

winter 2015-16

EarthScope News

Proposals to host EarthScope Synthesis Workshops are due Friday, March 4, 2016

As the end of the formal EarthScope program approaches, it is timely for the geosciences community to work towards synthesis of multiple types of data focused on a single region or topic. For example, data from USArray, PBO, and SAFOD activities could be linked with results from other disciplines. EarthScope science offers many opportunities for synthesis, both within and between disciplines. Over the next four years, the EarthScope National Office at the University of Alaska Fairbanks will support a series of roughly 10 EarthScope Synthesis Workshops, each of which will bring a small group of scientists together from multiple disciplines.

Synthesis Workshops are envisioned to be small workshops of

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Mackenzie Mountains Mystery

New EarthScope project peers underneath an unlikely mountain range

by Kerry Klein

At first blush, the Mackenzie Mountains in northern Canada could be the Rocky Mountains' long lost sibling. They appear just as angular and majestic as the more southerly range, but they're 1400 meters shorter and roughly 25 million years older. Gaze up at their bald peaks and you're likely to spot more caribou, too.

What really sets the Mackenzies apart, though, is their unlikely tectonic history. Stretching as far as 1000 km from the nearest plate boundary, straddling the border between the Yukon and Northwest Territories, they're practically in the middle of the continent. And while the Rockies, similarly far from a plate boundary, stopped growing around 50 million years ago, the Mackenzies are still active today. "It seems like they uplifted before the Rockies uplifted, then that stopped," says seismologist Derek Schutt of Colorado State University in Fort Collins—and then, sometime in the last few million years, they reactivated. "They're still uplifting now and popping off earthquakes."

What's happening underneath these mountains is the focus of an ambitious new EarthScope project with Schutt at the helm. Over the next five years, he and colleagues from Colorado State, University of Alaska Fairbanks and Yukon College in Whitehorse will collect and analyze seismic and GPS data from the region—the most comprehensive subsurface data collected there to date. The team hopes their analyses will paint a picture under the mountains as deep as the mantle and help provide geological context for the entire northwestern corner of North America. "We're not refining existing results; we're looking at unexplored territory," says Schutt. "It's a wonderful opportunity."

Schutt first heard about the Mackenzie Mountains from a colleague at a 2009 EarthScope meeting. Pascal Audet, a geophysicist from the University of Ottawa who set up some of the few seismometers already near the Mackenzies, lamented the scarcity of seismic data and research infrastructure in the area.



Max Kaufman, Research Assistant with University of Alaska Fairbanks, gets ready to install a continuous GPS station at Macmillan Pass, near the Yukon Territory-Northwest Territories border. Photo by Derek Schutt.

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Mackenzie Mountains Mystery

Peering underneath an unlikely mountain range

The conversation drove Schutt to create the Mackenzie Mountain EarthScope Project. Now in its second field season, the project is slated to install 40 seismometers and a handful of GPS units along a 1000-kilometer-long transect across the mountains. It will connect the Transportable Array's easternmost seismometers in Alaska and the Yukon to the highly studied North American Craton in the Northwest Territories. The units will be deployed for two years, designed to survive 8-month winters and the curiosity of bears and musk ox.

Schutt and his team will come away with high-resolution tomographic images and seismic velocity maps extending hundreds of kilometers into the mantle. They hope a clearer idea of the thickness of the crust and the temperature and strength of the mantle will illuminate the processes that both created the Mackenzie Mountains and kicked them back into motion.

"People used to think all the action was in the crust," says Rick Aster, head of Colorado State's geosciences department and a seismologist on the project. "But we've learned that there's lots of structures in the mantle that influence the high topography of the Earth."

Based on models developed by others, the team posits that the Mackenzies are fundamentally connected to the Yakutat terrane, an unusually thick chunk of oceanic crust that's colliding with Alaska between Juneau and Anchorage. If the base of the crust in the Yukon Territory is mostly hot and weak, stress from the collision could be shifting the upper part of the crust towards the northeast. Eventually, the slab bucks up against thicker, stronger lithosphere beneath the mountains and the Canadian Shield and pushes the crust along with it. "The Mackenzie Mountains are just kind of rolling up against the Canadian Craton," posits Schutt; "kind of like you were pushing a rug against the wall."

This crumpling motion is shortening the mountains by a few millimeters per year, says geophysicist Jeff Freymueller of the University of Alaska Fairbanks. Also causing this motion, he says, is isostatic rebound from the last glacial period. He hopes that two years of observation will be long enough to disentangle these two forces. "One concern will be whether we can get enough data," he says. "You have to wait for the earth to move before you can really measure the signal."

Joel Cubley, a geologist at Yukon College, helps coordinate local logistics for the project and looks forward to getting his undergraduates involved as field assistants. Yukon College is a two-year technical school, and he says that few students get the opportunity to learn outside the classroom. "Our hope is it shows them the possibilities and potential out there for geoscience," he says, "and might get them invested enough to keep going."

Northwest of Whitehorse, geophysicist Michael Schmidt, science coordinator for the Kluane Lake Research Station, is excited for these seismometers to join the Transportable Array in northwestern Canada. "It will hugely compliment that and give us a really nice profile across the mountains," he says. "It'll just be pretty exciting to see what comes out of here."

When Schutt looks up at the Mackenzie Mountains, he doesn't see a mountain range dwarfed by the peaks in his backyard in Colorado; he sees new horizons. "Anytime we put instruments out, we learn something new," he says. "It's just like going to Pluto with a space probe." ■

Supporting Earth Science in the Canadian Sub-Arctic

by Justin Sweet

Canada's Yukon and Northwest Territories are not known as hospitable land. This sub-arctic region, home to the Mackenzie Mountains project, presented interesting logistical problems to the IRIS-PASSCAL Instrument Center—based at New Mexico Tech and charged with deploying 40 seismic stations along a 1,000-km-long line spanning elevations from sea level to nearly 1,500 m. The study area covers an array of climates, too, from coastal rainforest to alpine tundra, and often frigid temperatures with snowfall ranging from none to lots.

The seismic stations are being deployed in two main groups: 27 near and along the Canol Road in the Yukon Territory, and 13 in remote locations in the Northwest Territories, delivered via bush plane. A handful of pilot stations were deployed in and around Whitehorse, Yukon Territory, in summer 2015. The remaining 35 stations will be installed this summer by a team of PIs, graduate students, and local undergrads from Yukon College in Whitehorse.

Winter isn't "down time" for PASSCAL—seasonal ice roads currently serve to transport equipment for the 13 remote stations of the upcoming summer's deployment. From the staging point, individual stations will be deployed by air once the weather warms.

Weighing in at around 120 kilograms total, each station includes several components. There is the seismometer itself: a broadband sensor that records seismic energy across a range of frequencies. A datalogger and hard disk store the incoming data. For power, stations contain a complementary set of solar panels and lead acid and air cell batteries—solar panels reduce the number of batteries hauled to each station, and the air cells allow the stations to run throughout winter when light is low. Weatherproof housing protects the datalogger, disk, batteries, and electronics aboveground, while the seismometers are installed in temporary vaults just at the surface or down to 1.5 m deep, depending on the terrain.

The stations will run until summer 2018. Over the next couple of years, they will need periodic visits for maintenance and data collection. After the logistical hurdle of installation is cleared, a fantastic dataset will emerge, allowing scientists to fill in the blanks in this geophysical terra incognita. ■



Installed seismometer and continuous GPS site at Macmillan Pass. Photo by Derek Schutt.

Good Times, Better Ages

How the EarthScope AGeS program evolved

by Elisabeth Nadin

Several years ago, geoscientists gathered to discuss how EarthScope could meet its own challenge to address the time component in its core science goal of understanding the evolution of the North American continent. Independently of this mission, it was becoming apparent in the broader community that some geochronology labs faced difficulties in finding users, and conversely, some users had trouble finding labs that met their needs.

From this fortuitous convergence came the AGeS (Awards for Geochronology Student research) program, an effort to help pair students with a lab in order to gain geochronologic data—and, perhaps more importantly, skills—integral to their own tectonic puzzles.

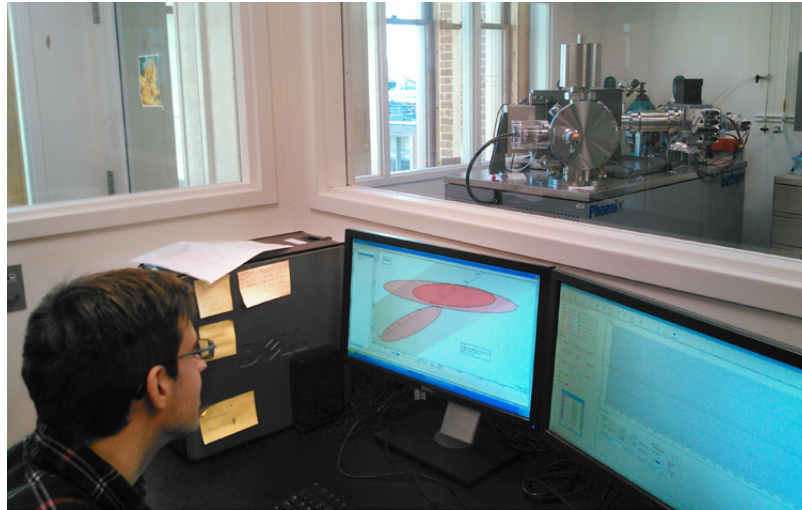
A team of geoscientists solicited information from geochronology labs across the country that were interested in forming new collaborations, then offered graduate students a pool of money to visit these labs, learn their techniques, and get results for projects that align with EarthScope scientific objectives.

The results:

- 34 labs across the country joined the endeavor—visit <http://www.earthscope.org/science/geochronology/participating-labs> for a list of the broad array of geochronology services offered.
- 47 students submitted proposals for funding in the first round of the EarthScope AGeS program.
- 10 proposals were awarded an average of \$8,500.

The awarded proposals cover a range of topics, including understanding earthquake cycles, linking source rocks to sediment sinks, and analyzing the evolution of topography, deformation, and magma generation.

Among these projects, Sean Kinney (Columbia University) was awarded funds for high-resolution U-Pb zircon dating at Princeton University. He is examining the White Mountain magma series in New Hampshire, which contains two distinct magma bodies—one that is associated with



Graduate student Sean Kinney, 2015 AGeS recipient, reducing data at the Princeton University Radiogenic Isotopes Laboratory.

voluminous 200-million-year-old magmatism and the nascent Atlantic basin, and the other that may relate to now-extinct hotspot activity along the eastern margin of North America. So far, he has determined new crystallization ages for these rocks that links them with early rifting, meeting the EarthScope objective to evaluate the timing of continental breakup.

Another recipient, Shelby Fredrickson (UC Santa Barbara), used her AGeS award to date a marine terrace near Carpinteria, CA, with optically stimulated luminescence (OSL) at Utah State University. Her preliminary results suggest that this terrace, which lies just south of the “big bend” of the San Andreas fault, has moved upward at a rate of ~2 mm/yr since it was deposited around 35 thousand years ago. Ongoing uplift related to motion along the fault contributes to earthquakes in this seismically active region.

Rebecca Flowers (CU-Boulder) talks about the EarthScope AGeS program, which is entering its second round.

Q: Tell us a bit more about the program.

A: Students can travel to a geochronology facility, be trained in a technique, and acquire data for a collaborative project with the lab. Last year’s proposals mostly involved analytical work at one lab, but there is the opportunity to visit several. We’re now seeking new applicants, for the March 16 deadline.

Q: How did the program come about?

A: It emerged from discussions with the EarthScope steering committee on the role of geochronology in EarthScope. Among the core goals of the science plan are the structure, dynamics, and evolution of the North American continent. This program was created to better address the third core goal of EarthScope, to decipher North American continental evolution.

We designed the program specifically to provide intellectual support to students—it’s not meant to just fund contract work. The idea is that the student can approach a lab with their idea and try to sell it. If the lab considers it to be a mutually beneficial project, they can help with the proposal and provide a support letter. Then if the project is funded, the student will visit the lab, prepare samples and acquire data, and get help from the lab in interpreting the data.

Q: How do you view the success of the program?

A: I feel that we had an extremely positive response from the labs, from users of geochronology, and from students. We were very pleased with getting 47 proposals submitted—we had considered it would be successful if we got half that number. And we have 34 participating labs.

We specifically designed the program to better link users and producers of geochronologic data, and to provide seed data for new collaborative projects. It can be difficult for scientists who don’t have connections with geochronology labs to know who to contact about acquiring data for a project. On the other side, there are some labs that are very interested in developing new collaborations to support their

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Good Times, Better Ages How the EarthScope AGeS program evolved

facilities. Until now there hasn't been a good mechanism to connect labs with new users. The participating labs listed on the EarthScope AGeS program website are open to being approached about new projects, and they list information about their analytical rates, sample preparation, and lab visits—this is critical for geoscientists planning budgets. Although it was a simple step, I think that merely compiling this information and making it available was an important contribution because it has helped facilitate communication between the broader user community and labs. The AGeS program also provides funds to support the acquisition of seed geochronologic data through the lab visits, which allows the students to be trained and provides results that can be used for broader projects.

We have funds to run our second proposal cycle this year, and we are looking at strategies to continue the program in 2017. We have a lot of momentum.

Visit <http://www.earthscope.org/science/geochronology> for more information and to apply. The initiative is a collaboration between Rebecca Flowers (CU-Boulder), Ramon Arrowsmith (ASU), James Metcalf (CU-Boulder), Blair Schoene (Princeton), and Tammy Rittenour (USU).

The students are clearly fulfilling the hopes of the program. At Princeton, Kinney says, "My EarthScope project gave me the opportunity to talk about new ideas that fostered a new project. I've started a collaboration on something completely different."

For her part, Fredrickson enjoyed learning a new technique. "I got to use liquid nitrogen, and work in darkroom conditions with amber lighting. It was really cool," she says. As a result of this experience, she adds, "I could foresee working in a lab in the future."

AGeS is accepting applications, due March 16, for the second round of funding. ■

Drawing Lines from the Air High-resolution topographic data comes of age

by Ramon Arrowsmith

As the resolution of topographic data continues to heighten, earthquake scientists are able to make increasingly refined surface observations and surface-evolution models. How to use such data was the focus of a recent two-day course at Arizona State University, hosted in part by EarthScope. The course showcased recent research results and provided training on airborne and terrestrial lidar, Structure from Motion technology, point cloud and raster-based data processing, and active fault-oriented analysis.

The short course, "Imaging and Analyzing Southern California's Active Faults with High-Resolution Topography," was a joint effort between OpenTopography, the Southern California Earthquake Center, UNAVCO, and EarthScope. Participants emphasized fault trace and geomorphic mapping, topographic differencing, integration with other geospatial data, and data visualization and analysis approaches.

Within the last decade, several efforts—the B4 project, EarthScope, and numerous NCALM and USGS projects, for example—have been made to collect high-resolution topographic data for active faults. Notably, the EarthScope program has supported the acquisition of several thousand square kilometers of high-resolution topography from lidar along active faults in California, Washington, and Alaska, as well as portions of the Intermountain Seismic Belt. Such data are instrumental for studying deformation processes, and complement the fault-zone drilling, geodetic, and seismological observatories of EarthScope.

Topography datasets are freely available online through OpenTopography, an NSF-funded data distribution portal, and have been used by the active faulting community to generate new and important insights into earthquake processes. For EarthScope data alone, 200 billion points have been processed by 1400 users on the OpenTopography site. ■



The 2002 Denali earthquake surface rupture crosses alluvial fans, as imaged in EarthScope lidar data.

Read more about the workshop at:
http://www.opentopography.org/community/workshops/16SCEC_course

Reference:
Prentice, C. S., Crosby, C. J., Whitehill, C. S., Arrowsmith, J. R., Furlong, K. P., Phillips, D. A., GeoEarthScope LiDAR illuminates northern California's active faults, EOS Transactions of the American Geophysical Union, v. 90, no. 7, p. 55, 2009.

Back to the Mothership

How PBO Data Gets from Everywhere to Somewhere

by Ryan Turner and Beth Bartel

Collecting continuous GPS/GNSS data throughout the Plate Boundary Observatory requires enormous investments in planning, hardware, and physical effort. Getting those data back to a central repository for distribution as quickly and reliably as possible presents even more challenges. In 2008, when the Plate Boundary Observatory was completed, the majority of stations had transfer rates of less than 15kB/s over first-generation cellular modems and Ethernet radios. Yet with an increasing demand for high-rate data to examine coseismic processes, and for real-time streams to contribute to earthquake early warning systems, the communications standards of a decade ago simply can't keep up. Fortunately, options for transmitting data wirelessly have grown enormously and upgrading these systems with modern internet gateways and radios allows transfer rate increases up to a hundredfold. PBO engineers have employed strategies ranging from cellular modems to satellite communications, and from local internet providers to multipoint radio networks spanning hundreds of square miles and a dozen stations to improve reliability and performance as well as expand capabilities.

Radio networking, in particular, is a crucial tool for data retrieval in much of the network. Improving these networks affords more efficient, lower-cost data transfers. In Alaska, for example, 60 percent (85 of the 140 stations) are linked by 900 MHz radios to some other type of telemetry hub upstream. In the Pacific Northwest, 30 percent of all stations rely on radio telemetry. Due to poor cell coverage and expansive geography, it would not be possible to maintain 270 real-time GPS stations any other

way. In some cases, as many as 12 stations operate through one internet connection, making for a highly cost-effective network. Upgrading these radio networks improves reliability as well.

Critical radio work in 2015 included upgrades of 13 instruments on the volcanoes of Unimak Island, AK, 19 stations on Mount St. Helens, WA, and five stations on the western side of Yellowstone National Park that are used to help monitor uplift and subsidence (up to 7cm/yr) of the nearby Yellowstone Caldera as well as constrain the Hebgen Lake fault and potential associated seismicity. In California, radio upgrades focused on the Channel Islands, Long Valley, and Menlo Park areas, with creation of new radio networks in the area of Hollister and the Mojave Desert. Each of these networks is critical for monitoring and understanding volcanic and seismic hazards throughout the North American plate boundary.

Field engineers employ various techniques for overcoming technical obstacles, including installing higher-gain, highly directional antennas, using different radios and frequency ranges, and using comms-only repeater stations to get signals back from the most isolated stations. While we can plan for most of these technical challenges, working in the field, often far from civilization, frequently presents less predictable obstacles as well. Field engineers might find themselves in whiteout snow conditions on the side of an active volcano, or stuck in a sandy wash in the desert. Overcoming these challenges not only enables better stability and state-of-health monitoring, but new science as well. ■



Station AC46 Skwentna lies close to the Iditarod trail in south-central Alaska. The twin radome-shielded antennas relay data from the highest elevation site on the southern edge of Denali National Park, providing important information about the ongoing uplift of the Alaska Range. *Photo by Alaska Field Engineer Ellie Boyce.*

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10–15 people that are intended to kickstart successful working groups. The EarthScope National Office will be using the output from these workshops as part of its efforts to bring EarthScope science to the public, and we hope that the workshops themselves will lead to working groups that will follow up with additional research, papers, or their own proposals as appropriate.

More information and the application form can be found at <http://www.earthscope.org/call-for-synthesis-proposals>.

EarthScope, IRIS, and UNAVCO foster STEM in D.C.

Once again, the EarthScope National Office, IRIS,

and UNAVCO will be participating in the upcoming USA Science and Engineering Festival, April 16–17, in Washington, D.C. This festival is the largest science festival of its kind in the U.S., with more than 1,000 STEM organizations from all over the country bringing exciting science to the public. The event is free throughout the weekend, and schools and homeschoolers get a “sneak peek” on Friday, April 15. This is a great opportunity for EarthScope to reach out to a large number of visitors of all ages and backgrounds, inspiring them through fun, educational and hands-on activities. Making Earthscope science more easily accessible to the public and increasing Earth science literacy are ongoing goals of our Education & Outreach program.

If you will be in the area, please stop by our booths #3535 and #3537 to learn what EarthScope, IRIS, and UNAVCO are doing! ■

Dates and Times:

Saturday, April 16, 10 am–6 pm

Sunday, April 17, 10 am–4 pm

Location:

Walter E. Washington Convention Center, Washington D.C.

<http://www.usasciencefestival.org>

inSights

the EarthScope newsletter

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A young visitor learns about earthquake shaking at the EarthScope–IRIS–UNAVCO booths at the USA Science & Engineering Festival in Washington, D.C. (Photo/Beth Bartel, UNAVCO)



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