

### New Date and Location for the National Meeting!

There has been a change to the date and location for the 2015 EarthScope National Meeting. Mark your calendars for **June 14-17, 2015**, the meeting will be held in beautiful **Stowe, Vermont**.

Information on the schedule, speakers, poster session, field trip, registration, and more can be found on the EarthScope web site at [www.earthscope.org/events/2015-earthscope-national-meeting](http://www.earthscope.org/events/2015-earthscope-national-meeting).

### Congratulations!

The GPS Reflections Group led by Dr. Kristine M. Larson (University of Colorado, Boulder), and including Dr. Eric E. Small (University of Colorado), Dr. Valery Zavorotny (NOAA) and Dr. John Braun (UCAR) has been awarded the Prince Sultan Bin Abdulaziz International Creativity Prize for Water for demonstrating that geodetic GPS instruments can be used to measure soil moisture, snow depth, and vegetation water content.

### Just in Time for the Holidays!

Visit the EarthScope store at [www.cafepress.com/earthscopeshop](http://www.cafepress.com/earthscopeshop) for a wide selection of EarthScope mugs, t-shirts, stickers and more!



## Using the Midcontinent Rift as a Unifying Theme for Park Interpreters and Educators

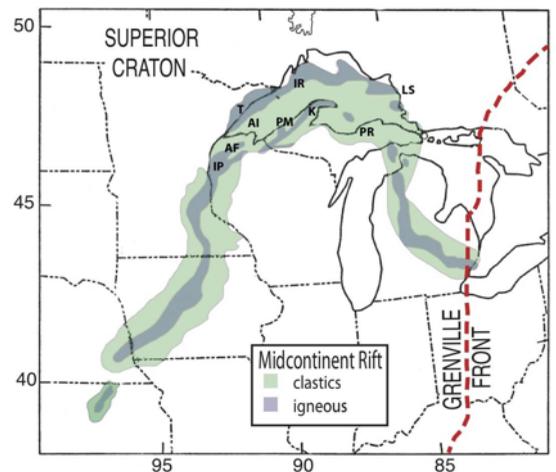
Seth Stein (Northwestern University), Carol Stein (University of Illinois at Chicago), and Eunice Blavascunas (Rachel Carson Center for Environment and Society, University of Munich)

One of EarthScope's major targets is the Midcontinent Rift (MCR), a 1.1 billion-year-old scar along which the continent started to split, just as Africa is rifting today along the East African Rift, but failed to form a new ocean. Although the rift's volcanic rocks and sediments outcrop near Lake Superior, its arms are buried under thick sediment. Hence data from the Transportable Array and a multi-institutional flexible array survey called SPREE are being used to map structure at depth. In addition, gravity and magnetotelluric studies are being conducted.

Initial results give new insight into the rift's evolution. Although it was previously thought to have formed by midcontinent volcanism, it now seems to have formed as part of the rifting of Amazonia (Precambrian northeast South America) from Laurentia (Precambrian North America). Similarly, rifting seems to have stopped once seafloor spreading was established, rather than failing due to the Grenville orogeny, the collisions that assembled Amazonia and other continents into the supercontinent of Rodinia.

The MCR gives rise to spectacular scenery in national, state, or provincial parks near Lake Superior that provide an enormous but underutilized opportunity for park interpreters and educators. Unfortunately, many parks describe only local and sometimes only recent geology, rather than explaining how they are pieces of a huge ancient structure. Few explain that Lake Superior's location reflects the rift. At Interstate Park, where a massive stack of volcanic flows is exposed, the visitor center explains only glacial geology. Keweenaw National Historical Park explains how copper mining shaped the area's growth, but does not explain that the copper deposits resulted from the MCR's volcanic rocks.

Drawing on our experiences studying the MCR and as an interpreter at Isle Royale National Park, we have developed a brief introduction to the MCR for interpreters (available at [www.earth.northwestern.edu/people/seth/research/mcr.html](http://www.earth.northwestern.edu/people/seth/research/mcr.html)) explaining in nontechnical terms what researchers know and are learning today. We seek to help interpreters understand and present how what one sees at a site fits into an exciting regional picture spanning much of the Midwest. This effort is part of an EarthScope program for educators that held its first workshop in August 2014.



Above: Map of the Midcontinent Rift, showing some of the parks where rift-related rocks can be seen. Igneous rocks outcrop at Interstate (IP), Isle Royale (IR), Amincon Falls (AF), Tettegouche (T), Lake Superior (LS), and Porcupine Mountains (PM) parks. Sediments deposited after volcanism outcrop at Apostle Islands (AI) and Pictured Rocks (PR) National Lakeshores. The history of copper mining in the rift rocks is presented at Keweenaw National Historical Park (K).

Left: Bill Rose from Michigan Tech explains MCR volcanic rocks at the educators' workshop, on a soggy Upper Peninsula day.

# Teaching Educators: PBO Data and Classroom Resources

UNAVCO

With the Plate Boundary Observatory (PBO) maturing to a decade old, many of the GPS time series tell compelling stories. Sites in the Pacific Northwest show the signature of subduction including episodic tremor and slip. Sites in California shear along the San Andreas Fault. Sites on Yellowstone and other volcanoes move up and down as magma moves and erupts. And sites throughout the network have captured numerous earthquakes. In an effort to share these stories with the public, UNAVCO hosted training sessions throughout 2014 for park interpreters, K-12 teachers, and university faculty to help them incorporate PBO data into their teaching settings. These workshops use a "train-the-trainer model." According to UNAVCO's Donna Charlevoix, "When you train educators, they spread the word for you because they reach hundreds of people, if not thousands."

Workshops took place in Anchorage, Alaska; Bozeman, Montana; Houghton, Michigan; and Aurora and Golden, Colorado. Hundreds of educators experienced hands-on opportunities to explore PBO-focused classroom materials, introducing students to PBO data and scientific summaries of data interpretation.

Providing these trainers with greater skills and knowledge of EarthScope, awareness of available resources, and tie-ins to regional geology empowers them to better engage students and the general public when discussing PBO data and earth science. Awareness of EarthScope, UNAVCO, and PBO is efficiently reaching broader audiences as a result of this training approach.

A collection of PBO-focused education material is available from the UNAVCO website: <http://www.unavco.org/education/resources/resources.html>



Above: USGS Geologist Rob Witter describes how a ghost forest is formed and sands are deposited during a tsunami. Photo by Shelley Olds, UNAVCO.

## New Active Earth Monitor Content Set - Midcontinent Rift Available in Spring 2015

Patrick McQuillan (IRIS), Carol Engelmann (Einstein Evaluation Group, LLC), and Gregory Waite (MTU)

This past August, a group of formal educators and informal educators descended upon the campus of Michigan Technological University in Houghton, Michigan for a week-long workshop on the geology of the Midcontinent Rift (MCR). The workshop was designed to provide training and build experience using geophysical methods to investigate the MCR. The educators engaged in activities that they could use in their respective educational facilities. After the workshop, educators were tasked with developing a content set for the IRIS Active Earth Monitor Display.



Above: the New Madrid Seismic Zone Active Earth Monitor content set. Several content sets are currently available; look for the MCR Set in early 2015.

The development of this Active Earth Monitor content set is unique in that teams consisting of both formal and informal educators were paired to create the content pages. The formal educators (classroom teachers from grades 8-16) shared ways for teaching how and why we know what we know about the MCR and how to relate that to state and national science standards. The informal educators (from national, state and regional parks) taught the classroom teachers about interpretation, how to help people relate with heart and mind, and to look for the "hook" that can capture each audience member's personal attention.

In addition to the participants, Education and Outreach specialists from EarthScope Kathy Ellins (UT) and Sarah Robinson (ESNO), Patrick McQuillan (IRIS), and Shelley Olds (UNAVCO) led activities and shared experiences throughout the workshop. The leaders of the field and classroom activities were Carol Engelmann (Einstein Evaluation Group, LLC), Bill Rose (MTU), Carol Stein (UIC), Seth Stein (NU), Suzan van der Lee (NU), and Gregory Waite (MTU).

The MCR Active Earth Monitor content set and related educational components will be available for free distribution in Spring 2015. Learn more about the IRIS Active Earth Monitor and currently available geology content sets at: [www.iris.edu/hq/programs/education\\_and\\_outreach/museum\\_displays/active\\_earth/](http://www.iris.edu/hq/programs/education_and_outreach/museum_displays/active_earth/)

# New EarthScope Geochronology Graduate Student Research and Training Program

Organizers: Rebecca Flowers (CU), Ramon Arrowsmith (ASU), Jim Metcalf (CU), Blair Schoene (Princeton), Tammy Rittenour (USU)

The EarthScope Institute on Geochronology and the Earth Sciences brought together 43 participants and 16 geochronology experts in Vancouver, British Columbia on October 17-18, 2014, immediately before the 2014 Geological Society of America National Meeting. The audience consisted of graduate students and faculty interested in using geochronology in their research, but lacking experience with the methods. The course introduced the participants to the basic theory of well-established geochronology methods, highlighted examples of how geochronology data sets can be used to answer significant Earth science questions, and emphasized practical considerations and tactical strategies for designing projects that include geochronology. The methods covered ranged from U-Pb and  $^{40}\text{Ar}/^{39}\text{Ar}$  to luminescence and  $^{14}\text{C}$  dating. The speakers included long-standing leaders in their fields as well as early to mid-career scientists. In addition, the course introduced the new EarthScope Geochronology Graduate Student Research and Training program, a multi-year project that will offer support of up to \$10,000 to graduate students to collect and interpret geochronology data with relevance to EarthScope science targets (<http://www.earthscope.org/information/publications/science-plan/>) through visits and hands-on data acquisition in participating geochronology labs (see more information at <http://www.earthscope.org/science/geochronology/>). The program aims to promote interdisciplinary and innovative science by fostering new relationships between graduate students, scientists, and geochronology labs at different institutions. The awards will be made via a competitive process with the first submission deadline on March 16, 2015. Feedback from both the lecturers and participants was overwhelmingly positive about the potential benefits of this program.



This unique gathering of geochronology experts and participants led to insightful exchanges about promoting successful interdisciplinary collaborations. Themes that emerged included the importance of: 1) close interaction between geochronologists and collaborating students at all stages of the process, even from the outset of study design so that optimal samples are targeted and collected properly, 2) using appropriate mineral separation and sample preparation procedures prior to arriving at the lab, 3) reporting the uncertainties associated with geochronology dates, and 4) developing skills to rigorously evaluate, present, and interpret geochronology data. This hands-on training at the graduate level provides the foundation for students to become an expert user of these facilities throughout their careers.

Watch the videos of the geochronology methods presentations on the official EarthScope channel at [www.youtube.com/earthscopeinfo](http://www.youtube.com/earthscopeinfo)

Above: Alexandra Horne measures pit volumes created during laser ablation at the Arizona State University Geochronology Laboratories. The new Training Program will support graduate students collecting similar geochronology data in support of EarthScope science targets.

## Workshop Report: Modern and Ancient Basement Arches and the Connection to Flat Slab Subduction

Megan Anderson (CC), Kate Miller (TAMU), Susan Beck (UA), and Margarete Jadamec (UH)

Basement arch regions represent zones at a tipping point of critical stress within continental interiors and thus have broad implications for tectonics and seismology. In light of the recent seismological experiments in South America and North America, a workshop was organized to examine the seismic signature of and reconsider mechanisms for basement arch formation.

The 2.5-day workshop was held at the University of Arizona, Tucson, in 2014, with 40 participants from Argentina, Australia, Canada, and the United States. The interdisciplinary group included seismologists, structural geologists, volcanologists, and geodynamicists.

A strong lithospheric rheology was identified as a common element for basement arches. Key research questions focused on the role of flat slab subduction, slab dehydration, the seismic signal in the lower crust, and temperature profiles in arch regions. The group recommended a stronger link between geodynamical modeling and observational constraints, including comparative studies of basement arches. Studies should include onshore and offshore seismic data and/or synthesis of broadband and active source data to connect crustal structures accommodating deformation between arches. A better understanding of basement arch deformation could serve as a barometer for lithospheric rheology. In addition, more systematic connection between modeling and data constraints could lead to the development of better predictive models for earthquake hazards in continental interiors. The workshop was co-sponsored by the NSF Eastern Sierras Pampeanas Experiment and the NSF Bighorns Arch EarthScope Project. We thank the workshop participants for insightful discussions.

An extended workshop summary is available online at [www.earthscope.org/information/publications/newsletters/modern-and-ancient-basement-arches-the-connection-to-flat-slab-subduction](http://www.earthscope.org/information/publications/newsletters/modern-and-ancient-basement-arches-the-connection-to-flat-slab-subduction)



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 <http://insights.asu.edu>



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inSights is a quarterly publication showcasing exciting scientific findings, developments, and news relevant to the EarthScope program. Contact [earthscope@asu.edu](mailto:earthscope@asu.edu) to be added or deleted from the hardcopy mailing list; electronic copies are available at [www.earthscope.org](http://www.earthscope.org). Editor: Devon Baumbach ASU/EarthScope National Office.

## Hot New Science

In each inSights, we will highlight a few recent publications of EarthScope results. Please submit your latest publications to [earthscope@asu.edu](mailto:earthscope@asu.edu)

McGary, R. S., Evans, R. L., Wannamaker, P. E., Elsenbeck, J., & Rondenay, S. (2014). Pathway from subducting slab to surface for melt and fluids beneath Mount Rainier. *Nature*, 511(7509), 338–40. doi:10.1038/nature13493

Tanimoto, T., & Lamintagne, A. (2014). Temporal and spatial evolution of an on-land hurricane observed by seismic data. *Geophysical Research Letters*. doi:10.1002/2014GL061934

Yang, X., Pavlis, G. L., Hamburger, M. W., Sherrill, E., Gilbert, H., Marshak, S., ... Larson, T. H. (2014). Seismicity of the Ste . Genevieve Seismic Zone Based on Observations from the EarthScope OIINK Flexible Array. *Seismological Research Letters*, 85(6). doi:10.1785/0220140079