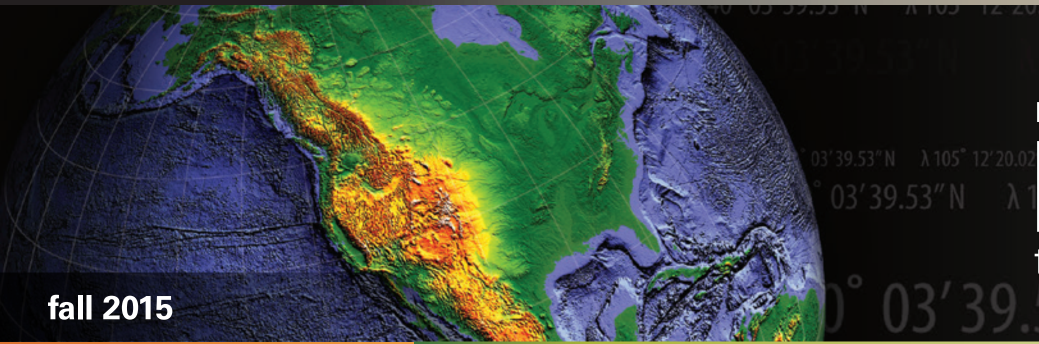
fall 2015



# inSights
the EarthScope newsletter

## EarthScope News

### Call for Community Engagement

Are you a scientist interested in participating in EarthScope outreach activities? Email us today at uaf-esno@alaska.edu. We keep the following information updated and rely on your involvement.

- **Journal publications:** send us references of your EarthScope-related or -funded research.
- **Media contacts:** if you are willing to be contacted by the news media, please email us with your biographical information, including 3–5 key words that describe your scientific expertise.
- **Story ideas:** email us if you would like to publicize your research via our quarterly newsletter inSights.
- **Social media:** we update Facebook and Twitter feeds every day, and are happy to include your quick news or photo items.

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## Inside this issue...



# Alaska bound
## Transportable Array migrates northward

by Kerry Klein

Alaska isn't always hospitable to newcomers—human or mechanical. Ellie Boyce learned this when she flew out to Augustine Volcano in 2011 to investigate a malfunctioning GPS unit on its slope. Boyce, an engineer with UNAVCO, monitors geodetic stations in Alaska that are part of EarthScope's Plate Boundary Observatory. When she and her crew arrived at the volcano, they had to dislodge an 800-pound boulder that had rolled against the fiberglass hut housing the electronics. When they returned this past summer, the hut was gone—all that remained were chunks of metal and plastic scattered down the hillside. "We're pretty sure an avalanche just swept it right away," says Boyce.

Hurtling boulders are some of the many challenges awaiting one of Alaska's newest arrivals: EarthScope's Transportable Array (TA). Since 2004, its vast grid of 400 seismometers has rolled methodically across the lower 48 states. Now, the project is entering its final stage: migration to Alaska and northwestern Canada. The TA's new home is a land of extremes, but with the help of UNAVCO and other organizations already operating in Alaska, the TA's technology is evolving to meet the demands of a tougher terrain.

The Transportable Array is the centerpiece of USArray, a far-reaching network of sensors logging the seismic and magnetotelluric signals crisscrossing beneath North America. The Transportable Array's vast quantities of data have yielded hundreds of studies and have been essential for improving earthquake recordkeeping throughout the country. But in some ways the TA's fruitful first decade was a warm-up, says Andy Frassetto, a project associate with IRIS, which oversees the TA. "The idea was to get some experience," he says, "before we took on the most challenging environment to work in the U.S."

Crews installed the first pilot seismometers in Alaska in 2011. The biggest challenge since then, Frassetto says, has been access to field sites. Installing the seismometers is no easy task: each unit requires cementing a sensor into an 8-foot hole drilled or augured into the ground, then housing the sensor, batteries and data communication devices in a tent-shaped plastic hut. In the lower 48 states, Frassetto says, most grid sites are accessible by road, allowing pickup trucks and forklifts to transport the heavy machinery. But in sparsely developed Alaska, the hut, drill rigs and augurs have to be

*continued on page 2*

TA and Alaska Earthquake Center (AEC) field staff work together to drill a borehole at a southeast Alaska seismic station that is part of the permanent regional seismic network. The seismometer had been installed ~2 feet deep inside the yellow drum (foreground), but in summer 2015 it was repositioned into an 8-foot hole with the help of the drill rig flown in by a helicopter. So far there have been 18 of these "TA upgrades" to regional seismic stations, as well as 38 completely new stations installed. Pictured: Jeremy Miner (TA) and Josh Folmar (GeoTek) operate the drill while Sara Meyer (AEC) works on the communications equipment housed inside the hut. *Photo by Helena Buurman.*

# EarthScope News

*continued from front*

## Call for ideas: EarthScope Synthesis

As the EarthScope instrumentation program approaches completion, it is time for the geosciences community to consider what have been the main research highlights resulting from the project. Over the next four years, the EarthScope National Office (ESNO) will support a series of EarthScope Synthesis Workshops. We are looking for ideas and participation on synthesizing multiple streams of data toward a single region or problem. For example, geophysical data from USArray and PBO activities could be linked with structural and petrological interpertations, with implications for surface processes. Synthesis topics need to include work that has been done using EarthScope data or supported by the EarthScope science program. However, we encourage scientists to think broadly, beyond purely geophysical topics.

These workshops are an excellent chance to broaden the scope of EarthScope research. We are looking for (1) synthesis topics, and (2) individuals who would like to collaborate on synthesis topics for the workshops. Each workshop will bring together a group of 10–15 Earth scientists from varied subdisciplines.

For further information visit http://earthscope.org/information/about-synthesis-workshops

## Report on Future Facilities Workshop

A workshop aimed at defining the future facility needs in the geosciences was held in Leesburg, Virginia in May 2015. The final report from the workshop, "Future Geophysical Facilities Required to Address Grand Challenges in the Earth Sciences," is now available for download: https://www.iris.edu/hq/workshops/2015/05/future_seismic_and_geodetic_facility_needs_in_the_geosciences.

The report describes the facilities needed to sustain ongoing scientific efforts and those needed to respond to current and future opportunities.

*continued from front*

# **Alaska Bound** Transportable Array migrates northward

hauled in by helicopter. "We're putting out seismometers on a grid," Frassetto says. "The grid doesn't care about convenience of getting there."

The other major obstacle, says Frassetto, is power. In most of the U.S., a rooftop of solar panels and a few backup batteries are sufficient to keep the units running 24 hours a day all year round. But Alaska's long winters—and high potential for burial under snow—mean each hut has to be equipped with hundreds of pounds of batteries.

Anywhere they're installed, grid stations require regular monitoring and upkeep. An occasional problem previously, says Frassetto, included vandals using the solar panels for target practice. In Alaska, however, damage is more likely to come from wilder threats—like bears. "We certainly expect some of our sites to be gnawed on at some point," Frassetto says, "but the most important part of the site, which is the seismometer, would be below ground."

The remote, extreme nature of the sites makes for exhilarating fieldwork, says Helena Buurman. A station specialist with the University of Alaska Fairbanks, Buurman installed a wave of seismometers around the state this past summer. She and her crew mostly slept in hotels in small villages or remote hunting lodges—and each night was a surprise. "We're putting out equipment and the door of the hut next door has a bearskin drying on it," she says, "and sheep that are being bled." New field areas means opportunities to see new places, too—like the Revelation Mountains. "I've done field work for many years in Alaska," Buurman says, "and I've never flown around mountains like that. Ever."

The TA's transition wouldn't have run nearly as smoothly without its predecessors' boots already on the ground. When UNAVCO began operating the Plate Boundary Observatory in 2003, it benefitted from the experience of the Alaska Earthquake Center and Alaska Volcano Observatory. It adopted strategies from the two institutions, saving time on permitting and exploring, and redesigned their huts to fit more solar panels. Now, UNAVCO shares some field sites with the TA, and IRIS has already modified its huts to fit the array's needs. "There's a lot of benefit from collaborating and sharing resources," UNAVCO's Ellie Boyce says. "I think we've all found that we can both save money and save time if we just figure out how to do things together—or decide what not to do again."

So far, field crews have installed or upgraded roughly 60 seismic stations in Alaska. Around 150 more will be placed there, in the Yukon, British Columbia, and the Northwest Territories before the project wraps up in 2018. This may be the TA's final few years, but Frassetto says the project feels far from over. "In 2016 and 2017, we're going to put out the bulk of the stations. There's a lot to look forward to still," he says. "We kind of feel like we've got the wind in our sails at this point." ■

## **Learn** more

**Read more about EarthScope's recent activities in Alaska:**


- Boyce E.S., Bierma R.M., Willoughby H., Feaux K., Mattioli G.S., Enders M., and Busby R.W., 2014. EarthScope's Plate Boundary Observatory in Alaska: building on existing infrastructure to provide a platform for integrated research and hazard-monitoring efforts. *American Geophysical Union Fall Meeting, 2014,* Abstract T11A-4525. http://search.proquest.com/docview/1696874446?accountid=14470
- O'Driscoll L., Miller M.S., 2014, Crustal and lithospheric thickness variation across Alaska in advance of Earthscope Transportable Array. *American Geophysical Union Fall Meeting, 2014,* Abstract T11A-4524. http://search.proquest.com/docview/1696875294?accountid=14470

# Underground Clues Help Explain an Old Earthquake Mystery

by Adam Mann

In 1811 and 1812, the New Madrid earthquakes destroyed homes and buildings through northeast Arkansas and the Missouri Bootheel. According to historical accounts, the quakes—estimated to have been of magnitude between 7 and 8—may have temporarily reversed the course of the Mississippi River and set church bells ringing as far away as Boston.

The cause of these formidable events remains a mystery. Earthquakes tend to occur at the boundaries between tectonic plates, where stress builds up and releases as the plates shift. It's unclear how such strong seismic activity could have emerged so far from the North American plate's edge.

But new clues are emerging about these areas, known as the New Madrid and Wabash Valley seismic zones, and whether they might ever again experience such devastating earthquakes. By analyzing subtle underground vibrations created by distant tremors, researchers have peered 80 to 130 km beneath the surface to create a picture of the Earth's composition here.

"It's like a CAT scan," said graduate student Chen Chen of Purdue University, who led the recent study.

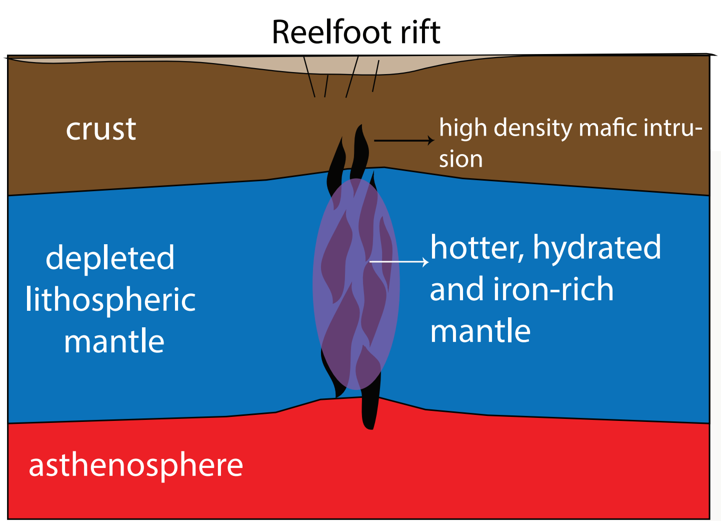
Chen used data collected over two years from an EarthScope project known as the OIINK experiment, for Ozarks, Illinois, Indiana, and Kentucky, an array of seismometers spaced roughly 25 km apart throughout the region, and the USArray, whose stations are set 70 km apart. The instruments are sensitive enough to pick up seismic waves set off by earthquakes of magnitude 5.8 on the other side of the globe. The velocity of such waves is determined by the properties of the medium they move through. As the traveling waves reached each station in succession, Chen could determine how fast they swept through the Earth and map out the upper mantle.

She found that in certain spots beneath the New Madrid and Wabash Valley seismic zones, the waves traveled slower than normal. These anomalously low-velocity parts of the interior could be remnant scars from an event hundreds of millions of years ago, when the Reelfoot Rift began to tear North America apart at this location. Though the rifting eventually shut down, it may have exhumed iron- and water-bearing minerals from the lower-level asthenosphere into the crust, leaving it weaker than normal.

Chen said her work suggests that "this low-velocity zone helps concentrate the seismicity." She likened the New Madrid and Wabash Valley zones to weak sections in a large block, which could be damaged when stress is applied.

The next steps in the work will be to investigate whether the lithosphere in the region is thinner than normal, which could make it more prone to seismic activity. Because major cities like St. Louis and Memphis sit over the region, scientists are interested to know whether or not major seismic events could reoccur.

But the big remaining question is what exactly set off the New Madrid quakes. Some models suggest that spreading from the mid-Atlantic ridge—far to the east of the area—might have generated the necessary forces. Another possibility is that after the retreat of the heavy ice sheets that once covered North America, the crust may have sprung back in fits and starts, providing a local source of energy to shake the region. Figuring out the answer could help explain the occurrence of devastating earthquakes at other mid-plate zones, such as the 1976 Tangshan quake in northern China. ■




Cartoon illustration of the mantle beneath the Reelfoot rift in the New Madrid–Wabash Valley seismic zone. The aligned black lenses represent iron- and water- rich melts that were extracted from the asthenosphere and channeled through the lithosphere. The infiltration of such melts may have led to "scarring" that makes the region beneath the rift more vulnerable to rupture under high stress. *Image by Chen Chen.*

## Learn more

**To learn more about their science, please see Chen's talk at the upcoming GSA national meeting:**

- Chen, Chen: The lithospheric signature of the Reelfoot rift as revealed in the shear velocity structure beneath the central United States. Session: Intraplate Earthquakes, Seismotectonics, and Geodynamics in Eastern and Central North America (No. 182), Tuesday, November 3, 8:35 AM, Room 322/323

**Or read:**


- Chen C., Zhao D., Wu S., 2014, Crust and upper mantle structure of the New Madrid seismic zone: insight into intraplate earthquakes. *Physics of the Earth and Planetary Interiors, 230*, 1-14. doi:10.1016/j.pepi.2014.01.016
- Chen C., Gilbert H. J., Pavlis G. L., Hamburger M. W., Yang X., Marshak S., and Larson T. H., 2014, Is there a zone of weakness beneath the New Madrid and Wabash Valley seismic zones? *American Geophysical Union Fall Meeting, 2014,* Abstract T13B-4636. http://search.proquest.com/docview/1692741161?accountid=14470

## EarthScope National Meeting June 2015

The 2015 EarthScope National Meeting in Stowe, Vermont showcased pioneering EarthScope studies in poster and talk sessions, preceded by an optional pre-meeting field trip (see photo at right).

The main meeting themes included:

1. Dynamics and Evolution of the North American Continent: Crust, Lithosphere, and Deep Mantle
2. From Groundwater to the Ionosphere
3. Active Tectonics and Modern Earth Processes of North America
4. Advances in Understanding and Forecasting Hazards
5. EarthScope Innovations and Looking into the Future

Breakout discussions included (a) Alaska Deployments: Science, Outreach, and Logistics Coordination; (b) GeoPrisms/EarthScope/Amphibious Array; (c) Cyberinfrastructure/EarthCube/Web Services; (d) 4D-Earth Initiative: A Community Geologic Model and New Scientific Initiative for the 4D Evolution of the North American Continent; (e) Subduction Zone Observatory; (f) Geodetic Imaging; (g) Fault Zone Studies.

Most of the presentations are available on the web: http://www.iris.edu/hq/workshops/2015/06/earthscope_national_meeting_2015

Many thanks to the IRIS team, led by Mary Baranowski and Bob Detrick, and to their staff who managed the meeting, as well as to the National Science Foundation for meeting support. We are grateful to the organizing committee for their efforts, and in particular to our local host Laura Webb from University of Vermont. ■

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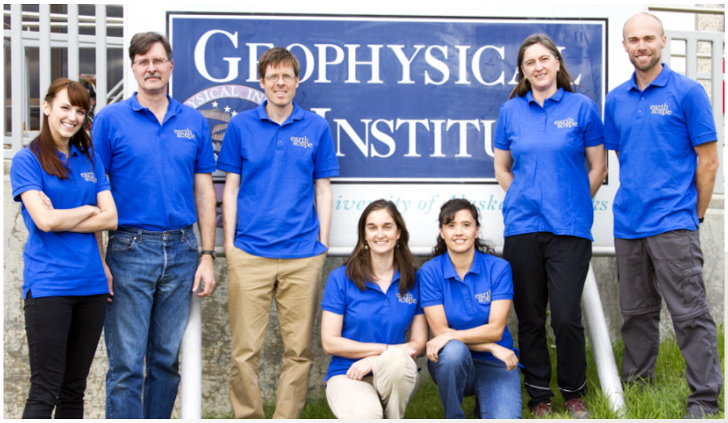
## Meet the New EarthScope National Office

Over the next four years, the EarthScope National Office (ESNO) at the University of Alaska Fairbanks will focus on bringing EarthScope science to the public and fostering EarthScope scientific synthesis efforts.



Amanda is a Ph.D. candidate in volcanology under the guidance of Jessica Larsen. She manages ESNO social media. Jeff, a geophysicist and geodesist with UAF's Geophysical Institute, is the new ESNO director. Carl is a seismologist with the Geophysical Institute. Elisabeth is a structural geologist and coordinator for ESNO education and outreach efforts. Yolanda is the ESNO office manager. Jessica is a volcanologist with the Geophysical Institute and Alaska Volcano Observatory. David, also with the Geophysical Institute and Alaska Volcano Observatory, specializes in volcano acoustics.

The team, from left to right: Amanda Lindoo, Jeff Freymueller, Carl Tape, Elisabeth Nadin, Yolanda White, Jessica Larsen, and David Fee.

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