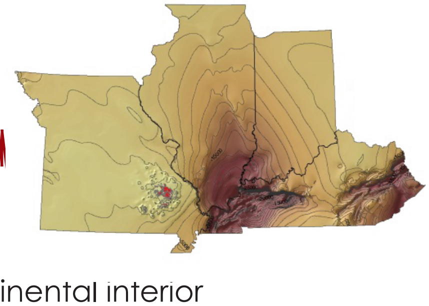
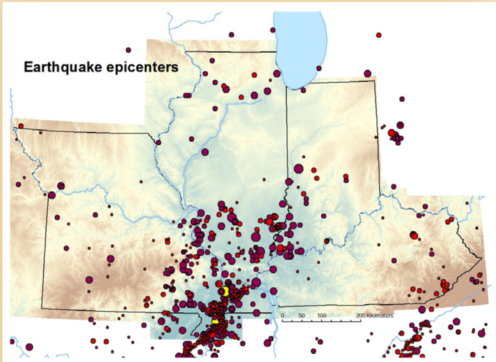
OIINK

OZARKS | ILLINOIS | INDIANA | KENTUCKY



unraveling the secrets of North America's continental interior

Spring/Summer 2012



What is OIINK?

Three university research teams from Indiana University, Purdue University, and the University of Illinois—together with the Indiana and Illinois state geological surveys—have teamed up to take on an ambitious project to help understand earthquakes and the geological structures that trigger them.

This new research project, supported by the National Science Foundation, is playfully dubbed "**OIINK**" after its principal study area—the **O**zarks, **I**llinois, **I**ndiana, and **K**entucky.

The project involves the operation of a large seismic array centered over the Illinois Basin. This new project is being conducted in coordination with the deployment of a nationwide array of seismometers called the USArray (www.iris.edu/USArray/).

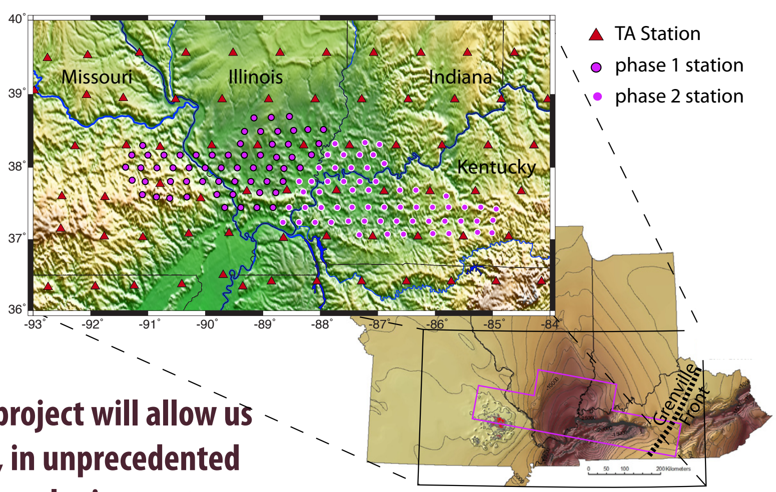
USArray is a component of a large experimental program called EarthScope (www.earthscope.org), a national scientific experiment directed at understanding the geologic processes that create earthquakes and their relation to continental-scale geologic structures.

A Telescope to Peer into Earth's Interior

The OIINK experiment is directed at improving our understanding of the structure of North America's continental interior. Our study area includes some of the world's best examples of geologic structures typical of Earth's continental interiors (or "cratons").

Our seismic network, which will eventually include 120 earthquake monitoring stations, will span four of the major geologic structures that characterize the midcontinental area of the central U.S.: the *Ozark Dome* of southeastern Missouri, the *Illinois Basin* of southern Illinois and Indiana, the *Rough Creek Graben* of western Kentucky, and the *Grenville Front* of central Kentucky. These features also include major fault zones such as the *Wabash Valley seismic zone*, the source of many earthquakes in the Midwest.

The study is intended to help us understand the structure of the Earth's crust and underlying mantle, the causes of earthquakes within the interior of an otherwise stable craton, and the geologic history of the North American continent.



Map of the OIINK study area showing the locations of the seismic network stations.

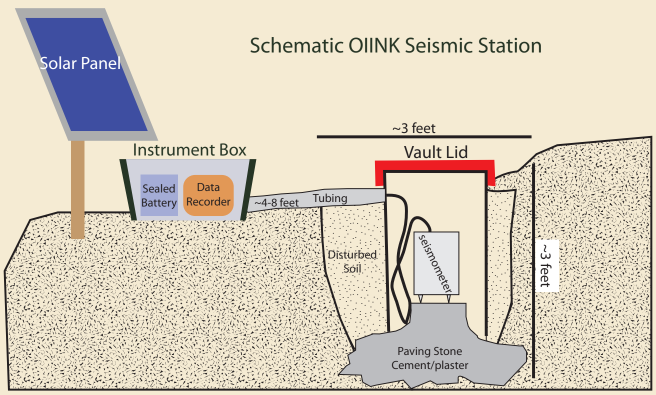
> **"The OIINK project will allow us to observe, in unprecedented detail, the geologic structures and processes that generate earthquakes in the Midwest."**
>
> *Michael Hamburger, Indiana University*

Design of the Seismic Array

Over the course of the OIINK project, we will deploy about 60 state-of-the-art earthquake sensors, or seismometers, in 120 locations spanning an area from southeastern Missouri to western Kentucky. The instruments will be in place for approximately 18 months. During the experiment, the seismographs will record thousands of earthquakes, both within the study area and from around the world, as well as nearby mining and quarry explosions.

Designed like an array of radio telescopes, seismometers will be placed at regular intervals (about every 15 miles) to provide an optimal geometry for imaging the Earth's interior structure.

Think of it like a telescope directed not at the stars and planets, but at the Earth's interior.



The seismic stations deployed for this experiment contain digital instruments that are capable of recording every type of ground vibration, from nearby quarry or mine blasts to tiny local earthquakes and larger quakes from around the globe. The ground motion sensors (or "seismometers") are highly sensitive instruments that turn ground motion into small electrical signals. Those signals, in turn, are amplified and turned into digital signals that are recorded in a small data recorder. Where possible, we will use cell phone technology to transmit data to a central recording site at Indiana University.

A schematic of an OIINK seismic station is shown in the figure below. Typically, we bury the seismometer on a concrete base in a hole a few feet deep, and install a post for solar panels and a weatherproof box for the electronic recording instruments. A plastic drum is added to protect the seismometer from moisture and dirt, and to insulate the seismometer. This construction, which we term a "field vault," is capped by insulation and a lid and then buried.

The instrument is powered by batteries and a solar panel. A small GPS receiver is mounted within a few feet of the recording equipment or within the box containing the recording equipment.

In a few cases, where the site is in a pasture for grazing animals, we construct a small fence around the site to protect the equipment from damage. This setup is similar to one used successfully on both public and private lands all across the United States

A newly completed seismic station installation

Site Selection

How do we choose sites? The critical conditions for deploying a seismometer include:

- Sites with a thin layer of well-drained soil over bedrock.
- Sites far enough away from power poles, rivers, roads, houses, or other structures that might produce vibrations.
- Adequate security from vandalism or theft.
- Significant distance from sources of seismic noise such as highways, railways, farm machinery, urban areas, active mines.
- Southern exposure to power our stations using solar panels.
- Adequate road access (generally within a few hundred feet of a road or driveway).

The "Dirty Work"

Station Installation

The equipment will be installed in several stages. First, a reconnaissance team will visit prospective sites and choose the final locations for our 120 seismograph stations. Then a site preparation team will install the equipment. This is the hands-on work of our field effort; these installations typically require a pick and shovel, a container for mixing concrete, and two people to do the work. Access to the site by vehicle at this time is helpful, but not essential.

The second phase involves the actual installation of the electronic equipment that will collect data. This typically involves a two-person crew, installing the seismometer, data recorder, battery and solar panels, and cell-phone modem for data transmission. The instruments are designed to run for months without human intervention.

We expect to visit each site once every few months during the course of the experiment. At the end, we remove the equipment and the field vault. The hole will be refilled and all signs of the installation will be eliminated.

Installing the earthquake sensors

Testing the equipment

The Array

Network Operation

The OIINK network is deploying in several stages. Beginning in summer 2011, our researchers visited dozens of sites in southern Illinois and southeastern Missouri, selecting sites for the first 60 of the OIINK array stations.

We installed seismic vaults at 38 of the 60 sites. With only a fraction of the network instruments available, we elected to install a pilot network, consisting of 23 seismic stations at sites in a subset of the western half-network.

The pilot network, shown on the map on the following page, together with neighboring sites of the national USArray network (red triangles), are providing us with detailed data on earthquakes and earth structure along the Ozark Dome/Illinois Basin transition.

Results

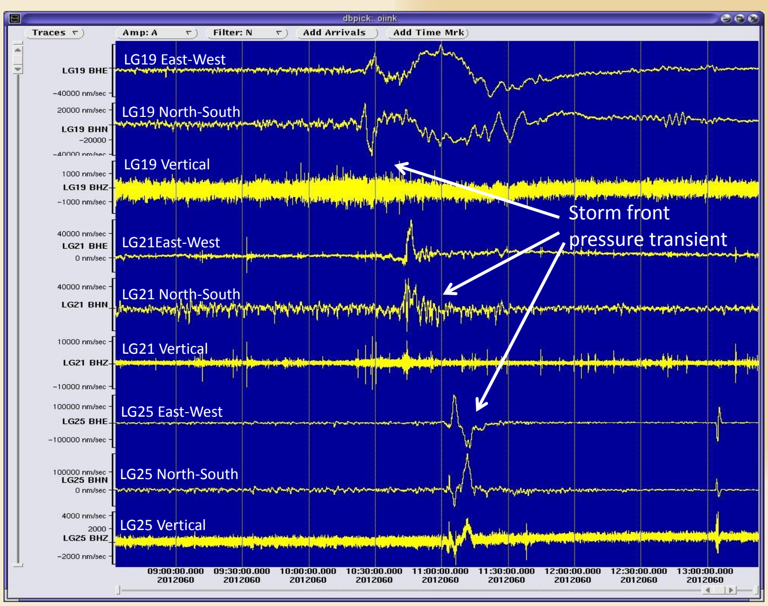
The Research

The data collected as part of this experiment will be used by research scientists and students at the five institutions. The recordings made with these instruments will be archived with the IRIS Data Management Center and made available to scientists around the globe and the public.

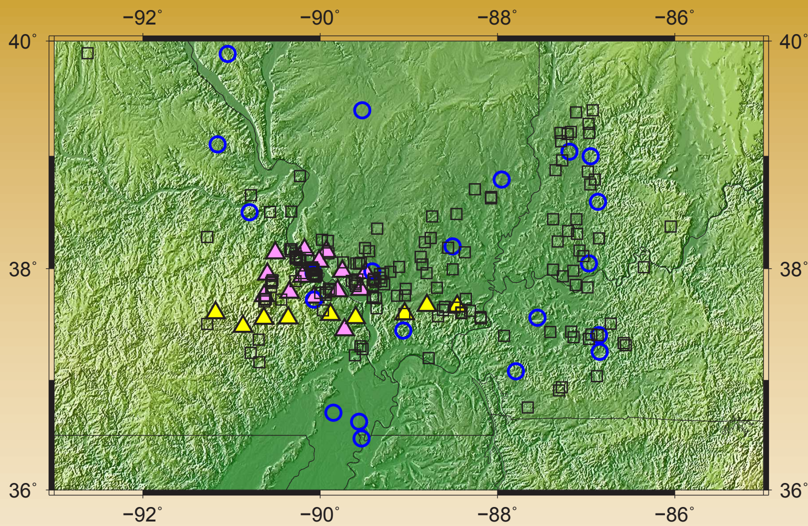
You will be able to scan the data from your seismograph station to visualize earthquakes recorded there.

The scientific analysis will take several years to complete. It will take the form of scientific research papers, student theses, and presentations at scientific meetings.

We expect a wide range of professionals interested in earth resources, natural hazards, and science education will use the results. An important component of our project involves sharing scientific results with teachers, students, museums, and other educational institutions throughout the region.



The OIINK array detected unusual seismic signals (above) associated with the recent deadly tornadoes that struck southern Missouri and Illinois. The seismograms showed a strong, low-frequency pulse beginning around 4:45 a.m. on Feb. 29. Preliminary interpretation, based on other seismic records of tornadoes, suggests that the recording was not of the tornado itself, but a large atmospheric pressure transient related to the thunderstorms that spawned the tornadoes. This sort of pressure-related signal may help scientists better understand atmospheric activity that takes place right before tornadoes touch down. While seismographs have been known to detect seismic activity related to tornadoes, it is highly unusual to have state-of-the-art digital instruments recording information in such close proximity to a tornado.



Map showing locations of earthquakes and blasts recorded during the first month of pilot seismic network operation. Pink and yellow triangles show the locations of OIINK network seismograph stations, and circles and squares show the estimated locations of probable small earthquakes and mining/quarry blasts, respectively.

For more information:

OIINK website: www.indiana.edu/~oiink

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Preliminary results

In its first several months of recording, the OIINK network has already recorded several thousand seismic events.

We have recorded a small number of local earthquakes and a much larger number of regional earthquakes from the New Madrid earthquake zone, Oklahoma, Arkansas, Virginia, and Texas. We are able to record earthquakes as small as magnitude 2.0 for local earthquakes and magnitude 3.0 elsewhere in the region.

Our seismic network is also capable of recording distant earthquakes (or “teleseisms”) with magnitudes greater than 5.0 from virtually anywhere in the world. Because our network is in an area of active mining, we also record numerous “artificial earthquakes” produced by blasting from neighboring quarries and surface mines.

Data from the OIINK array are also being used to help us understand the geologic structures that produce these small earthquakes. Initial results from a sophisticated imaging techniques suggest that the Earth’s crust and underlying mantle beneath the Ozark Plateau and the Illinois Basin vary considerably both in thickness and in physical properties.

Outreach Program

An important component of this project is outreach to K-12 teachers, students, and communities in the area surrounding the OIINK network. We hope to use this opportunity to engage teachers, students, and community members in the exciting scientific project on which we are embarking.

As part of our outreach effort, we are collaborating with scholars from Illinois State University to offer a 2-week professional development course for middle and high school teachers from the four-state area. The course—*Central United States EarthScope*—will focus on earthquakes in the Midwest and new methods of understanding Earth structure.

The course will take place from July 30 through August 10, 2012, at the Illinois State University campus in Normal, Illinois. Additional information is available from http://lilt.ilstu.edu/rsnelso/

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