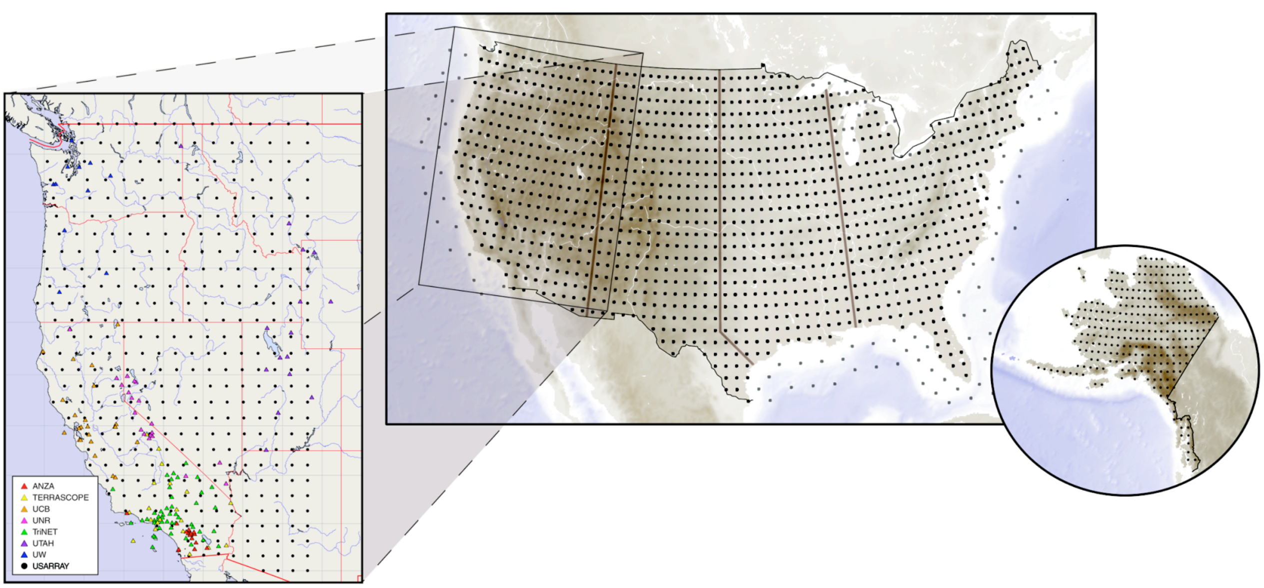
Hosting a USArray Earthquake Monitoring System

The EarthScope USArray is a nationally funded project for university research into the study of plate tectonics and basic earth science. In a nutshell, we intend to install equipment every 42 miles, everywhere in the US, to monitor distant earthquakes and thereby develop a detailed map of the structure beneath the North American continent.

This document describes the project generally and how, in particular, we install equipment on a property. We hope the information here answers some of the many questions people have when approached by scientists to cooperate in our grand experiment. We hope you will participate and learn with us.

Where do we locate our instruments (why me???):
The choice of location for the Transportable Array is based on a regular grid pattern with a station spacing of 70km. A list of nominal station locations can be found at http://www.earthscope.org/usarray/usarray_assets/TransArray.htm. The 70km spacing was derived from the scale of resolution that seismologists wish to image structures in the Earth's mantle. There is no requirement that this grid be adhered to precisely. The key to station location is to maintain an inter-station spacing of approximately 70km, and if this means morphing adjacent areas of the grid by up to 15km or so, then this will not impact the science objectives. In order to meet the scientific goals of the project some instruments must be located on Federal lands such as National Forests, BLM or National Parks.



Background: IRIS is a US University Consortium that has been funded by the National Science Foundation (NSF) to construct the EarthScope Observatory. This facility will apply modern observational, analytical and telecommunications technologies to investigate the three-dimensional structure and evolution of the North American continent and the physical processes controlling earthquakes and volcanic eruptions. It is a research project studying basic earth science with university and government researchers cooperating to analyze the data.

Funding to construct the EarthScope Observatory is approved at around $200M, and will take 5 years to complete. Operations and maintenance of the facility will extend another 10 years.

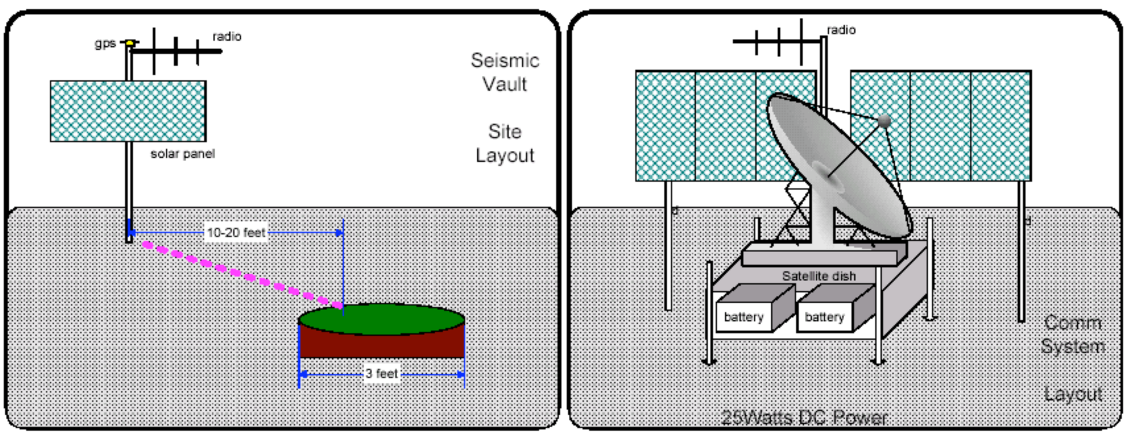
IRIS is responsible for implementing the USArray component of EarthScope. The Transportable Array will record earthquakes that occur locally, nationally or worldwide and will produce significant new insights into the earthquake process. The research will produce maps of crustal and upper mantle structure with resolution on the order of tens of kilometers, and increase the resolution of imaged structures in the lower mantle and at the core-mantle boundary, at depths of 50-1500 miles below the surface.

The Transportable Array will migrate west to east across the country where each monitoring location is occupied for about 24 months. The entire continental United States and Alaska will be occupied, in sections, over a period of 10-12 years. Equipment costs alone is around $16M. Site selection, permitting and installation of the first 400 sites in the western states will start in 2004, and will take 4 years to complete. In 2008 the array will begin to roll, meaning that each week five stations will be removed and reinstalled at a new location on the eastern edge of the array pattern, until reaching the east coast around 2013. The cost of installing and operating the first 400 stations will be around $21M. All hardware will be purchased and owned by NSF/IRIS.

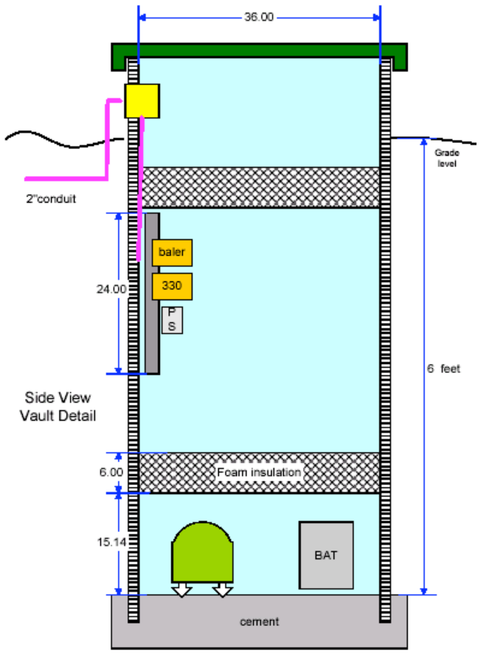
Data from the Transportable Array and other components of USArray will be transmitted in real time via satellite or other means and archived and distributed to the geoscience end educational communities by the IRIS-operated Data Management Center (DMC) in Seattle, WA. The DMC is a pre-existing entity, and USArray will be easily merged with its current operations.

USArray and the Plate Boundary Observatory (PBO) components of EarthScope Observatory are highly integrated, often sharing sites, communications links, and data products.

Logistics of Site Installation: USArray Transportable Array installations will have a low impact on the landscape, much less than a cellular tower. A site must be selected and permitted. Then Transportable Array engineers, employing local contractors for construction work, will install the instruments in standard configurations. In all cases we work with land owners to site these stations in areas that have been previously disturbed but free from sources of vibration. There are two parts to a station; a seismometer vault and a freestanding communications module. The Seismometer vault consists of a cylindrical tank that is approximately 3ft in diameter and 6ft in depth. A seismometer is placed on a concrete pad at the bottom of a hole. The tank extends above grade less than a foot and is covered with a gravel or soil mound if possible. The tank encloses the batteries, data system, GPS receiver, communications equipment, and other electronics. A metal mast is installed within 15 feet of the seismometer vault on which a solar panel is secured to a metal mast that also supports the communications antenna. The complete footprint is about 6ft x 15ft. A livestock fence, if required at the installation, would extend the installation to 20ft x 20ft. Existing vegetation is preserved as much as possible at the site and surface disturbance is minimal. Colored paint can be applied to the equipment to blend the installation into the landscape as much as possible.



The communication module may not be required at all sites depending on the available services. It is a free-standing pedestral enclosing power supplies, communications hardware and a pole mounted 1 meter satellite dish. If AC power is not available, a solar panel array is mounted on poles.



Construction would occur in two phases: a construction crew (2 person) would arrive to excavate and cement in the vault, cable ways and mast which will take one or two days. The temporary work area would extend to 30 x 30 feet for the seismic vault and only 5x5 feet for the communication module (if needed). The work would involve a backhoe for excavation with some temporary noise and dust impact. An installation crew (2 person) would arrive later to install, test and commission the electronics equipment. This work would not require any temporary work area nor any disturbance. The work is entirely related to the connection of electronic assemblies and instrument calibration with a laptop computer occupying the most attention and frustration.

Example: Equipment Delivered by FedEx or UPS Ground Freight

The next photograph shows how the supplies had arrived at Hasting Reserve, near Salinas California.

Seismic equipment and other supplies are in this special container.

Figure 2 Camel Valley

vault and large supplies.

The vault assembly parts were shipped on pallets, and the trucks that delivered them unloaded the pallets with a tommy-lift.

This photo was taken near the Hasting Reserve maintenance shop.
Please notice the cabin on the top right corner of this photo, reference the location of the last photo.

Example Vault Installation

Photo demonstrating the installation of a vault into the ground using a backhoe.

Figure 3 Camel Valley

Mario Torres was almost looking directly south when he took the photo above.

The tube is required to be 7' into the earth to help reduce temperature changes and wind noise the ground motion sensor might pick up.

earthscope USArray

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Example Instrument Installation

Photograph demonstrates how some of the equipment located inside of the enclosure.

Figure 4 Camel Valley

The main sensor is in another layer under the equipment being shown.
The ground motion sensor needs to be kept in a cool and stable temperature.

Example: Site Completed

The Photo below demonstrates how completed installation will look. It will remain for a period of approximately 2 years.

Figure 5 Camel Valley

The vault is usually completely covered with dirt or rock, to help protect the lid and the tube from any dangerous fires or animals and to provide further temperature stability. The vault is also more discreet.

The solar panels can be enclosed with a fence to protect the panels from animals rubbing on the panels. The solar panels face south, at 38-degrees.

Installation Schedule: The initial deployment of the Transportable Array includes 400 stations to be installed in the western US over a period of 4 years. However, we will be ramping up to this number gradually, such that we expect to have only a few stations operating at the end of 2004, building to about 40 stations in northern California by the end of 2005, 150-200 stations in Oregon, Washington and Nevada by the end of 2006, and 400 stations (adding Idaho, Montana, Arizona, Utah and parts of Wyoming) at the end of 2007. We will then start redeploying the stations to the east in 2008. The scientific objectives require a contiguous patch of operating stations extending 1200 x 3000 km.

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