fall 2012

earth scope onSite

news from USArray

From the *onSite* Editor

After a long hiatus, we are reviving our effort to bring news from USArray to our station hosts and other interested readers. During this publication break, the Transportable Array has steadfastly continued its eastward roll. Earlier this year, the array reached the Atlantic Coast, and stations are currently operating in Florida and Georgia. In cooperation with Canadian seismologists, we are installing stations in the southern regions of Ontario and Quebec (see page 2 for the current footprint). To date, nearly 1500 locations have been occupied since the project began nine years ago!

More than a year ago, we began using a vault made of a high-density rotomolded plastic that has significantly reduced water seepage into the tank. We have also added a high-performance barometer and an infrasound sensor to each station to measure atmospheric conditions. To muffle the wind, the outlet for these sensors is hidden in a pile of rocks secured with chicken wire (see the schematic on page 2, the article on page 3, and the photo on page 4).

If you are ever driving southbound on US Interstate 55 near Marston, Missouri, make sure to stop at the welcome center. This building has an earthquake theme and features information about EarthScope and the Transportable Array, including touchscreen monitors that display real-time data from EarthScope seismic stations. Also, EarthScope was prominently featured in the National Geographic Channel special "X-Ray Earth." If you missed this show, the DVD can be purchased online in the National Geographic Store (Item#:1095406).

We value your continued interest in our project and greatly appreciate your contribution to expanding our knowledge of the structure and formation of continents and the physical processes that control earthquakes and volcanic eruptions. If there is a topic of special interest to you, please let us know by contacting me at onsite@usarray.org or the USArray office.

Perle Dorr
Public Outreach Manager

Perle Dorr

featured science:

An EarthScope Experiment Focused on North America's Continental Interior

By Michael Hamburger and Gary Pavlis (Indiana University), Hersh Gilbert (Purdue University), Stephen Marshak (University of Illinois), Tim Larson (Illinois State Geological Survey), and John Rupp (Indiana Geological Survey)

Three university research teams — from Indiana University, Purdue University, and the University of Illinois, together with the Indiana and Illinois state geological surveys — have joined forces to take on an ambitious project to help understand earthquakes and the fundamental geological processes associated with the formation and evolution of the North American continent. This project is known by its acronym "OIINK" after its principal study area — the Ozarks, Illinois, Indiana, and Kentucky.

Teachers assist researcher Gary Pavlis (wearing hat) install an OIINK seismic station.

The heart of the OIINK project is a dense array of state-of-the-art seismic instruments at 120 sites surrounding the Illinois Basin (see Figure 1). The experiment is timed to coincide with the deployment of EarthScope's Transportable Array of seismometers in the Midwest. This three-year experiment focuses on some of the world's best examples of geologic structures typical of Earth's continental interiors (or "cratons").

The OIINK seismic network will span four of the major geologic features that characterize the North American continental craton: the Ozark Dome of southeastern Missouri; the Illinois Basin of southern Illinois and Indiana; the Rough Creek Graben, a geological trough extending through western Kentucky; and the Grenville Front, the bounding fault of an ancient mountain belt in central Kentucky. These features also include major fault zones, such as the Wabash Valley fault zone, which have been implicated in the generation of earthquakes in this region. The study is likely to help understand the causes of earthquakes within the interior of a tectonically stable continental craton, to shed light on the structure of the Earth's crust and underlying mantle and, in turn, to decipher the geologic evolution of the North American continent.

During the experiment, the seismographs will record thousands of earthquakes, both within the study area and from around the world, as well as tens of thousands of tremors from nearby mining and quarry explosions. Designed like an array of radio telescopes, seismometers will be placed about every 15 miles (25 km) to provide an optimal geometry for imaging this largely unexplored segment of Earth's interior. Where possible, cell phone technology will transmit the data to a central repository at Indiana University.

The OIINK network is being deployed in two phases. In the first phase, conducted during

(continued on page 3)

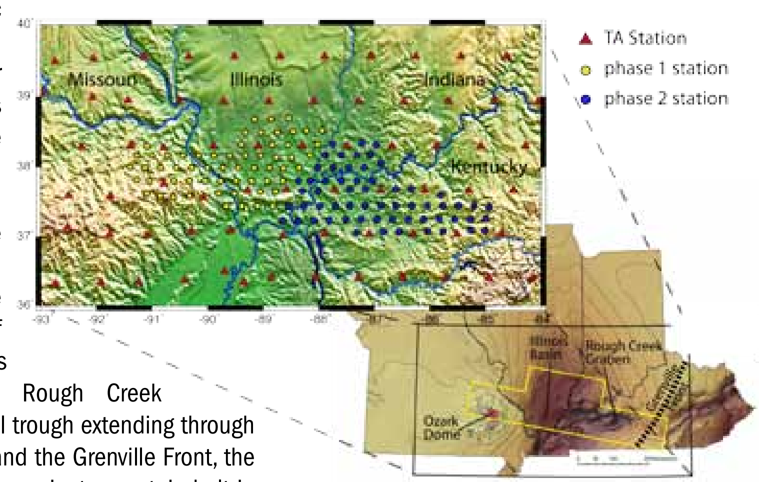


FIGURE 1: The OIINK study area showing the location of the seismic stations and topographic contours showing the depth of the basement rocks in the Illinois basin.

USArray Operating Stations as of September 4, 2012

REAL-TIME STATION STATUS

To view a map of current EarthScope instruments, visit www.earthscope.org/current_status/.

To view seismograms recorded at a USArray station, go to http://usarray.seis.sc.edu/ and enter the station code. You can also enter a zip code to view the recordings from the USArray station closest to that area.

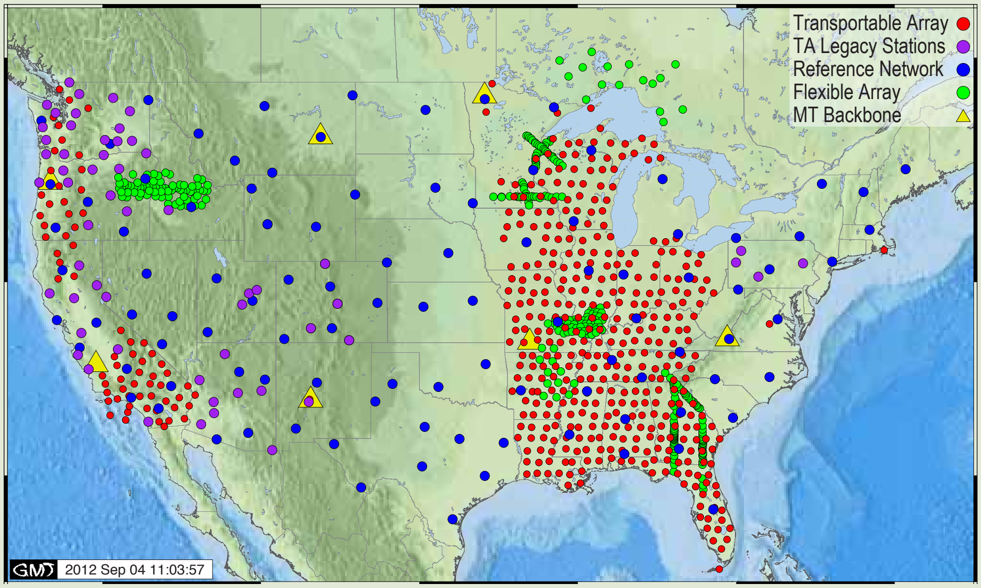
To select a station from a map and view its seismograms, go to www.iris.edu/activeearth/content/es_TA_status.phtml. Click on a station location (red dot) and view today's or yesterday's data.

EARTHQUAKES INDUCED BY FLUID INJECTION

http://www.usgs.gov/faq/index.php?action=show&cat=125

http://www.doi.gov/news/doinews/Is-the-Recent-Increase-in-Felt-Earthquakes-in-the-Central-US-Natural-or-Manmade.cfm

Where is USArray?



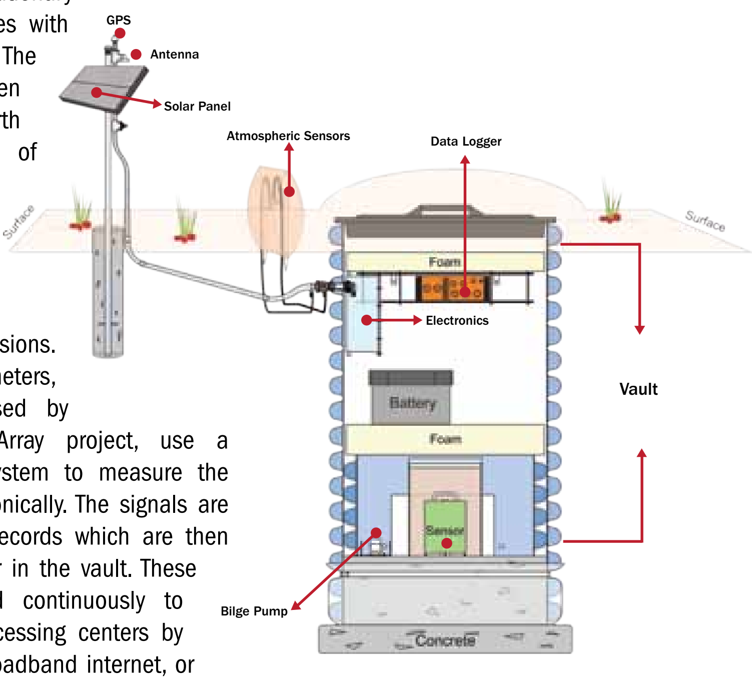
TRANSPORTABLE ARRAY COORDINATING OFFICE: usarray@iris.edu 1-800-504-0357

featured science:

How Does a USArray Seismic Station Work?

The EarthScope USArray earthquake monitoring station consists of a seismometer and some additional electronics and communication equipment buried in a sealed, thermally insulated chamber, or vault, about six feet below the surface. The seismometer detects and measures the Earth's ground motion. These vibrations are similar to sound waves in air, but span a wide frequency range that extends well below the threshold for human hearing. The sensors are extremely sensitive and can pick up a broad spectrum of motions ranging from low-amplitude background vibrations, such as those generated by wind or pounding surf, to signals from local, regional, and distant earthquakes. The sensitivity of the station depends on how quiet the local conditions are – the lower the "background noise" from human and natural sources such as traffic and swaying trees, the more likely the station will be able to detect faint earthquake signals. Sites are chosen to minimize the background noise as much as is practical, while still allowing access for the installation of the equipment.

The seismometer, which is a little larger than a one-gallon paint can, contains delicate moving parts and sophisticated electronics, but operates on a very simple principle. The motion sensor consists of a weight hanging on a spring that is suspended from the frame of the seismometer. When an earthquake occurs, the suspended weight initially remains stationary while the frame moves with the Earth's surface. The relative motion between the weight and the Earth provides a measure of the ground motion. Three sensors are combined in a single package to measure ground motion in three dimensions. Modern seismometers, like those being used by the EarthScope USArray project, use a complex feedback system to measure the ground motion electronically. The signals are converted to digital records which are then stored on a computer in the vault. These data are transmitted continuously to EarthScope data processing centers by cellular telephone, broadband internet, or satellite communications systems. The type of communications system chosen depends on the conditions at the site and in the surrounding area. Once the data are received at the processing center, they are indexed and then sent to the IRIS Data Management Center (http://www.iris.edu/about/DMC) where they are stored and made available via the internet to researchers and the general public.



Each station also measures atmospheric conditions with an infrasound sensor and a high performance barometer. Like the seismic data, these observations are transmitted continuously to the data processing center. The station's equipment is powered by a battery that is recharged with solar energy.

featured science: (continued from front page)

An EarthScope Experiment Focused on North American's Continental Interior

the summers of 2011 and 2012, researchers selected sites in the western half of the study area and installed 63 seismic instruments. Next summer, the entire network will migrate to the east to occupy the Phase 2 sites in Indiana and Kentucky.

The OIINK network (shown by yellow triangles in Figure 2), together with neighboring sites of the Transportable Array (red triangles), is already providing detailed data about the Ozark Dome/Illinois Basin transition. For example, there is a concentration of numerous small earthquakes (shown as gray dots) in the Mississippi Valley's New Madrid seismic zone and a halo of activity from the neighboring Wabash Valley seismic zone of southern Missouri, Illinois, and Indiana. The map also shows a vast number of 'artificial earthquakes' (black squares) associated with mine and quarry blasts in the Illinois Basin.

Analysis of these data also show marked changes in the structure of Earth's crust, from the uplifted Ozark Dome to the deeply subsided Illinois Basin, where the Earth's crust appears to thicken by about 5 miles (8 km).

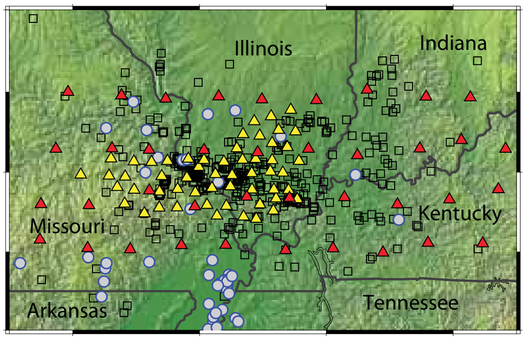


FIGURE 2: Earthquake epicenters (gray dots) and mine blasts (black squares) recorded by OIINK and Transportable Array stations (yellow and red triangles, respectively) in the study area.

Equally important to its research impact, the OIINK project offers an extraordinary opportunity to share the excitement of EarthScope science with teachers and students in the area covered by the seismic array. During the summer of 2012, in collaboration with Illinois State University, 30 teachers from Illinois, Indiana, Missouri, and Kentucky participated in a two-week workshop and field trip that will help bring EarthScope science into middle- and high-school earth science classes across the region. As part of their experience, the teachers assisted with the installation of several OIINK seismic stations (see photo on page 1) — and now are proud co-owners of a new EarthScope seismic array.

For more information, visit the OIINK website http://www.indiana.edu/~oiink.

Transportable Array's Atmospheric Sensors Detect Rare Weather Event

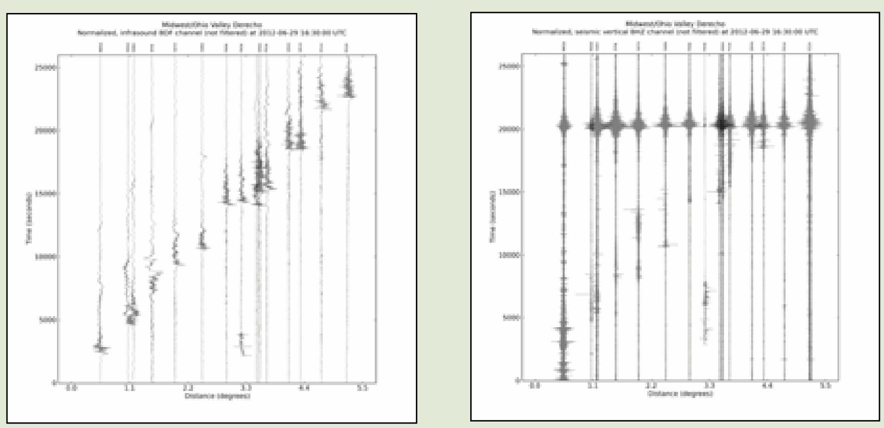
By Manochehr Bahavar, IRIS Data Management Center

On June 29, 2012, a derecho formed in northwest Indiana that raced 600 miles to the southeast with winds reaching 100 miles per hour. This rare weather event passed over more than 15 Transportable Array stations in Indiana, Ohio and Kentucky, each equipped with both seismic and infrasound sensors. Data from these stations clearly show the change in pressure at the surface during the passage of the derecho.

Red and yellow circles are EarthScope Transportable Array stations. The strongest part of the derecho passed over the stations that are shown in yellow.

(a) Infrasound data

(b) Seismic data



These plots show data recorded at the Transportable Array stations in the derecho's path (yellow dots on the map). The infrasound traces (left) show the change in pressure at the surface as the derecho moved southeastward. The seismic data (right) have a similar but fainter trend to the infrasound data. On the plots, time (in seconds) increases from the bottom to the top with 0 seconds being at 12:30 EDT or 16:30 UTC (Coordinated Universal Time), and distance increases from left to right. The most noticeable feature on the seismic plot is the magnitude 6.3 earthquake from the Xinjiang, China region that was recorded across the seismic array at about 20,000 seconds.

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news from USArray

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First EarthScope Seismic Station Installed in Virginia

On August 8 2012, EarthScope installed a seismic station in Mineral, Virginia, near the epicenter of last year's magnitude 5.8 earthquake. This station, R58B, is a complement to other seismic stations in the area and is capable of detecting small regional aftershocks as well as earthquakes of about magnitude 5 occurring anywhere in the world. See "Where is USArray?" (on page 2) to learn how to view data from this station. Both a broadband seismometer and a strong motion accelerometer were installed. This EarthScope station will operate for about 2.5 years. In Spring 2013, an additional 18 stations will be installed in Virginia when the Transportable Array blankets the Mid-Atlantic states.

Because of the station's proximity to Washington, DC, this installation was observed by a small group of visitors including the Virginia state geologist, geoscience researchers from James Madison University in Harrisonburg, Virginia, and staff from IRIS Headquarters.