ALASKA EARTHQUAKE CENTER

A 2020 PERSPECTIVE

Advancing Alaska's resilience to earthquakes through monitoring, research, and public engagement

2020 Snapshot

Earthquake Roundup

- ***49,250*** earthquakes
- ***7,000+*** hours invested in earthquake analysis
- ***6,000*** aftershocks followed the July 21 M7.8 Simeonof Earthquake

Social Media

- ***38,000*** total social media followers
- ***7,000*** new followers
- ***600*** total posts
- ***89,000*** content engagements
- ***9,000*** people viewed the 2019 Seismicity YouTube video

Seismic Network

- ***96*** project sites adopted into permanent network
- ***123*** sites visited
- ***194*** technician-days in the field

Website

- ***2 million*** site visits
- ***1.3 million*** recent event map & list visits
- ***17*** earthquake and tsunami science stories

Media

- ***420*** media mentions in more than ***250*** different outlets
- ***88%*** of coverage was outside of Alaska

Data & Information Infrastructure

- ***2x*** compute capacity upgrade
- ***3x*** RAM capacity upgrade
- ***2x*** storage capacity upgrade
- ***200 TB*** of digital seismogram storage capacity

Tsunami Research

- ***8,000*** visitors to the tsunami inundation map tool
- ***1,700*** new map tool views during statewide radio spots
- ***3*** new community inundation reports
- ***2*** new pedestrian travel-time reports

Contents

Director's View

On behalf of the two dozen staff, faculty, and students at the Alaska Earthquake Center, I want to thank you for taking the time to get to know us. The center has evolved considerably in the past few years. We are expanding our reach with new partners — federal, corporate, defense, and state. We have substantially grown the monitoring network that underpins much of our work. We continue to benefit from outstanding support at the UAF Geophysical Institute. Despite the COVID-19 crisis, we have maintained collaborations with community leaders, scientists, and emergency managers to continue preparing for rare but life-changing earthquakes and tsunamis. Some of our newest research partnerships leverage the network for uses including national security, resource development, and tracking growing hazards such as coastal landslides.

Recent earthquake and tsunami events in Southcentral, Kodiak, the North Slope, Southeast, the Aleutians, and elsewhere have provided us with ample — if unwanted — validation for what we do. We are fiercely proud of our mission to improve Alaska's resilience to earthquakes. We are proud to be a daily part of making Alaska a safer, more prepared, more economically attractive, and more informed place to call home.

I hope the following pages give you a glimpse into how we fulfill our mission for the wide range of stakeholders we serve.

> We are proud to be a daily part of making Alaska a safer, more prepared, more economically attractive, and more informed place to call home.

Michael West
Research Professor / State Seismologist

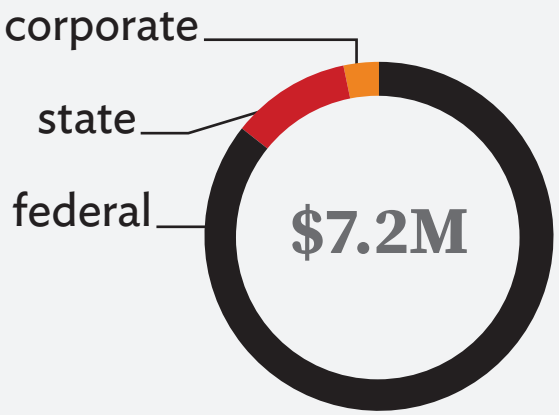
Funding Overview

The center is supported by a mix of state, federal, and corporate stakeholders. Federal investment has been increasing since 2017. Much of this is tied to expansion of the network as we have acquired stations previously part of the USArray project (see p. 12).

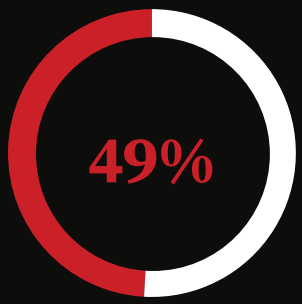
Nearly half of the center's support comes from the USGS Earthquake Hazards Program to support Alaska's participation in the Advanced National Seismic System. The ANSS provides national coordination to integrate Alaska's monitoring activities with what happens elsewhere in the country.

Center Support

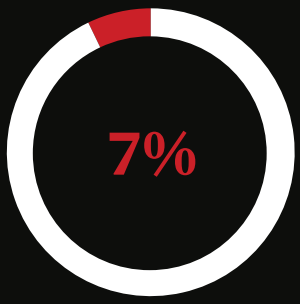
$5.5M direct project costs
$1.7M UAF facilities and services



Support as a percentage of overall funding



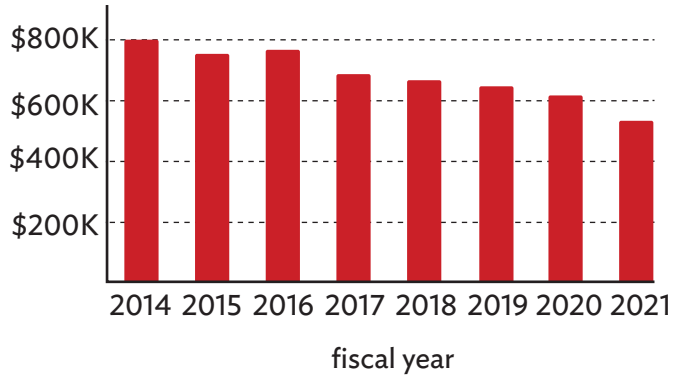
USGS



Dept. of Defense

NOAA

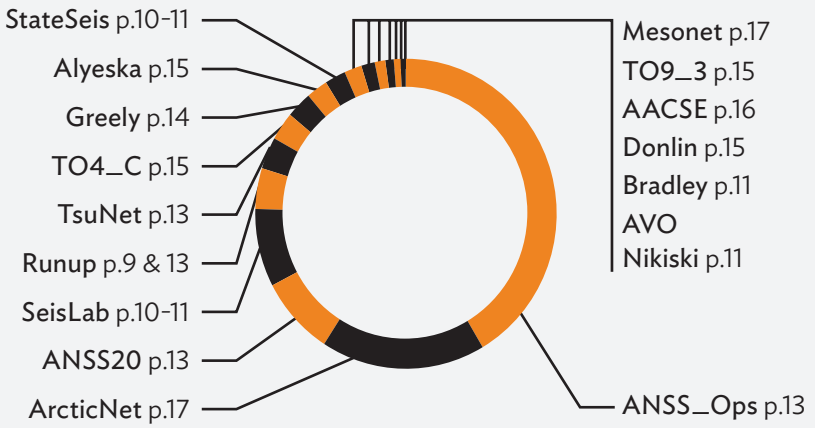
State Investment



For more than 30 years, our mission has been supported, in part, by the state. State investment has decreased steadily since 2014, roughly tracking the reduced support for the University of Alaska. This decrease has been largely offset by new federal investments. There is a long-term concern, however, that these trends will shift the focus more toward national priorities and potentially away from the needs of Alaska.

The center is supported across a wide range of projects. Some of these projects encompass much of the center's activity. Other projects are tied to customized services. Federal support to the center improved markedly in 2018 and remains strong (p. 12-13). Corporate sponsorships have increased in the past few years (p. 14-15). These are a small part of our overall operating budget but are important because they align closely with our mission objectives. Department of Defense investments have grown (p. 14-15) to be an appreciable part of our portfolio in the past few years. This is due to the combination of recent growth in DoD facilities in Alaska and UAF's recent designation as a University Affiliated Research Center.

FY2021 Project Support



2020 Seismicity in Alaska

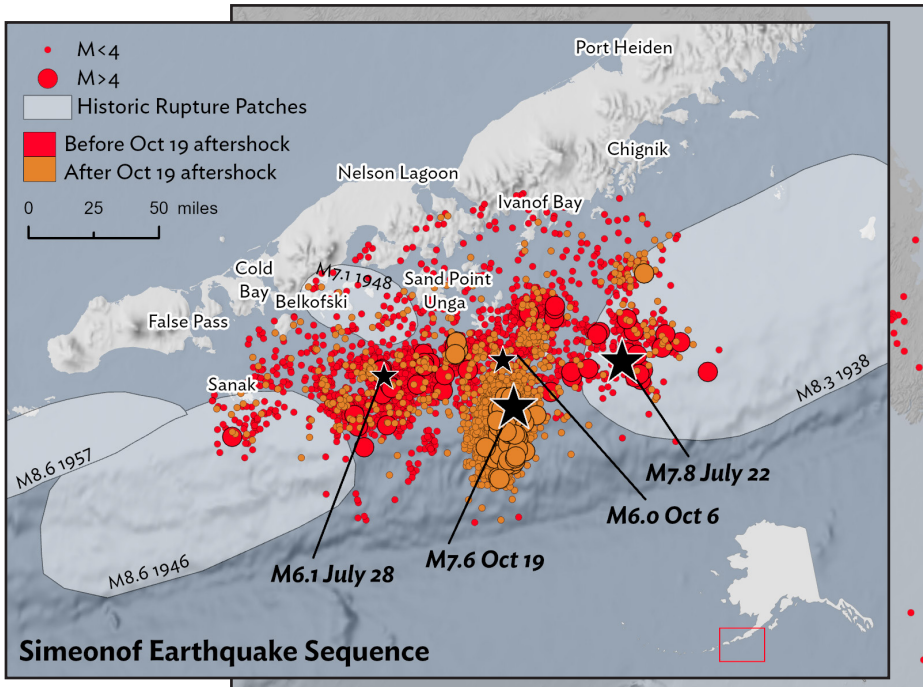
The largest and third largest earthquakes worldwide in 2020 were both in Alaska: the M7.8 Simeonof Earthquake and its M7.6 aftershock. Overall, the Earthquake Center reported 49,250 seismic events in Alaska and nearby regions in 2020. This ranks as the state's third largest year, after 2018 (about 55,000 seismic events) and 2019 (about 50,000 seismic events). Below, we explore some of the noteworthy events from 2020.

Simeonof Earthquake

The M7.8 Simeonof Earthquake and M7.6 aftershock both caused damage in several Alaska Peninsula communities and prompted tsunami evacuations, although fortunately neither triggered significant tsunamis. These two earthquakes were also some of the most scientifically interesting of 2020. In the era of instrumental recordings, very large earthquakes have occurred along the Aleutian Islands chain, with the exception of the region near the Shumagin Islands.

Seismologists have long suspected the "Shumagin Gap" would eventually experience a large earthquake. On July 22, a magnitude 7.8 earthquake struck the Shumagin Islands region, just south of Simeonof Island. On October 19, a magnitude 7.6 aftershock shook the region. The Simeonof Earthquake series partially filled this long-recognized seismic gap.

There are more differences than similarities between the two earthquakes. The July M7.8 earthquake ruptured a section of the boundary between the subducting Pacific and overriding North American plates. The M7.6 earthquake had a different source mechanism and was likely associated with a fault inside the subducting Pacific Plate rather than on the plate interface.



Simeonof Earthquake Sequence

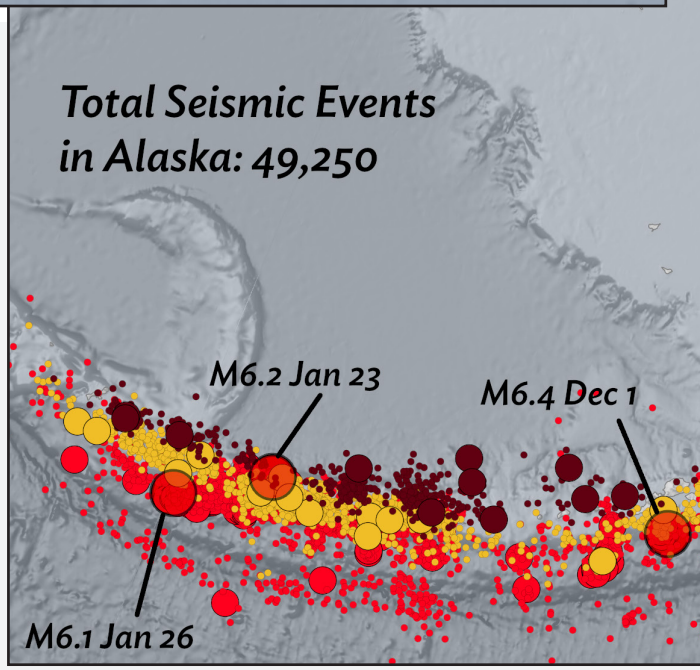
Prior to the October 19 aftershock, we recorded over 2,200 aftershocks with the largest magnitude of 6.1. The M7.6 earthquake generated its own aftershock sequence, which has produced more aftershocks than the M7.8 sequence. We expect this Simeonof aftershock sequence to continue through most of 2021, at least.

2018 Anchorage Earthquake Aftershocks

Aftershocks from the November 30, 2018 M7.1 Anchorage Earthquake continued into their second year at an average of about 26 earthquakes per week. Several days of renewed aftershock activity — spurred by a M5.1 aftershock on November 7 — were felt across Anchorage and the Mat-Su Valley.

2018 Kaktovik Aftershocks

We continued to record aftershocks of the 2018 M6.4 Kaktovik Earthquake. We expect this to continue in 2021.



Purcell Mountains Swarm

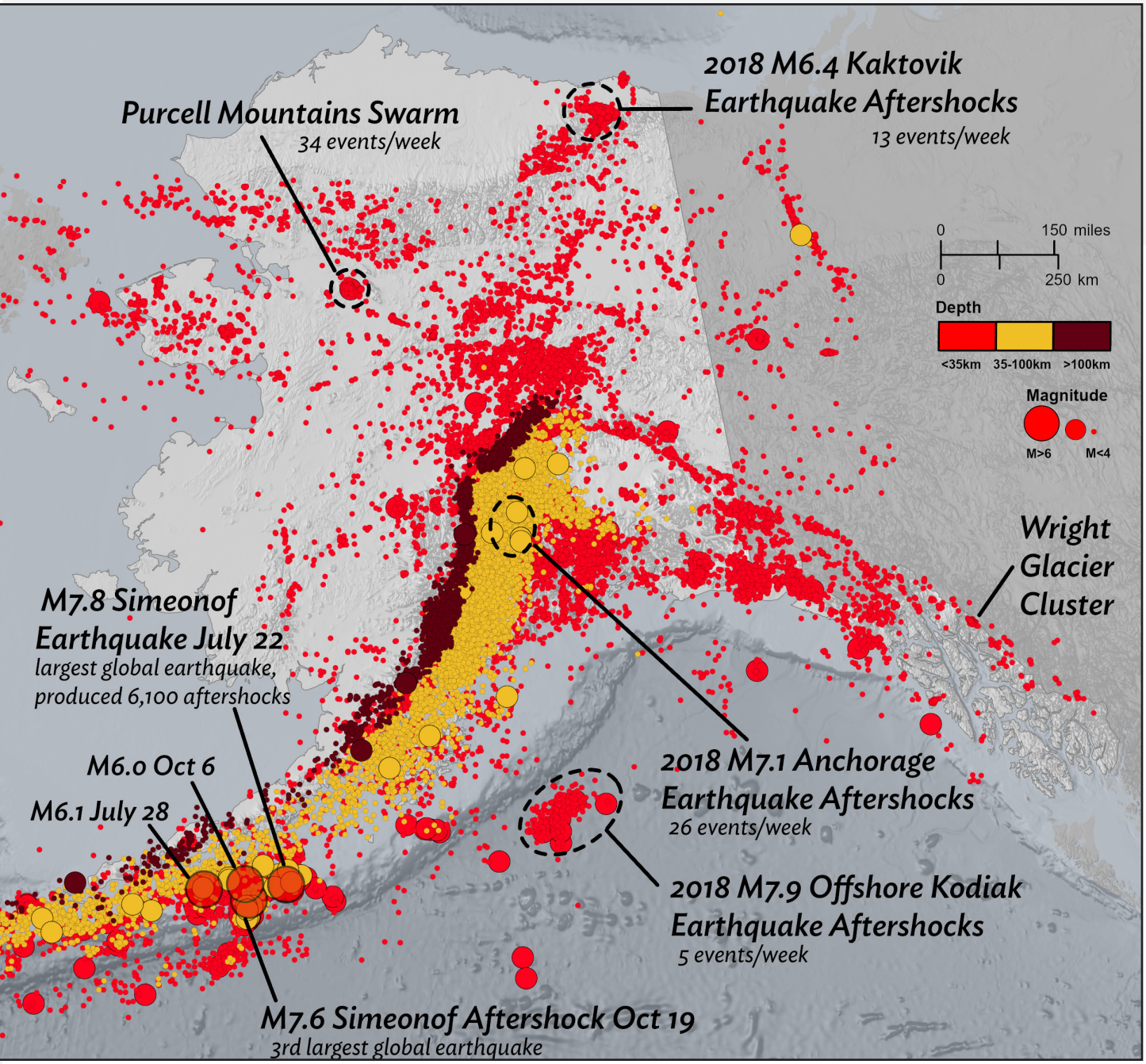
The Purcell Mountains Swarm, which began in March 2019, turned out to be the second largest contributor to the statewide earthquake total in 2020. Although less active than in 2019, in 2020 it continued at a steady pace of about 34 earthquakes per week.

Wright Glacier Cluster

An unusual cluster of quakes occurred July-September under Wright Glacier about 40 miles northeast of Juneau. A few of these events reached M3.0-3.4 and were felt in Juneau. These events are enigmatic and possibly glacial in origin.

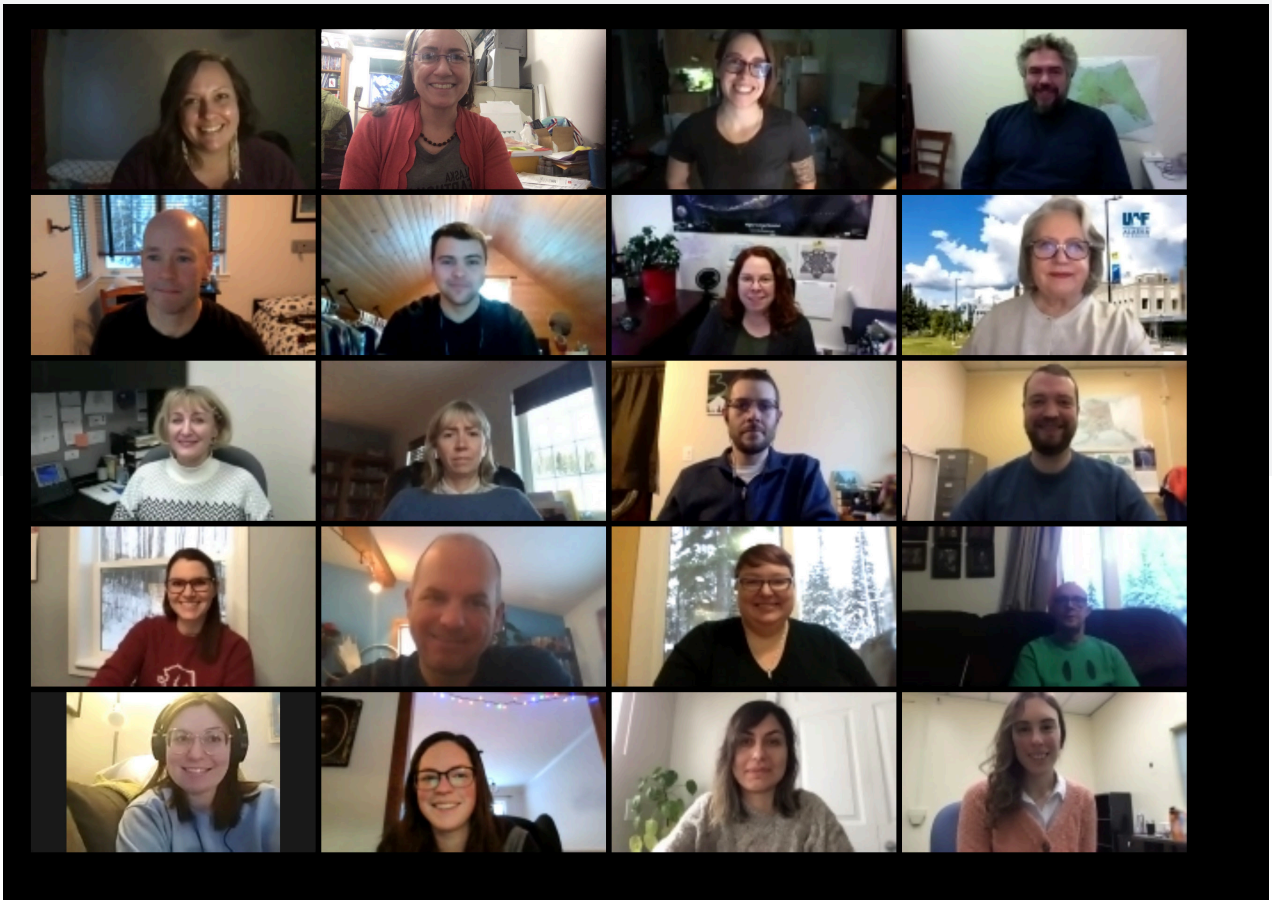
2018 Offshore Kodiak Aftershocks

We also continued to record aftershocks of the M7.9 Offshore Kodiak Earthquake sequence. We expect this sequence to continue in 2021.



Together While Working Apart

In March 2020, the Earthquake Center staff switched to working remotely in response to the COVID-19 pandemic. Zoom meetings (like the one below) became the norm. Because we have long been configured to respond to earthquakes off-hours from home, we transitioned smoothly to keeping our operations running from home offices.



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Research Technician

Ezgi Karasözen
Postdoctoral Fellow

Alexandra Farrell
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Not pictured: Ronni Grapenthin, Dmitry Nicolsky, Carl Tape, Lucas Cheek, Pete Reynoldson, Kenneth Macpherson, Kenneth Becker, Nicholas Alexeev

We Serve...

The Alaska Earthquake Center exists to make Alaska more resilient to earthquakes and tsunamis through the combined efforts of monitoring, research, and public engagement. Our charge comes from the Alaska Legislature (AS 14.40.075) and the many stakeholders we support with data, products, and outreach.

Nature sets our agenda. We adapt our infrastructure, analyses, and even personal schedules in ways that enable us to serve our stakeholders' needs rapidly and efficiently. The center's values emphasize a team environment that encourages different perspectives, supports staff in professional growth to meet evolving needs, and fosters the clear communication of science internally and externally.

The following pages illustrate the different ways we serve Alaskans, state organizations, federal agencies, industry and defense partners, the scientific community, and the University of Alaska.

our mission:

advancing Alaska's resilience to earthquakes through monitoring, research, and public engagement

Organizational Values

We Serve Alaskans

Reaching Out about the Tsunami Map Tool

Tsunamis can strike within minutes in Alaska. Anyone who lives, works, or visits a coastal community needs to be aware of tsunami safety. In September 2019, the center launched a new, interactive tsunami map tool at **tsunami.alaska.edu**. The map provides a quick, easy way to view information from our science-based reports about potential worst-case scenarios for tsunami flooding. In early 2020, we experimented with running statewide radio spots to encourage use of the map tool. The spots aired from January 27 through April 30.

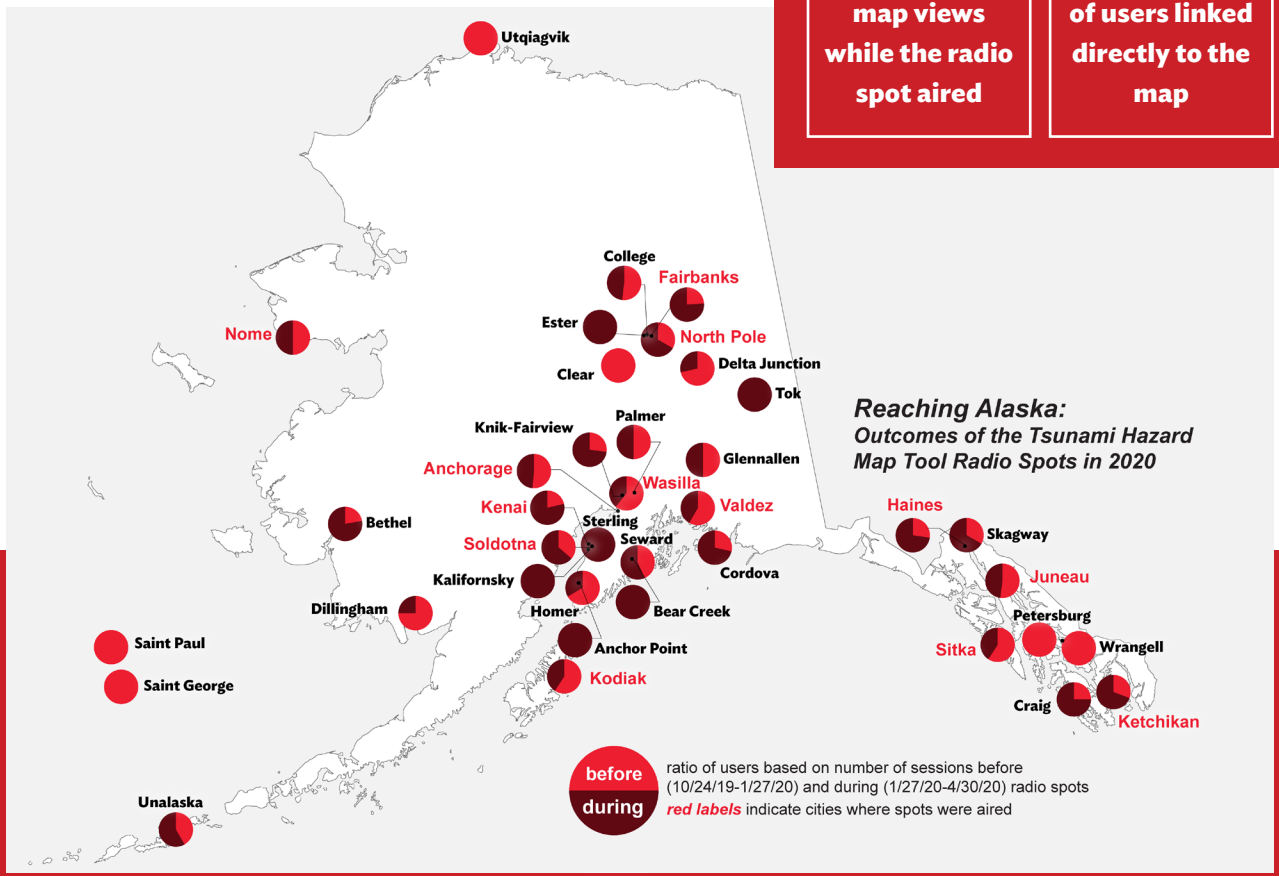
We found that 96% of all traffic was direct traffic (people used tsunami.alaska.edu to reach the tool). Overall, during the radio spot period the session duration averages increased — people engaged for longer. By partnering with the Alaska Broadcasters Association, we were able to secure airtime on local community radio stations as well as stations with broad statewide reach.

51
stations aired radio spot

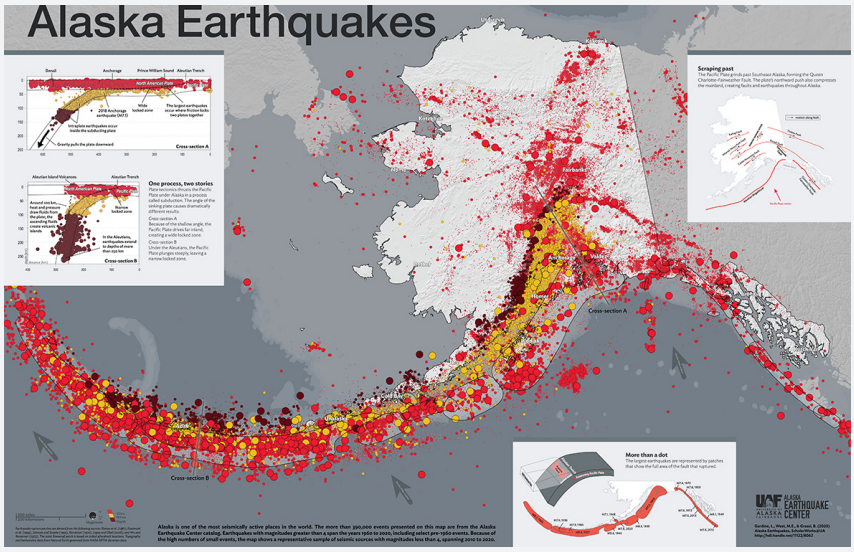
10,167
radio spots aired

1,700
map views while the radio spot aired

96%
of users linked directly to the map



Most communities saw a change in the number of tsunami map users while the radio spots aired.



(L) The City of Valdez plans to distribute 5,200 tsunami hazard brochures.
(R) New Alaska Earthquakes poster

New Website Products

The Earthquake Center's recent earthquakes map is the most visited page on our website. In light of 70% of users accessing our website on mobile devices, in 2020 we upgraded the recent earthquakes interactive map to be mobile-first. The new layout includes customizable magnitude, date, and depth tools as well as other information layers such as seismic stations and volcanoes. Give it a test drive today at **earthquakes.alaska.edu/earthquakes.**

Alaska has a long history of earthquakes, and the Earthquake Center's newly revised Significant Events page offers easy access to information about recent and historical earthquakes. The profile for each earthquake may include fault, tsunami, ShakeMap, tectonic setting, aftershock, or human impact information as appropriate. **earthquake.alaska.edu/significant-event-page**

New Alaska Earthquakes Poster

The Earthquake Center's new Alaska Earthquakes poster connects the geographic distribution of earthquakes from the center's catalog of earthquakes with the core concepts that drive Alaska seismicity. The poster includes historical seismicity up to and including the magnitude 7.8 Simeonoff earthquake in 2020. Print versions are available upon request. This publication is also available for download on UAF's Scholarworks page in the Geophysical Institute community. **(https://scholarworks.alaska.edu/handle/11122/8062)**

Community Tsunami Hazard Brochures

Scientific assessment of tsunami hazards for Alaska communities is one of the major efforts of the Earthquake Center. As a pilot project to make this hazard information more accessible to communities, we coordinated with Unalaska and Valdez to condense our inundation, marine response guidance, and pedestrian travel time reports into easy-to-distribute, community-specific brochures that complement the tsunami.alaska.edu webpage. Each brochure features a map with hazard information plus community-designated safety information. **earthquake.alaska.edu/tsunamis**

Expanding Social Media

Our ever-growing social media following (20% increase in 2020) prompted expanding our presence to include a Facebook Page in December, in addition to our Facebook Group. The page now hosts the majority of our posts and the group has returned to being a discussion forum. Our Twitter presence remains a crucial avenue for our social media engagement. **@AKEarthquake**

We Serve State Organizations

Landslide Tsunami Hazard in Barry Arm Fjord

In May of 2020, The Alaska Division of Geological and Geophysical Surveys (DGGS) warned of an unstable fjord wall in Barry Arm with the potential to fail catastrophically, generating a tsunami that could propagate throughout Prince William Sound. This announcement was based on data and research from a broad team of scientists. Though the timing and scope of natural events in Barry Arm are uncertain, recent events including the 2015 landslide tsunami in Icy Bay and slope instabilities fostered by glacier retreat throughout Alaska make clear that this hazard requires more attention. "If this slope were to release in a single catastrophic failure, it could be comparable to a magnitude 6 or larger earthquake," said Michael West, state seismologist at the Alaska Earthquake Center. Massive landslides can send tsunamis into coastal communities and threaten cruise ships, ferries, personal vessels, and other marine traffic throughout the sound. But the study of these phenomena in Alaska is in its infancy.

During a summer field season otherwise hampered by COVID-19 considerations, the Earthquake Center was well-positioned to contribute real-time, on-the-ground data to the DGGS-led effort. Field operations manager Scott Dalton said a July site visit showed "We didn't have good cellular coverage in Barry Arm. We had to build a third site as a repeater for the two stations in Barry Arm." In late August and early September, the field crew installed all three sites, with safety as a major concern. One Barry Arm station perches on the landslide area. For safety, the crew compressed the installation into only three hours on the ground. The field team pre-assembled the instrument hut, which a helicopter carried to the site. The crew buried the sensors directly in the ground. In contrast, the site on the opposite side of the fjord took two days for the team to dig a hole and pour concrete to create a standard instrument vault. This second site also hosts a webcam that sends photos of the unstable slope during daylight hours.

The 2020 seismic installations were an initial foothold in what is sure to be a long-term multidisciplinary study and monitoring effort. DGGS, the National Tsunami Warning Center, and the U.S. Geological Survey are developing warning techniques. The Earthquake Center's rapid response in 2020 is providing input on how to operate effectively in this setting and is providing data to study the minute-by-minute evolution of this landscape feature.

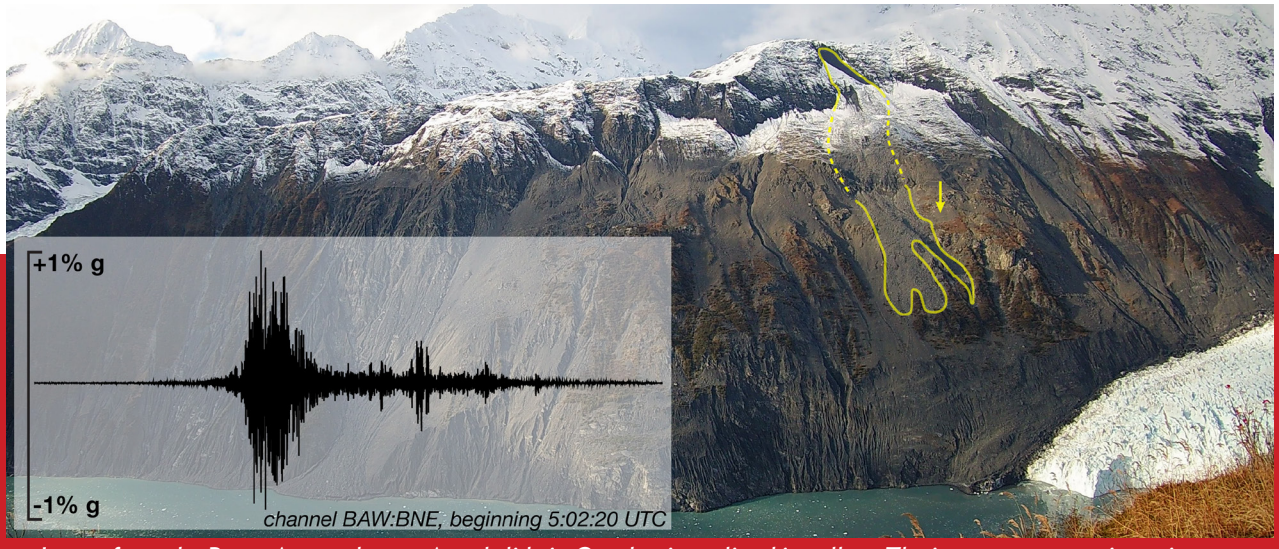


Image from the Barry Arm webcam. A rockslide in October is outlined in yellow. The inset strong-motion seismogram shows the likely seismic signal of this event, recorded at the location marked by the yellow arrow.

Bradley Lake Dam

Committees the Alaska Earthquake Center Advises

We provide technical expertise to a wide variety of state and local planning organizations. These include appointments to the Alaska Seismic Hazards Safety Commission and the Fairbanks North Star Borough Emergency Planning Committee. We interact frequently with the Anchorage Geotechnical Advisory Committee, the Western States Seismic Policy Council, the Alaska chapter of the Earthquake Engineering Research Institute, and various hazard planning committees coordinated by the Alaska Division of Homeland Security.

Alaska Division of Homeland Security and Emergency Management

The Alaska Division of Homeland Security and Emergency Management leads the state's tsunami preparations. The Earthquake Center has long partnered with DHS&EM to provide a scientific foundation that supports community-level efforts to plan for evacuations and increase tsunami resilience. Products include reports and maps of maximum anticipated tsunami inundation, pedestrian evacuation travel times, permanent subsidence, harbor currents, and maritime guidance. The core products are published through the Alaska Division of Geological and Geophysical Surveys. Led by DHS&EM, all three organizations partner to work on the ground with community leaders and the public to prepare for rare, but inevitable, tsunamis. Multiple evacuations over the past three years, plus growing landslide awareness, has given these efforts a renewed sense of urgency.

Alaska Gasline Development Corporation

The center entered a new arrangement this year with AGDC to operate a strong-motion site in Nikiski near the terminal of the proposed liquified natural gas export facility. This site replaces an earlier proprietary station, making it possible to integrate these data into the center's earthquake and ground motion information products.

Bradley Lake Utility

For the past decade, the center has maintained four stations at the Bradley Lake Hydroelectric Project: two strong motion sensors in the dam itself, and two broadband stations a short distance away. The center provides dedicated earthquake monitoring and reporting in the vicinity of the hydroelectric plant.

We Serve Federal Agencies

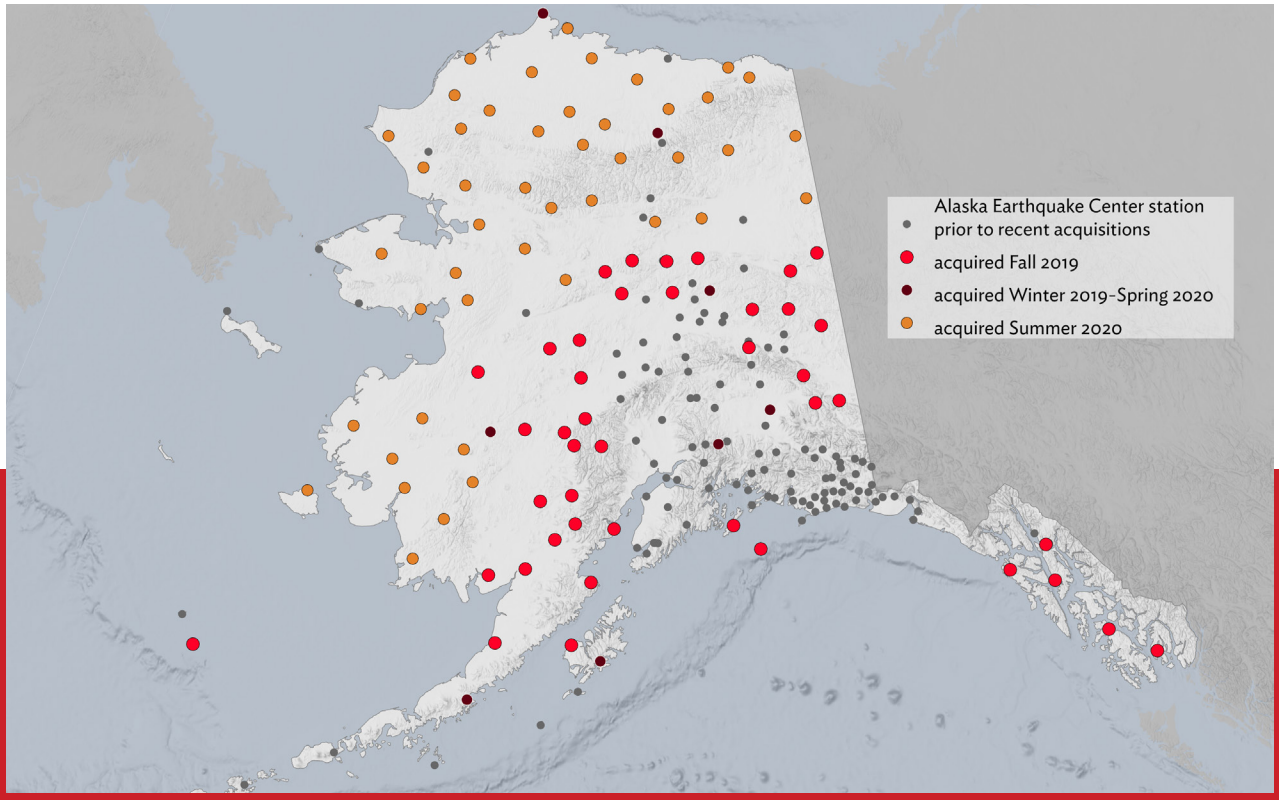
Expanding Alaska's Seismic Network

During 2019-2020, the Earthquake Center underwent an unprecedented expansion of our permanent seismic monitoring network, with fall 2020 marking the first full year of expanded operation in southern Alaska. We acquired 96 sites from the USArray project. These sites were originally installed as part of the USArray project funded by the National Science Foundation. The project, however, had a limited time span: all seismic sites were scheduled for removal in 2020-21.

The acquisition process began in fall 2019 with 43 sites in Southcentral, central, and Southeast Alaska. This effort was made possible through strong support from the U.S. Geological Survey and help from Alaska's congressional delegation. We added eight more sites in winter 2019 and spring 2020. Later in 2020, we acquired an additional 45 stations in northern and western Alaska.

The acquired stations bring a variety of benefits. The denser network coverage has increased our detection of smaller magnitude earthquakes. Most of the stations also host weather and infrasound instruments, which have brought in new partners such as the National Weather Service.

The former USArray stations rely on a mix of lithium batteries and more traditional lead-acid batteries. Field operations manager Scott Dalton said the USArray project was "trying to push the envelope a little and use new technology when they installed the stations." The lithium batteries weigh less than lead-acid batteries, they last longer, and perform better at low temperatures, all useful qualities for remote Alaska stations. As the technology develops, they could become a more common part of our network operations.



The Earthquake Center acquired 96 stations from the USArray project, greatly expanding statewide network coverage.

(L) Map from the regional tsunami hazard assessment for St. Paul, Alaska
(R) The field crew practiced COVID-19 precautions during site visits.

USGS Advanced National Seismic System Support

The Alaska Earthquake Center has been in formal collaboration with the U.S. Geological Survey since 1989. For the past two decades this collaboration has been under the umbrella of the Advanced National Seismic System. Under the ANSS, the center contributes authoritative earthquake information into national databases maintained by the USGS, and follows operating standards agreed to by the collective ANSS partners across the nation. Through the ANSS program, the USGS provides a considerable portion of the financial support necessary to maintain the seismic network and produce downstream products.

National Tsunami Warning Center Support

Since the early 2000s, the center has partnered with the NOAA/NTWC to ensure that Alaska's seismic network includes sufficient monitoring capability to support NTWC's tsunami warning mission. The Earthquake Center operates a dedicated set of stations specific to NTWC's standards. In addition, we maintain dedicated, and redundant, delivery of seismic data from across the region as well as direct communication on data issues and situational awareness.

National Tsunami Hazard Mitigation Program

Since its founding in the late 1990s, we have been a partner to NOAA's National Tsunami Hazard Mitigation Program. The NTHMP brings together federal and state partners with the shared goal of improving tsunami preparedness through research, community-specific products, and direct engagement with civic leaders. Under the auspices of the NTHMP we continue to create and improve tsunami inundation products for coastal communities. Recent work has focused on incorporating the impact of splay faults, which in some situations can hasten the arrival time of tsunamis. Despite COVID-19 concerns, we were able to continue direct community involvement through the year using a mix of virtual and careful in-person gatherings.

Communities addressed by NTHMP publications in 2020 include Akhiok, Chiniak, Cordova, Dillingham, Hydaburg, Karluk, Kasaan, Klawock, Kodiak City, Larsen Bay, Metlakatla, Nelson Lagoon, Old Harbor, Ouzinkie, Pelican, Platinum, Point Baker, Port Lions, Port Protection, Saint George, Saint Paul, and Sitka.

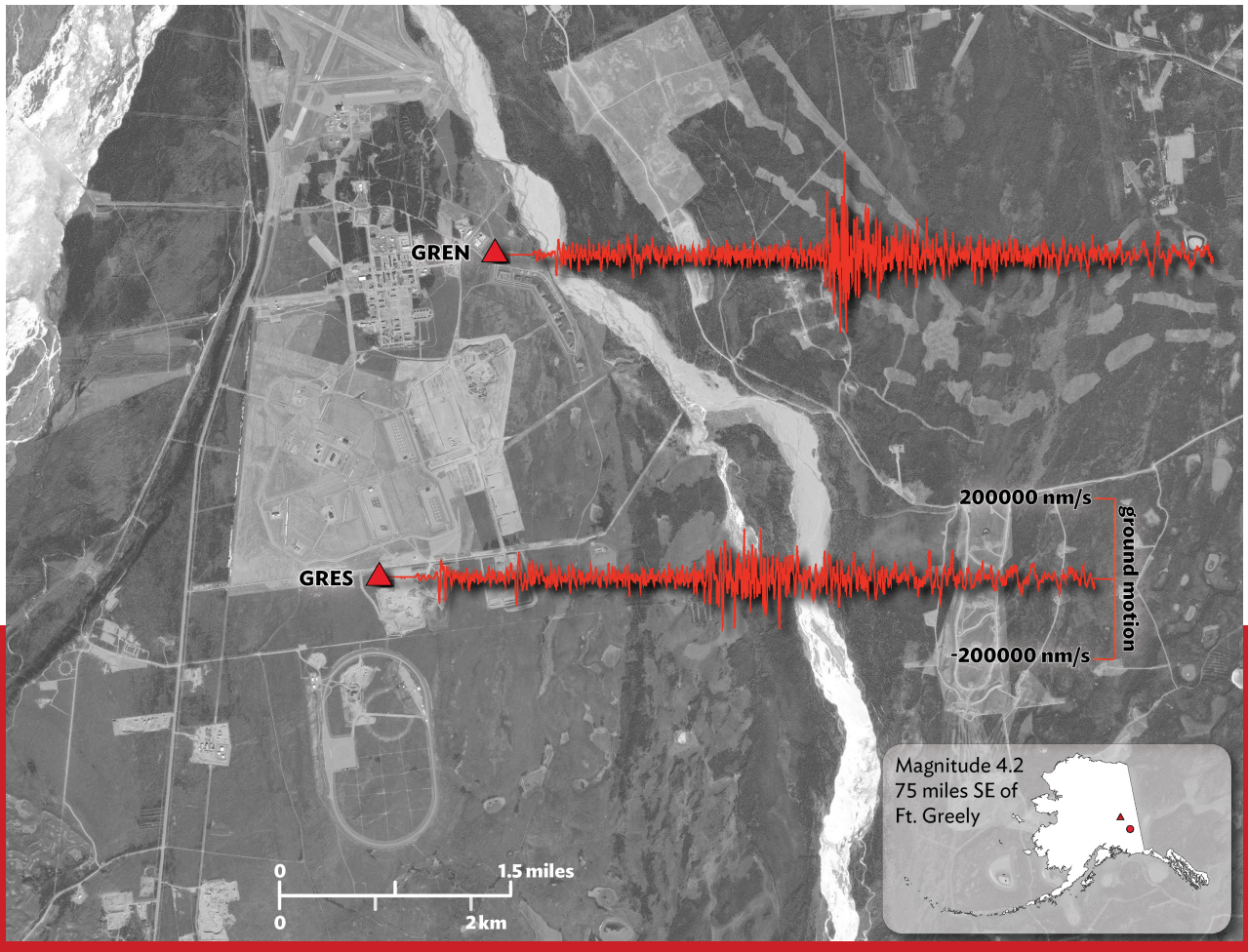
We Serve Defense and Industry Partners

Monitoring Structure Safety at Fort Greely

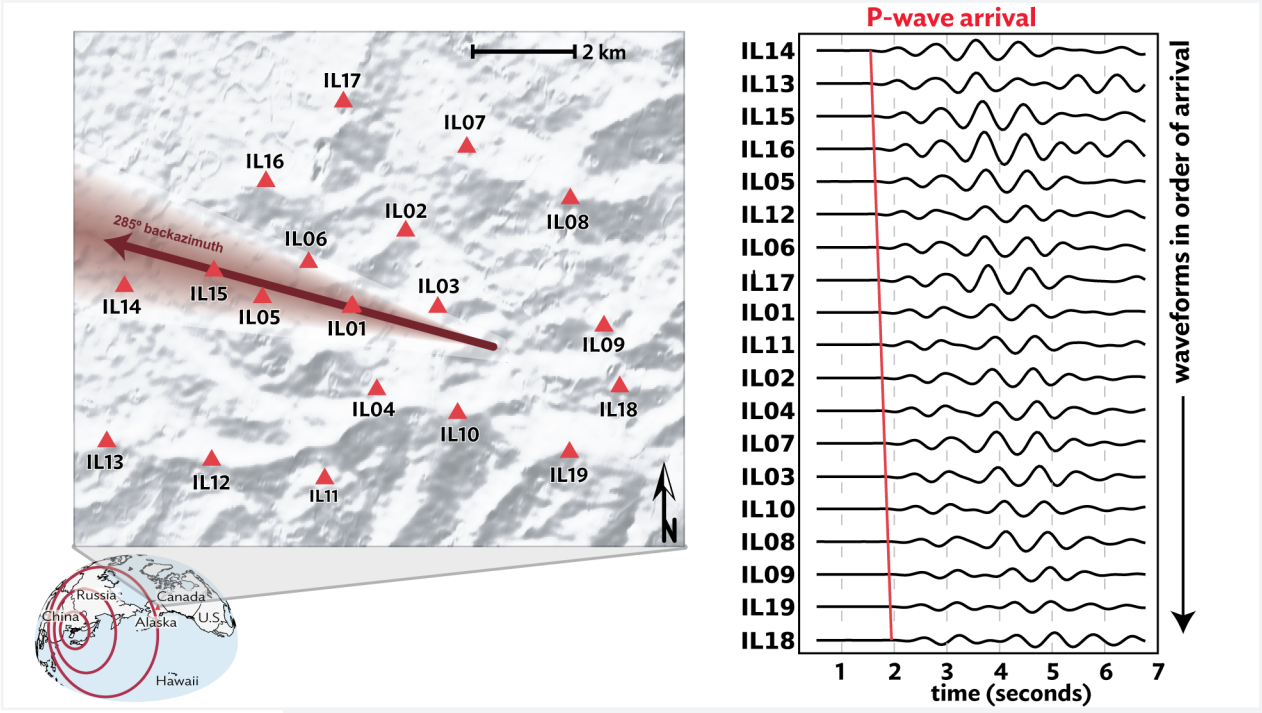
As part of a new pilot project with the Missile Defense Agency, the field team installed two new broadband and strong motion stations. Along with a nearby existing station, this mini-network will help assess site response issues and monitor for strong ground motion.

"The question people care about is how strong is the shaking, and will it damage stuff that they own? That's what this network measures," Earthquake Center operations seismologist Matt Gardine said. The project is similar to monitoring the center has done for the Trans Alaska Pipeline for the past 15 years. The Fort Greely effort is going a step further by tracking the seismic frequency of ground motions. Buildings and infrastructure respond differently to low- and high-frequency vibrations. Alarms tailored to specific frequencies can differentiate damaging seismic waves from other types of vibration, such as heavy equipment working nearby. "It's the next level of information about earthquakes," Gardine said.

"If you are a facility that has critical infrastructure, this can help direct what to inspect," Gardine said.



Strong-motion recordings of a M4.2 earthquake in the Fort Greely region



Seismic waves from a North Korea nuclear test propagating across the array at Eielson AFB. The time of arrival at each station can be used to determine the direction to the source, as well as the type of seismic wave.

Donlin Mine

In 2020, Donlin Gold provided financial support for the Earthquake Center to acquire a USArray station located about 6 miles from the company's proposed gold-mine site. In May 2020 the center began operating the station and reporting routinely on earthquake activity in the vicinity.

Alyeska Pipeline Service Company

Since 2008, the Earthquake Center has monitored earthquakes and strong ground motion along the Trans Alaska Pipeline System for the Alyeska Pipeline Service Company. There are 10 broadband and strong motion sensors at pump stations and one in the Valdez oil terminal. The center is frequently in routine contact with pipeline authorities. When strong ground motion triggers alarms, authorities initiate appropriate safety protocols. Due to COVID-19 concerns, 2020 annual inspections were cancelled, although all stations continue to be in good working order.

Array Applications

Michael West, Ezgi Karasözen, and Alex Farrell are developing better methods for analyzing data from small-aperture seismic arrays that are traditionally used for nuclear test monitoring. Alaska hosts four of these arrays. The primary effort this year focused on developing new noise-reduction algorithms. By benchmarking these algorithms on data from the Alaska arrays we have also been able to explore whether these arrays can be better leveraged for regional monitoring efforts.

Infrasound Network

Late in 2020, the Earthquake Center partnered with the Wilson Alaska Technical Center to begin a three-year project assessing the utility and performance of infrasound sensors colocated at 107 of our field sites. WATC brings considerable technical expertise to the analysis of infrasound data. The Earthquake Center is managing the acquisition and dissemination of these data and preparing field tests to improve data quality from these infrasound sensors.

We Serve the Scientific Community

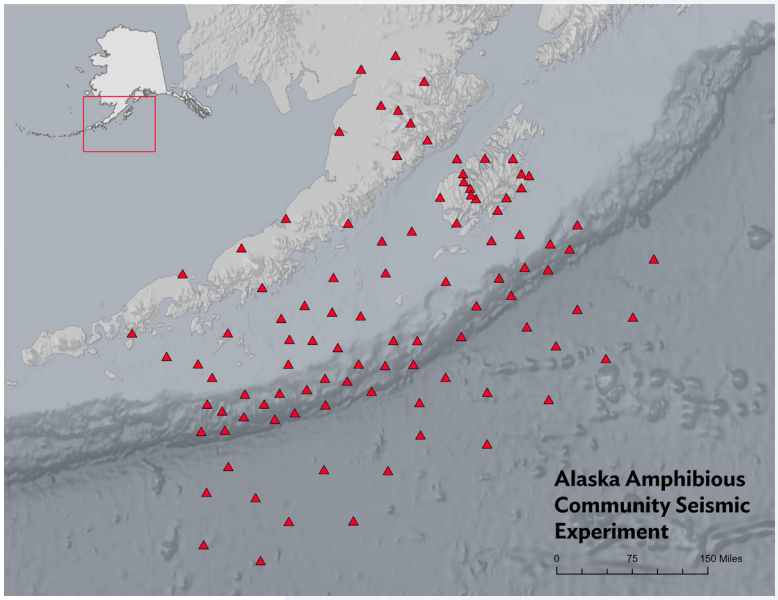
Offshore Seismic Network Improves Earthquake Detection

The Alaska Amphibious Community Seismic Experiment is a combination onshore/offshore temporary seismic deployment, supported by the National Science Foundation GeoPRISMS program, and executed by a team spanning many universities. An onshore set of 30 temporary seismic stations, along with 75 ocean bottom seismometers, were deployed from 2018 to 2019, spanning 400 miles along the subduction zone from Kodiak to Sand Point.

With support from the USGS, the Earthquake Center tackled the enormous task of analyzing earthquake activity observed by the deployment. Staff member Natalia Ruppert participated in the 2018 deployment and is leading the analysis. The new data provides a rare opportunity to derive much higher resolution earthquake locations and profiles. Observations in the offshore regions are normally hampered by the sparse distribution of the land-only seismic network. With Ruppert's guidance, the ocean-bottom deployment was shifted slightly to include the source region of the January 2018 magnitude 7.9 earthquake that occurred offshore of Kodiak Island. "We are seeing aftershocks we couldn't see before," undergraduate analyst Ken Becker said.

"Our goal is to compile a better catalog of earthquake activity, which can then be a foundation for downstream research on earthquakes, tsunami hazard, and volcanic processes," said Ruppert.

Deploying an ocean bottom seismometer takes precision; data is not accessible until the station is retrieved. (AACSE project photo)



(L) Map of AACSE stations, both offshore and on land
(R) Weather sensors are visible on top of the recently acquired station G19K (USArray photo).

Open Access Seismic Data

Unfettered public access to seismic data has been an Earthquake Center objective for years. In 2020 the few remaining corporate stations with embargoed data were successfully transferred into the public domain. As a result, these stakeholders will now benefit from full inclusion in research studies and quality control benchmarking by third parties. For new projects started in 2020, the center successfully negotiated full open data policies.

New Stations Provide Weather Data

The majority of the 96 stations acquired from the USArray project have sensors for temperature, wind, precipitation, barometric pressure, infrasound, and soil temperature. The Alaska Earthquake Center partnered with the Alaska Climate Research Center to join the NOAA National Mesonet Program and promote the dissemination and operational use of weather data. In addition to the IRIS Data Management Center, these auxiliary data are being distributed through standard community portals including MesoWest and the National Snow and Ice Data Center. These data are used by various weather forecasting operations and by the Alaska Interagency Coordination Center for wildfire management.

Special Journal Volumes

Many staff participated in a focus section of Seismological Research Letters capturing observations from the November 30, 2018 M7.1 Anchorage Earthquake. Much of this research was presented at the Anchorage Earthquake Symposium held in 2019. **(https://pubs.geoscienceworld.org/srl/issue/91/1)**
Dr. Natasha Ruppert guest edited a special focus section of Seismological Research Letters that presented observations from the EarthScope program in Alaska and Canada, including the AACSE project.
(https://pubs.geoscienceworld.org/srl/issue/91/6)

Arctic Observing Network

2020 marks the start of a large, five-year National Science Foundation award to increase observations of environmental change in the U.S. Arctic. The network operated by the center is ideally situated to facilitate long-term research studies that cross traditional discipline boundaries. As this project gets underway, the seismic observations linked with infrasound, weather, and soil temperature will provide data for a new crop of multidisciplinary graduate students.

We Serve the University of Alaska

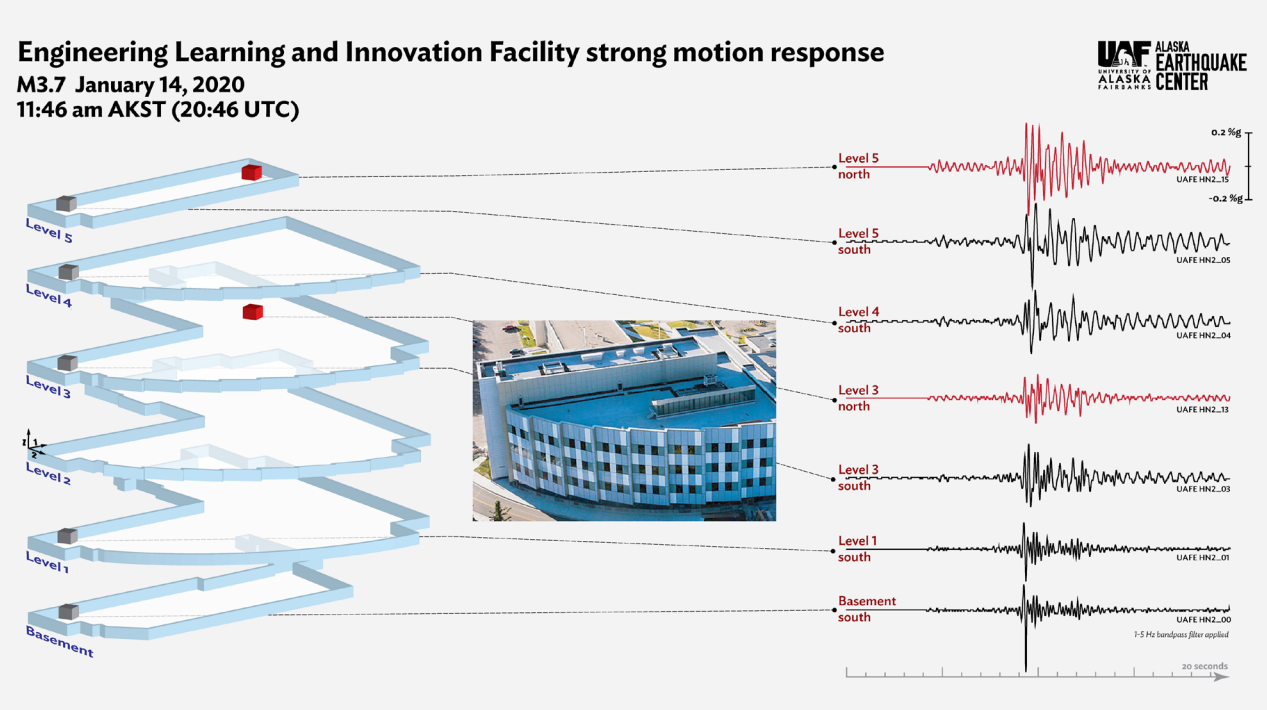
Measuring Building Shaking from Head to Toe

On the morning of January 14, seismic instruments throughout the University of Alaska Fairbanks Engineering Learning and Innovation Facility recorded a magnitude 3.7 earthquake. They also measured the way the two-year-old building responded to the shaking.

In 2016, the Earthquake Center and UAF Assistant Professor Dr. Il-Sang Ahn from the College of Engineering and Mines decided to try a joint project: equip the new ELIF building under construction on the Fairbanks campus with seismic sensors for structural monitoring. With seven sensors installed across five floors streaming continuous real-time data to the Earthquake Center, the ELIF building is now one of the most instrumented buildings in Alaska.

During the January 14 earthquake the motion on the upper floors was strongest. That is typical and agrees with what people reported. Sensors on the lower floors are primarily sensitive to the motion of the earth itself. Sensors higher up also record the motion of the building induced by the earthquake. The motion in the basement was dominated by a single strong pulse that lasted less than a second. As this oscillation traveled up the building it initiated a lower-frequency resonance (i.e., swaying) that could be felt for many seconds. The earthquake essentially "kicked" the building into resonating — a bit like kicking a signpost.

Instrumented buildings, such as the ELIF, provide scientists and engineers with the ability to measure how structures respond to earthquakes. The ELIF is the only building in Interior Alaska that is instrumented at several levels. The lessons learned from instrumented buildings — especially during larger, damaging earthquakes — are used to adjust and update building codes and practices.



ELIF seismograms arranged by floor, showing how different parts of the building responded to an earthquake.

New Partnership to Improve Strong-motion Monitoring

After the 2018 M7.1 Anchorage Earthquake, the center created a new partnership with the University of Alaska Anchorage's engineering department to install strong motion stations for more accurate monitoring. In 2020 the center field crew installed two new strong motion stations in Eagle River. During the M7.1 earthquake, Eagle River experienced more damage than other communities the same distance from the earthquake origin. This was potentially due to stronger ground shaking, but there were no local strong motion sensors to verify. Understanding the local ground response to earthquakes will help the community plan for emergencies more effectively.

Undergraduate Student Employees

Undergraduate interns and employees are an important part of the center, assisting in everything from research to field work to daily operations.

Kenneth Becker: Earthquake analysis and the AACSE project

Nick Alexeev: Machine learning algorithms and computing support

Daneel Ruppert: AACSE project

Shila Cotton: Earthquake analysis. Transitioned to full-time staff.

Joshua MacEachern: Structural strong-motion analysis of the ELIF building

Affiliated Graduate Students

The center benefits from and assists graduate students in a variety of disciplines across the Geophysical Institute.

Aakash Gupta: PhD in progress, *Seismic Imaging of the Anisotropic Structure of Alaska*. Using seismic wavefield simulations to improve the imaging capabilities for the Alaska mantle.

Amanda McPherson: PhD in progress, *Active Tectonics and Multi-Scale Seismic Imaging of Alaska*. Using seismic wavefield simulations to improve tomographic images of Alaska.

Cole Richards: MS 2020, *Shear-Wave Anisotropy in the Alaska Subduction Zone: Splitting Observations from Local Intraslab and Teleseismic Earthquakes*. Performed the first comprehensive study of how Alaska earthquakes can be used to characterize the anisotropic structure of the mantle that underlies Alaska.

Nealey Sims: PhD in progress, *Using Waveform Cross-Correlation and Earthquake Relocation to Study Slow Earthquake Processes in Minto Flats Fault Zone*. Using a central Alaska fault zone as a scientific laboratory for understanding patterns of earthquake occurrence and how they initiate.

Kyle Smith: PhD 2020, *The Seismic Wavefield of Nenana Basin and Cook Inlet Basin of Alaska*. Demonstrated the amplification of the seismic wavefield, from earthquakes and background noise, in large sedimentary basins of Alaska.

Postdoctoral Fellows

Postdoctoral Fellows provide expertise for specialized projects.

Ezgi Karasözen: Noise reduction and optimization of Alaska seismic arrays

Yuan Tian: Algorithm design for a Venus seismometer using analog seismic events from the Alaska earthquake catalog

Publications and Presentations

Publications

Gardine, L.A., West, M.E., & Grassi, B. Alaska Earthquakes Poster. *UA Scholarworks.* http://hdl.handle.net/11122/11193

Gibbons, S.J., **Ruppert, N.A., Karasözen, E.,** Aderhold, K., & **Dickson, I**. Resolving Northern Alaska Earthquake Sequences Using the Transportable Array and Probabilistic Location Methods. *Seismological Research Letters*, 91(6): 3028–3038. https://doi.org/10.1785/0220200142

McPherson, A.M., Christensen, D.H., Abers, G.A., & **Tape, C.** Shear Wave Splitting and Mantle Flow beneath Alaska. *Journal of Geophysical Research: Solid Earth,* 123, e2019JB018329. https://doi.org/10.1029/2019JB018329

Miller, M.S., **Ruppert, N.A.,** & Abers, G. Introduction to the Focus Section on EarthScope Alaska and Canada. *Seismological Research Letters*, 91(6): 3015–3016. https://doi.org/10.1785/0220200307

Nayak, A., Eberhart-Phillips, D., **Ruppert, N.A.,** Fang, H., Moore, M.M., **Tape, C.,** et al. 3D Seismic Velocity Models for Alaska from Joint Tomographic Inversion of Body-Wave and Surface-Wave Data. *Seismological Research Letters,* 91(6): 3106–3119. https://doi.org/10.1785/0220200214

Nicolsky, D.J., Gardine, L.A., & Macpherson, A.E. Pedestrian Travel-Time Maps for Cordova, Alaska: An Anisotropic Model to Support Tsunami Evacuation Planning. *UA Scholarworks.* http://hdl.handle.net/11122/11160

Nicolsky, D.J., Gardine, L.A., & Macpherson, A.E. Pedestrian Travel-Time Maps for Sitka, Alaska: An Anisotropic Model to Support Tsunami Evacuation Planning. *UA Scholarworks.* http://hdl.handle.net/11122/11162

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Ruppert, N.A., Nayak, A., Thurber, C., & Richards, C. Aftershock Analysis of the 2018Mw 7.1 Anchorage, Alaska, Earthquake: Relocations and Regional Moment Tensors. *Seismological Research Letters*, 91(1): 114–125. https://doi.org/10.1785/0220190199

Smith, K., & Tape, C. Seismic Response of Cook Inlet Sedimentary Basin, Southern Alaska. *Seismological Research Letters*, 91(1): 33–55. https://doi.org/10.1785/0220190205

Suleimani, E.N., & Freymueller, J.T. Near-Field Modeling of the 1964 Alaska Tsunami: The Role of Splay Faults and Horizontal Displacements. *Journal of Geophysical Research: Solid Earth*, 125, e2020JB019620. https://doi.org/10.1029/2020JB019620

Suleimani, E.N., Nicolsky, D.J., & Salisbury, J.B. Regional Tsunami Hazard Assessment for Communities of Bristol Bay and the Pribilof Islands, Alaska. *Alaska Division of Geological & Geophysical Surveys Report of Investigation 2020-1.* https://doi.org/10.14509/30422

Suleimani, E.N., Nicolsky, D.J., Salisbury, J.B., & **West, M.E.** (a) Regional Tsunami Hazard Assessment for the Communities of Kasaan, Klawock, Metlakatla, Pelican, Point Baker, and Port Protection in Southeast Alaska. *Alaska Division of Geological & Geophysical Surveys Report of Investigation 2020-2.* http://doi.org/10.14509/30423

Suleimani, E.N., Nicolsky, D.J., Salisbury, J.B., & **West, M.E.** (b) Addendum A: Regional Tsunami Hazard Assessment for Hydaburg, Alaska, in Regional Tsunami Hazard Assessment for the Communities of Kasaan, Klawock, Metlakatla, Pelican, Point Baker, and Port Protection in Southeast Alaska. *Alaska Division of Geological & Geophysical Surveys Report of Investigation 2020-2A*. https://doi.org/10.14509/30438

Tape, C., Ringler, A.T., & Hampton, D.L. Recording the Aurora at Seismometers across Alaska. *Seismological Research Letters,* 91(6): 3039–3053. https://doi.org/10.1785/0220200161

Presentations

Earthquake Center staff offered a mixture of virtual and safe in-person presentations in 2020.

Matt Gardine, Science for Alaska Lecture Series
Alaska aftershocks: the 2018 Anchorage Earthquake

Ezgi Karasözen & Michael West, Air Force Research Laboratory
Seismic array analysis in the presence of persistent cultural noise

Ezgi Karasözen, Alexandra Farrell, Michael West, & Matt Gardine, American Geophysical Union Fall Meeting
Observations of the 22 July 2020 Mw 7.8 Simeonof Earthquake from small-aperture seismic arrays in Alaska

Natalia Ruppert, UAF Dept. of Geosciences seminar
Does the 2020 M7.8 Simeonof Earthquake finally close a seismic gap in the Shumagin Islands?

Elena Suleimani, Kodiak Island Borough assembly session and City of Kodiak work session
Updated tsunami inundation maps for five communities in Kodiak Island

Elena Suleimani, Community presentation in Chiniak
Updated tsunami hazard map for Chiniak, Alaska

Elena Suleimani, Community presentation in Ouzinkie
Updated tsunami inundation map of Ouzinkie, Alaska

Brown Bag Talks

Brown bag talks are informal opportunities for faculty, staff, students, and guest speakers to present their research.

1/16/20	Mike Poland	USGS
	Science F(r)iction - Challenges and opportunities for science communication in a world that's gone bonkers	
6/18/20	Julien Thurin	UAF Postdoc
	Uncertainties estimation in Full Waveform Inversion using Ensemble methods	
6/25/20	Ben Heath	University of Wisconsin-Madison
	Interactions between tectonism and magmatism at Santorini Volancano: Insights from an active source seismic experiment	
8/6/20	Sarah Albert	Sandia National Laboratories
	Changes in background infrasound noise in Albuquerque, New Mexico due to COVID-19	
9/3/20	Yuan Tian	UAF postdoc
	Whether the seismic wavefield in the planet can alter the orbits of the planet's moon	
9/23/20	Benjamin Fernando	University of Oxford
	Seismology at the extremes of the Solar System	
10/8/20	Alex Witsil	Wilson Alaska Technical Center
	Analyzing continuous infrasound at Stromboli Volcano, Italy using unsupervised machine learning	
11/18/20	Társilo Girona	Alaska Volcano Observatory
	Towards a physics-based machine-learning model to better anticipate volcanic eruptions from tremor	

Earthquake Exhibit Goes Virtual


FAIRBANKS HIT BY ITS WORST QUAKE

Fairbanks Daily News-Miner

AMERICA'S FARTHEST NORTH DAILY NEWSPAPER — MEMBER OF THE ASSOCIATED PRESS

VOLUME XXXI — FAIRBANKS, ALASKA, THURSDAY, JULY 22, 1937 — PRICE TEN CENTS

TOWN TOPICS

Opponents Of Court Reform Bill Victorious

HIGH BENCH TO BE LEFT OUT OF NEW LEGISLATION

Damage Of $5,000 Done To Stores But Nobody Hurt

SLIDE BLOCKS RICHARDSON

FAITH IS PUT IN ISLANDS

FIRST SHOCK IS STRONGEST

Glacier Is OK

'FLU RAGES AT HOOPER

RIVERS IS RE-APPOINTED

Fly To Cordova With Gillam Airways To Connect With S. S. Alaska--$35

EARTHQUAKE INSURANCE---Alaska Insurance Agency--Call John Butrovich, Jr.

Users can peruse scans of historical newspaper articles covering Interior Alaska earthquakes.

The UAF Museum of the North's exhibit "shAKe: Earthquakes in Interior Alaska" debuted as the museum's first virtual exhibit in the fall of 2020. (**www.uaf.edu/museum/exhibits/virtual-exhibits/shake-earthquakes/**) The physical "shAKe" exhibit ran for a year from November 2018-2019. The museum's director of exhibits Roger Topp said, "It's not a website so much as a multimedia architecture." Prior to the pandemic, the museum attracted about 90,000 visitors per year, mostly from outside Alaska.

The virtual exhibit is the culmination of guest curator Carl Tape's several-year effort, starting in 2014, to combine historical accounts with earthquake science. Tape and Earthquake Center staff worked with the Fairbanks Daily News-Miner to photograph newspaper pages covering Interior Alaska earthquakes from the last 120 years. The Earthquake Center played a key role in helping to create the exhibit, including designing and generating custom graphics and helping record interviews with Alaska Native elders about their earthquake experiences. "Their stories serve as a reminder that, as a people, they have lived with earthquakes for thousands of years," Tape said. Other contributions to the physical exhibit from the center included a retired seismic station, a "jump test" for visitors to create their own seismograms, and a display of current earthquakes with a flashing siren each time an earthquake occurred in Alaska — on average every 12 minutes. Earthquake Center staff that contributed to the exhibit included Helena Buurman, Lucas Cheek, Lea Gardine, Matt Gardine, Dara Merz, Kat Timm, and Michael West.

With the virtual exhibit "we can offer the content in an interactive, archival fashion for an indefinite period of time," Tape said. Users can explore the virtual exhibit through a 3D app and other multimedia materials.

Meanwhile, the physical station exhibit, complete with jump test, is being adapted as a permanent fixture in the Earthquake Center. The full-scale mock-up is the final piece of a renovation intended to showcase earthquake and tsunami issues in Alaska along with the science and monitoring that helps improve our resilience to these hazards.

The virtual exhibit includes a 3D representation of the physical exhibit users can explore.

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Cover photo: Installing a new seismic station in Barry Arm fjord.