

# EarthScope Transportable Array Plan of Development



## Project Summary

From 2003 to 2013 the EarthScope Transportable Array (TA) installed over 1,700 seismometer stations across the continental United States and southern Canada in a dense semi-permanent array at a 70 km (42 mile) grid spacing. The TA is one segment of EarthScope, an extensive earth science research project funded by the National Science Foundation. The TA is operated by the Incorporated Research Institutions for Seismology (IRIS), a nonprofit 503C founded in 1984 that is a consortium of over 100 US universities dedicated to the operation of science facilities for the acquisition, management, and distribution of seismological data.

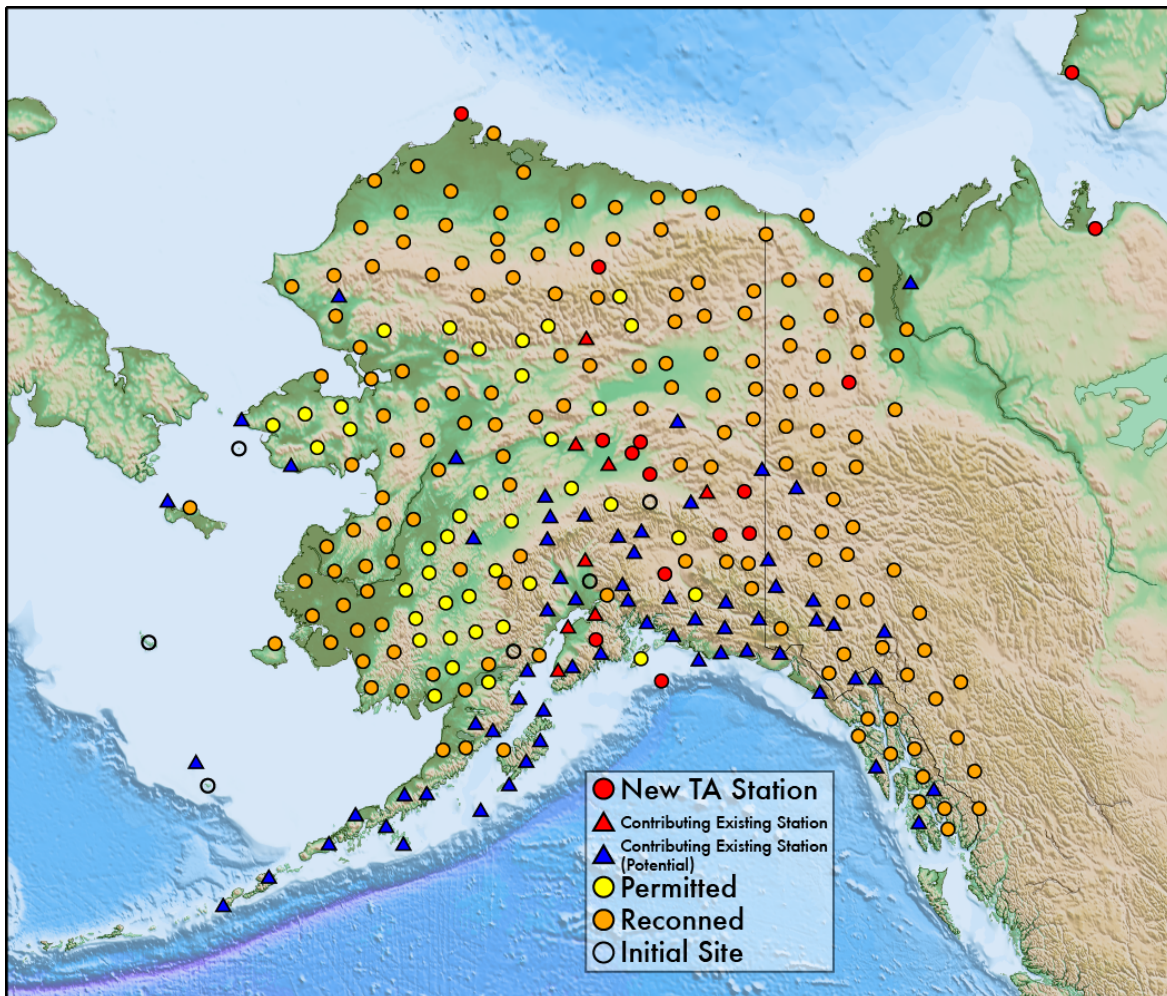


Figure 1: Proposed sites for the Transportable Array in Alaska, based on 2013 and 2014 reconnaissance efforts. Note that actual station locations are subject to permit approval.

Following the completion of the seismic installations in the lower 48 states, the EarthScope Transportable Array project is beginning work in Alaska and Western Canada. This project consists of a large deployment (approximately 270) of ground motion sensors (seismometers) at a nominal spacing of 85 km (51 miles) over the next 4 years. See [www.usarray.org/alaska](http://www.usarray.org/alaska) and Figure 1. Each station will remain in place for up to 5 years, at which time the equipment will be recovered and the site restored to its original condition.

## **Purpose and Need**

One of the main objectives of the project is to improve our understanding of the active tectonics and geologic history of the North American continent. The Transportable Array will create images of the deep structure of the earth, from depths of about 5 km to the core of the earth. The instruments are spread too far apart to provide detailed imaging commonly used for exploration for oil and gas (whose drills go less than 4 km deep). Further science objectives and rationale for the deployment of this large array are explained in a 63-page report found at

[http://www.iris.edu/hq/Alaska\\_Workshop\\_2011/report.phph](http://www.iris.edu/hq/Alaska_Workshop_2011/report.phph)

The seismometers record earthquakes that occur locally, regionally, and throughout the world. The unique value of data produced from this array is due to the large area covered, and to the dense, regular spacing of hundreds of high-quality seismometers. Data from these stations are open and freely available and are forwarded immediately to USGS National Earthquake Information Center in Golden CO, Alaska Earthquake Center at UAF, the Canadian Hazard Information Service in Ottawa (NRCAN), the Alaska Volcano Observatory, and NOAA's Tsunami Warning Center and distributed to hundreds of researchers worldwide. The data help scientists gain new insights into earthquake processes and source characteristics, expand our understanding of earthquakes and lower crustal processes, and improve earthquake and tsunami warning systems for hazard mitigation.

The locations proposed in Alaska will supplement or enhance existing seismic stations currently operated by the Alaska Earthquake Center (AEC), Alaska Volcano Observatory (AVO), Tsunami Warning Center (TWC), Canadian Hazards Information Service (CHIS), Yukon Geological Survey (YGS), and Pacific Geoscience Center of the Geologic Survey of Canada. About a dozen seismic stations will be co-located with existing GPS stations constructed by the EarthScope Plate Boundary Observatory (PBO). As the stations become operational, some of the partnering networks may seek to retain certain stations to be left in place and become part of the permanent seismic monitoring networks. It is difficult to predict the number and location of these selections and we will work with agencies to adapt permits where possible to accommodate the enhanced observational capability.

## Description of Proposed Work

The general design and construction of the TA stations will be uniform for all site locations across the state. Slight variations may be required for individual sites based on local and environmental conditions.

The typical Transportable Array station will occupy a footprint not to exceed 20 x 20 feet (6 x 6 meters), with a low physical profile. The equipment does not produce any noise or motion. To protect the sensor and reduce interference from surface noise, the seismometer will be placed in a PVC or steel cased hole 3 to 15 feet (1 to 5 meters) below the surface of the ground. The holes will either be augured or downhole hammered, and will be approximately 6 inches (15 cm) in diameter. Ground conditions at the site will dictate the hole depth and creation technique.

At most TA stations, the electronics and power system will be housed in an above ground-insulated enclosure. The most common enclosure is a grey hut, measuring approximately 5'x5'x7'H (1.5x1.5x2H meters) and made of fiberglass that can be painted to blend in with the form, line, and color of the surrounding landscape (Figure 2 and Figure 3). Solar panels are mounted directly to the hut. The alternate station configuration consists of boxes/containers, which are secured to a frame, and anchored to the ground; this frame will also serve as the mount for the solar panel.

In either case, the enclosure will house a power system comprising rechargeable lithium ion and lead-acid AGM batteries charged by solar panels. The solar panels will be mounted on the outside of the hut or on a vertical bracket attached to the base frame. The batteries inside the enclosure will power a [Quanterra Q330](#) datalogger connected to a three-component broadband seismometer (STS-4B, STS-5A, T120PH, or CMG-3T) residing in the augured or downhole hammered hole. Ground motion data is recorded continuously at 40 samples per second. Average power of the entire system is about 7 watts.

A standard TA atmospheric sensor package containing a MEMS barometer, a Hyperion IFS-4232 infrasound sensor ([hyperiontg.com](#)), and a [Setra 278](#) microbarograph ([setra.com](#)) will be included in each station. When present, weather station sensors will be mounted on top of the hut or on the enclosure support frame. Additional sensors that could be deployed at some stations as part of collaborative projects include a strong-motion accelerometer, and/or soil temperature profiler. Weather and pressure data is recorded at 1 sample every second, with infrasound also recorded at 40 samples per second. The UTC accuracy of time labels, which is required for seismology, is unusual in weather monitoring.

Power and data cables from the seismometer to the enclosure will be run through conduit placed in trenches, or anchored to rock surface, leading to the enclosure. The trenches will be backfilled after all cables have been secured and tested.

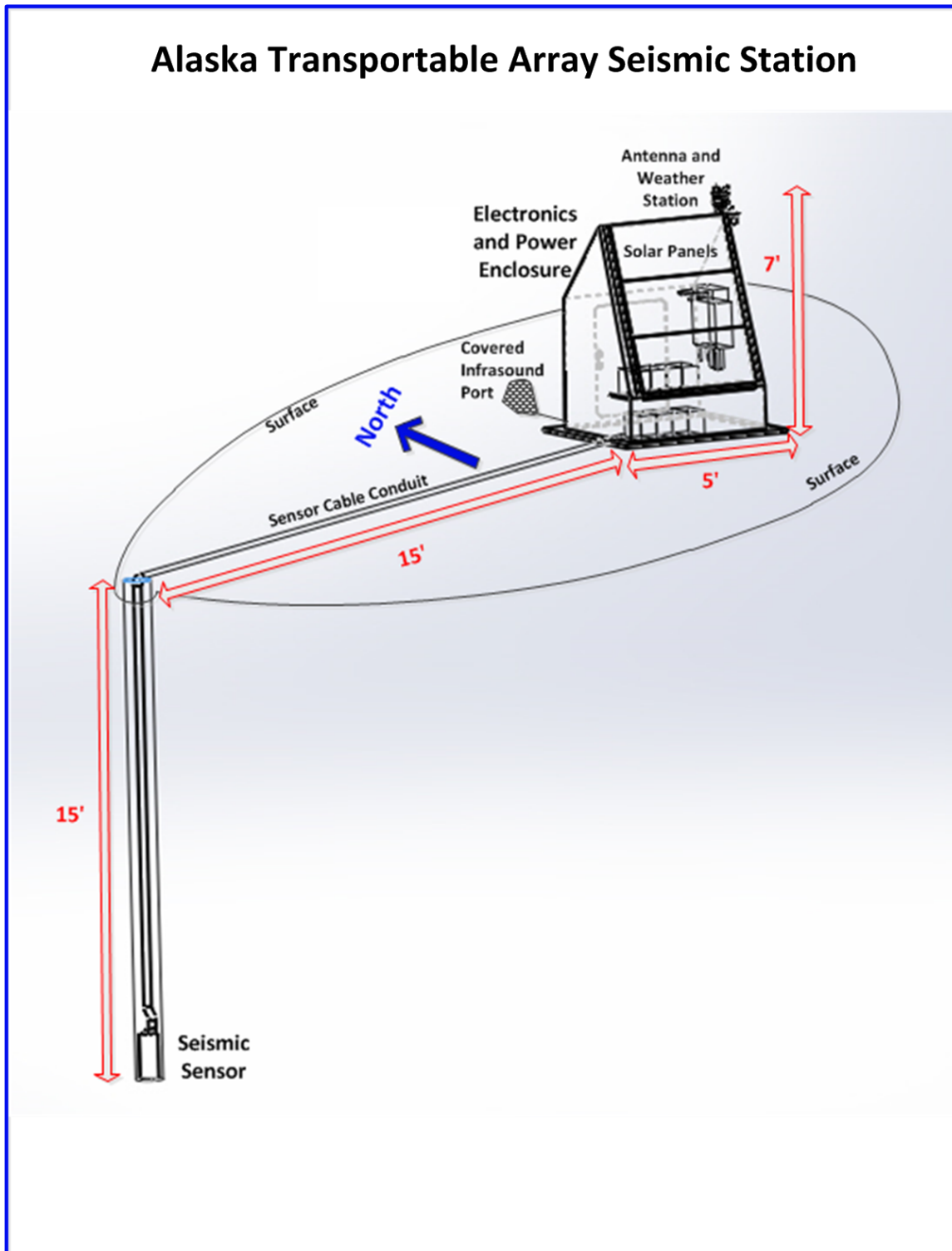


Figure 2: Illustration of a TA Seismic Installation. Dimensions in feet.





Figure 3 Photo of station N25K being installed near Chitina, Alaska, in the fall of 2014.

Data from the stations will be transmitted to the Internet via cell modem, radio links or through a satellite link and received at the Array Network Facility at UC San Diego Super Computing Center for processing, and archived at the IRIS Data Management Center in Seattle, Washington. All data are freely available to the public and to scientific researchers.

### **General Construction/Installation Procedure**

A lightweight portable drill rig with the ability to both auger and downhole hammer the boreholes will be transported via fixed wing or helicopter to sites that cannot be accessed by road. A team of two to three field engineers will construct the borehole (~6 in/15cm diameter and 3-15 feet/1-5 meters deep) and install 6 in (15cm) PVC or steel casing. The PVC or steel casing will be secured in place by grout. Care will be taken to minimize ground disturbance at the site. Construction and installation of a station will take approximately 8-10 hours. Installation of the electronics may proceed immediately but is often performed on a separate day within a week of construction and subject to weather conditions. Stations will typically be installed between mid-May and mid-October, as weather permits.

EarthScope is seeking participation from private landowners, state and federal agencies, First Nations, and Native Corporations to help accomplish this unprecedented research and public education project. EarthScope recognizes their responsibility to respect the property and privacy of landowners, the obligation to operate all stations safely and securely, while assuming full liability if the equipment is damaged or stolen. The landowner will be held harmless for any loss or injury involved with the EarthScope project.

## Project schedule:

In 2011, roughly 294 initial sites were identified within predetermined 20km areas. 2013 and 2014 field reconnaissance efforts refined these locations to within a few meters of the actual site location, and in some cases provided several alternate locations. With the actual sites located, efforts have moved to permitting and install logistics. As of fall 2014, 25 stations have been installed and/or incorporated into the array. The proposed schedule for future station installations over the next few years is depicted in Figure 4.

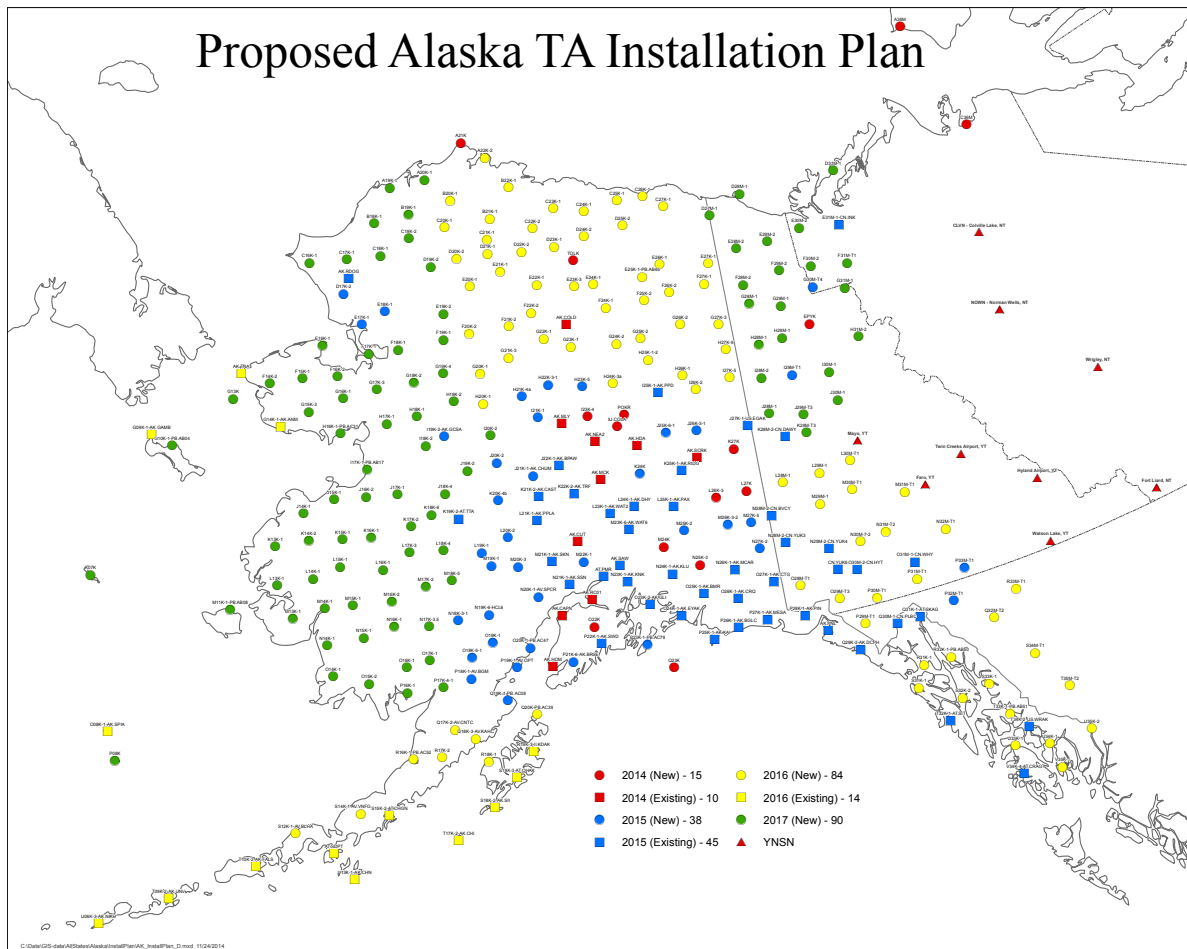


Figure 4 Location of sites based on 2013 and 2014 field reconnaissance work. Sites in red are installed seismic stations. Sites with square symbols are existing seismic stations that we anticipate being incorporated into the array. All other sites follow the installation plan.

## **Operation and Maintenance**

The seismometer and other equipment will operate continuously. Whenever possible maintenance will be performed remotely. If the equipment malfunctions, the problem can be identified at the data processing center. On occasion maintenance trips may be necessary and will be limited to roughly a few hours on one day about once a year. Most often maintenance issues are related to data communications.

## **Additional Information**

A significant portion of the funding for this project is dedicated to public outreach. EarthScope and its partners have developed activities, lesson plans, map tools, visualizations - and much more - to help students and teachers work with EarthScope data and scientific results. EarthScope materials include teachable moments, research summaries, links to research projects, and interactions with EarthScope scientists and staff. For more information on the EarthScope project, please review the links below:

<http://www.usarray.org/researchers/obs/transportable>

<http://www.nature.com/news/us-seismic-array-eyes-its-final-frontier-1.14099>

[www.popsi.com/science/gallery/2011-07/big-science-universes-ten-most-epic-projects?image=9](http://www.popsi.com/science/gallery/2011-07/big-science-universes-ten-most-epic-projects?image=9)

[www.earthscope.org](http://www.earthscope.org)

<http://www.earthscope.org/science/observatories>

<http://www.earthscope.org/resources>

[www.nature.nps.gov/geology/earthscope](http://www.nature.nps.gov/geology/earthscope)