in 2021. This site is hosted by the Alaska Department of Natural Resources.

Financial Supporters

Our funding comes from multiple sources:

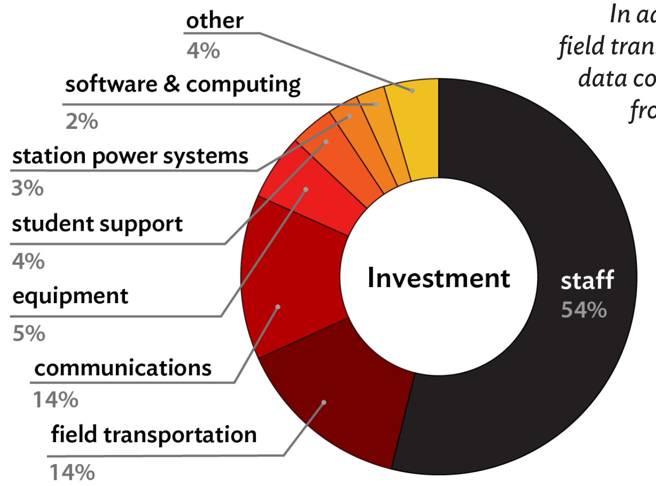
Federal Agencies include the U.S. Geological Survey, NASA, NOAA, the National Science Foundation, Lawrence Livermore National Lab, The Geophysical Detection of Nuclear Proliferation University Affiliated Research Center, U.S. Department of Defense, and the Federal Aviation Administration



State Agencies include the Alaska Energy Authority and the State of Alaska

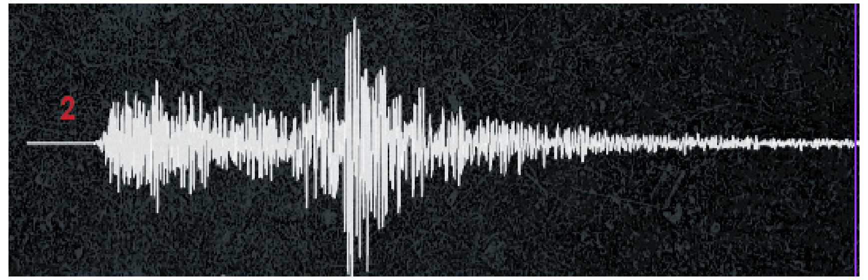
Corporate Entities include the Alaska Gasline Development Corporation, Alyeska Pipeline Service Company, Donlin Mine, and Synoptic Data

Spending



In addition to staff, field transportation and data communications from remote sites are major commitments.

Cover Image Key



1. Seismic record of a mine **explosion** near Healy, recorded by a seismic station near the entrance of Denali National Park and Preserve. *(AK.MCK.BHZ)*
2. Strong-motion record at False Pass during the magnitude 7.2 **earthquake** south of Sand Point on July 23, 2023. *(AK.FALS.HNZ)*
3. Long-period seismic record of a 2023 **landslide** in Denali National Park and Preserve. *(AK.KTH.BHZ)*
4. Infrasound signal of the Hunga, Tonga **eruption** on January 15, 2022, recorded in Homer. *(AK.HOM.BDF)*
5. One week of day–night **temperature changes** in July 2023 at station D25K in the Arctic National Wildlife Refuge. *(AK.D25K.LKO)*
6. Normal tidal fluctuation (high and low tides), shown in red, has a 30-foot range in upper Cook Inlet. The white line shows a modeled **tsunami** wave pushing water levels beyond normal high and low tide.
7. Ten years of **vertical motion** in the Susitna–Watana region north of Talkeetna. Data points (red) and the smoothed trend (white) show the seasonal loading and unloading of snow. The long-term upward trend reveals the buildup of strain in the subduction zone. (GNSS station *WAT1*)

Station names follow the format "network.station.channel."

ALASKA EARTHQUAKE CENTER

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UAF
UNIVERSITY OF ALASKA FAIRBANKS

ANSS

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Can you recognize the signal in these time series lines?

Test your knowledge, then check the answers on the inside back cover.