inSights
the EarthScope newsletter
summer 2013

EarthScope News

EarthScope Maine Interpretive Workshop

The EarthScope National Office is pleased to announce the EarthScope Northeast Regional Workshop for Interpretive Professionals. It will be held at Acadia National Park, Maine September 16-18, 2013.

This workshop will feature expert presentations and collaborative activities to help participants use EarthScope findings so that they can convey the story of the geologic setting, landscapes, and natural hazards of the region. For more information, please visit **http://www.earthscope.org/workshops/NEregional**

EarthMan Video

Have you ever wondered what the general public thinks about earthquakes or tectonics? EarthMan (the official EarthScope mascot) did, and he wants to share his findings with you. To watch the hilarious and educational video visit **www.youtube.com/EarthScopeInfo**

SPREE: A Seismic Study of Continental Modification

Trevor Bollmann, Emily Wolin, Suzan van der Lee, and the SPREE Team, Northwestern University

Northwestern University, Washington University in St. Louis, the University of Minnesota, the University of Manitoba, and the Université du Québec à Montréal are collaborating in the Superior Province Rifting EarthScope Experiment (SPREE). SPREE utilizes 82 broadband seismometers from EarthScope's Flexible Array pool in a mid-continent deployment (Figure 1). Our study area includes several Archean and Proterozoic terranes, crosscut by the western arm of the 1-Ga failed Midcontinent Rift System (MRS). The MRS hosts the largest gravity anomaly in the interior of the North American continent: The 1300-km-long rift may contain more than a million km^3 of mafic rocks (Cannon, 1992), producing a Bouguer gravity anomaly up to 65 mgal (Chase and Gilmer, 1973) (Figure 1). Sedimentary rocks deposited in the rift basin produce negative gravity anomalies along the rift's flanks. Inversion of rift-related normal faults have pushed the density anomalies closer to the surface, enhancing their effects on the gravity and magnetic fields (Cannon, 1994; Anderson, 1997). In the billion years since rifting ceased, the midcontinent region has remained tectonically quiet. One of the goals of SPREE is to resolve the mantle structure of the region to determine the role of the mantle in this rifting event.

One method we use to image mantle structure is teleseismic tomography. To date, we have measured approximately 25 thousand teleseismic P-wave delay times from 130 earthquakes using the AIMBAT package (Lou et al., 2012). These delay times are not correlated with MRS volcanism in the crust, suggesting that significant mantle heterogeneity may obscure the effects of the rift's crustal structure. We study crustal structure using receiver function analysis, H/V ratios, and ambient noise tomography. We also rely on a handful of previously acquired active source profiles (Behrendt et al. 1990; Chandler et al. 1989).

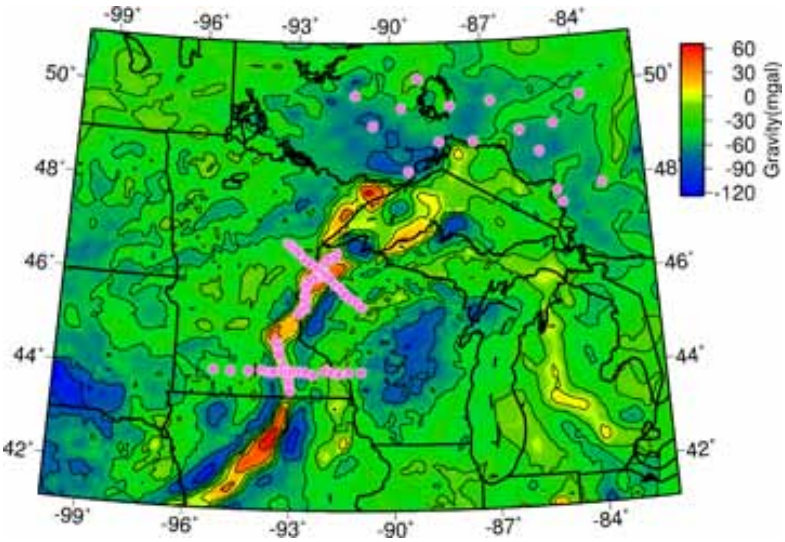

Figure 1. Bouguer Gravity Anomaly of the MRS region. Contours are 25 mgal and SPREE stations are shown with pink circles.

SPREE has recorded a number of rare, relatively large earthquakes in stable North America, including M > 5 events in Colorado, Virginia, and Oklahoma. These fortuitously-timed earthquakes have greatly enhanced wave path coverage for studies of regional S and surface waveforms. Shortly after deployment, SPREE recorded a M 2.5 earthquake in Minnesota—the first recorded since 1994. To date, SPREE has operated at a 97% data return. At the 2013 EarthScope National Meeting, the SPREE team had an opportunity for the first time to compare our preliminary data analyses and discuss potential implications of our findings to date.

The MRS is evidence of the Earth's Mesoproterozoic attempt to split apart evolving Laurentia, the Precambrian cratonic core of North America. The splitting was unsuccessful, and Laurentia survived within North America for the past billion years, though is now blanketed with Phanerozoic sediments and Quaternary glacial till. SPREE is imaging the crust and mantle beneath this blanket and expanding the story of the evolution of the deep midcontinent.

For full version with additional figures please visit www.earthscope.org

The USArray Infrasound Data Products at IRIS Data Management Center

Manochehr Bahavar and Chad Trabant, IRIS DMC

Diverse natural and man-made acoustic sources such as large explosions, rocket launches, and meteorites can act as sources of infrasound (frequencies below audible 20 Hz) energy. Signals from such sources can be detected over very long distances and often complement seismic data in addition to providing research opportunities in low-frequency acoustics.

Starting in 2011, infrasound sensors became a standard component and were installed at each new USArray Transportable Array (TA) site. Currently, with over 400 sensors, TA acts as a large infrasound array that continuously samples the wavefield of atmospheric acoustic sources. To support this new data set, the IRIS Data Management Center (DMC) has developed two infrasound data products: the TA Infrasound Reference Event Database (TAIRED) and TA Infrasound Detections (TAID). These two data products are designed to provide insight and tools for researchers to begin working with this large, and somewhat unique, new data set.

TAIRED (http://www.iris.edu/spud/infrasoundevent) is a user-supported evolving infrasound reference event depository where researchers can contribute to and find infrasound events for their research. This database currently holds 59 events including one meteorite, seven explosions, and 12 rocket launches. For each event, metadata, infrasound and seismic record sections, location map and a list of stations are provided. A recent addition to this database includes the Russian meteorite at Chelyabinsk (about 8,000 km away from the main TA cluster) that highlights the ability of the infrasound signals to travel long distances and the effectiveness of the TA infrasound sensors to record such signals (Figure 1).

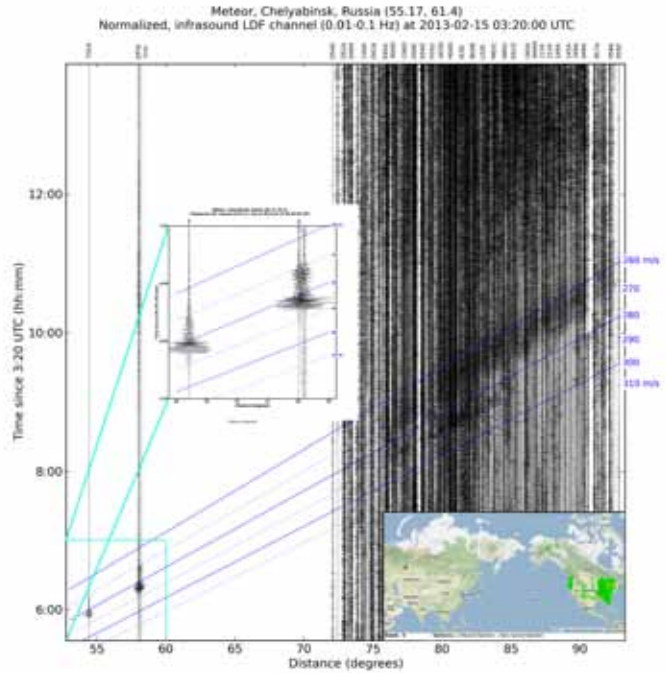

Figure 1. Infrasound record section of the TA low-frequency LDF channels for the Russian Chelyabinsk meteorite of 2013-02-15 with a 0.01-0.1 band-pass filter applied. Traces are normalized individually and are arranged based on their distance (in degrees along the horizontal axis) from Chelyabinsk.

TAID (http://www.iris.edu/dms/products/infrasound/detector) is an infrasound data product that regularly (with a 24-hour delay) scans TA broadband infrasound channels and generates station-based weekly detection lists. Researchers can scan these lists to build their own infrasound events or produce animations or images (Figure 2) that reveal patterns of infrasound signal passage or changes in background noise levels (change in detection rates).

The examples presented here from these two products illustrate the importance of the TA infrasound data and the ability of the DMS infrasound data products to facilitate their use.

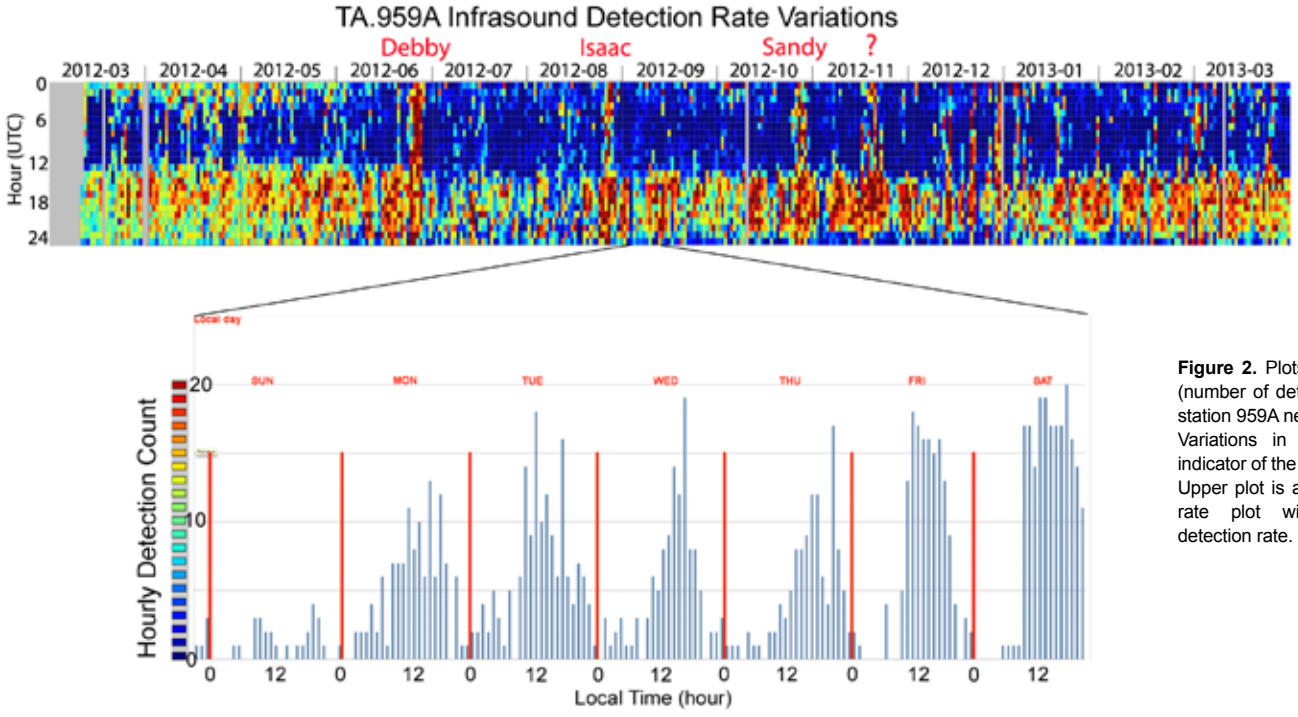

Figure 2. Plots of TAID detection rate (number of detections per hour) for TA station 959A near Okeechobee, Florida. Variations in detection rate are an indicator of the noise level at the station. Upper plot is a one-year 3-D detection rate plot with color representing detection rate.

The 2013 EarthScope National Meeting

EarthScope hosted its biennial National Meeting on May 12-15 in Raleigh, North Carolina. Two hundred and fifty people from around the country learned about research results and participated in planning for the "next big thing". The meeting had four plenary sessions, along with many posters to review and a number of breakout sessions for groups to come together and talk about more specific topics. The meeting agenda and presentations can be reviewed here: http://www.iris.edu/hq/earthscope_meeting/page/agenda.

We would like to give a special thanks to Mary Baranowski of IRIS for making the conference logistics run smoothly, the planning committee for assembling an engaging array of presenters and a great schedule, and Frank Pazzaglia and Sean Gallen for hosting the field trip to Raven Rock State Park.

PBO Multiple Monument Comparison Project

PBO Change Order 35 authorized UNAVCO to construct two additional geodetic monuments at five existing PBO stations in order to test and compare the long-term stability of various monument designs, including pillar, short drilled braced and singlemast monuments (Figure 1), under near-identical geologic and tectonic environments. To be cost effective, these installations were designed to use stations with existing PBO deep drill-braced monuments, which are considered to be the most stable and are the most expensive of all monuments currently used for PBO. Proposed sites will provide a variety of geographic and geologic conditions, including alluvium and bedrock. In addition to standard long-baselines generated by the PBO Analysis Centers, the UNAVCO development and testing group will perform short-baseline processing using the GAMIT/GLOBK software and make the results available on the UNAVCO website. Preliminary kinematic baselines have been generated utilizing the TRACK software (Figure 2).

Figure 1. Multiple GPS monuments (P804, P805, P806) at The Rock, GA.

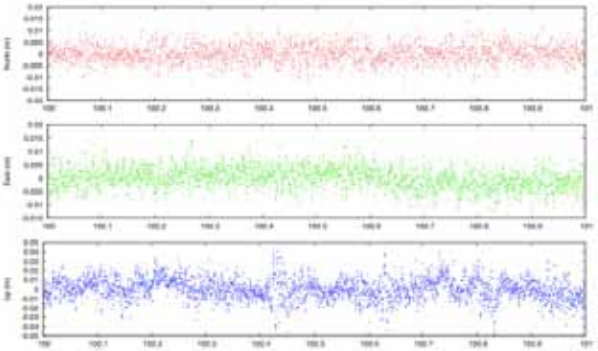

Figure 2. Kinematic processed baseline positions between P804 (deep drilled monument) and P805 (short drilled monument) for one 24-hour period (2013 Day 100) using the TRACK software. The baseline residuals for three components North, East, and Up are displayed in meters.

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

Anderson, D. L. (2012). Questioning mantle plumes. *Physics Today*, 65(10), 10. doi:10.1063/PT.3.1732

Keranen, K. M., Savage, H. M., Abers, G. A., & Cochran, E. S. (2013). Potentially induced earthquakes in Oklahoma, USA: Links between wastewater injection and the 2011 Mw 5.7 earthquake sequence. *Geology*, 2011–2014. doi:10.1130/G34045.1

Sigloch, K., & Mihalynuk, M. G. (2013). Intra-oceanic subduction shaped the assembly of Cordilleran North America. *Nature*, 496(7443), 50–56. doi:10.1038/nature12019

Sun, D., Helmberger, D. V., Jackson, J. M., Clayton, R. W., & Bower, D. J. (2013). Rolling hills on the core–mantle boundary. *Earth and Planetary Science Letters*, 361, 1–10. doi:10.1016/j.epsl.2012.10.027

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2013 - 2014 Speaker Series

The EarthScope National Office officially announces the EarthScope Speaker Series for 2013-2014, supported by the National Science Foundation. The six exemplary speakers for this series include: Corné Kreemer (University of Nevada, Reno), Michael Oskin (University of California, Davis), Ken Ridgway (Purdue University), Mousumi Roy (University of New Mexico), Anne Sheehan (University of Colorado, Boulder), and Ben van der Pluijm (University of Michigan).

Academic institutions are invited to apply for a Speaker visit for the 2013-2014 academic year. Complete information about the EarthScope Speaker Series, including speaker biographies and an online applications form, can be found on the EarthScope website at www.earthscope.org/speakers. The application deadline for a Speaker is August 16, 2013. Questions about the Speaker Series can be directed to earthscope@asu.edu.