

earth scope onSite

newsletter

From The Plate Boundary Observatory Principal Investigator

In this issue of *onSite* we highlight the use of LiDAR (*Light Detection And Ranging*), a technique that stands to revolutionize how we look at the Earth's surface. LiDAR data collection using Airborne Laser Swath Mapping (ALSM) techniques measures the distance from an airborne platform to the ground surface. The measurement is made using a pulse of laser light that is reflected off the ground, detected on the platform, and then converted to a distance. The Earth acts like a mirror, reflecting back a continual blast of pulses which paints the Earth's surface with multiple distance measurements for every square meter surveyed. Tens of thousands of pulses are emitted and collected every second. Knowing the exact position of the platform using GPS means the distances can be mapped to exact positions thereby creating a very high definition 3-D map of the Earth's surface. The beauty—and power—of LiDAR is that it is often not quite this simple. LiDAR pulses reflect off of vegetation providing scientists with accurate estimates of vegetation height, cover, and canopy structure. LiDAR data can even “virtually” remove vegetation and provide a truly unique look at ground features normally hidden by trees and plants. This is useful for many studies related to science and resource management including geology, biology, forestry, fisheries, and landscape processes such as erosion. LiDAR data will provide EarthScope scientists with new and exciting information for studying surface morphology related to fault geometry and long-term fault slip history, critical for understanding the earthquake cycle and short- and long-term earthquake hazards.

The next issue of *onSite* will highlight USArray activities. If there is a topic of special interest to you, please let us know by contacting one of the *onSite* editors (PBO: tallerday@unavco.org or USArray: dorr@iris.edu).

Mike Jackson

Mike Jackson
Plate Boundary Observatory Principal Investigator

featured science:

Airborne LiDAR Imagery of Active Faults for GeoEarthScope

GeoEarthScope is a component of EarthScope that includes the acquisition of aerial and satellite imagery and geochronology. As part of GeoEarthScope, we are working on collecting LiDAR (*Light Detection And Ranging*) data along major fault zones in the western U.S. and Alaska over the next year. This effort will provide extensive and detailed images of active faults throughout the tectonic plate boundary region on the west coast of North America. Airborne LiDAR is an unparalleled remote sensing technique for generating extremely detailed maps of ground elevation. Because of LiDAR's advantages over previous remote sensing techniques, it is rapidly becoming a key tool in studies of active faulting, landscape processes, and ground deformation.

The data obtained through the Northern California GeoEarthScope LiDAR project will be used for improving our understanding of hazards along the San Andreas plate boundary region. The ability to “see through” the vegetation provides images of the faults that were previously unobtainable. These data then allow the creation of precise maps that show where faults break the Earth's surface (see Figure 1). These images will aid paleoseismologists (those who study the records of pre-historic earthquakes) in determining the timing and size of earthquakes that occurred on the faults in the geologic past, which may be an indicator of potential earthquake magnitude on that fault segment in the future. The precision of these LiDAR images also allows us to determine the rate of fault movement in the past by identifying a dateable feature that has been offset by the fault, something that was previously difficult to accomplish in remote locations by foot.

The first part of this project was the mapping of active faults throughout Northern California, the most well-known being the San Andreas. More than 1500 km² of the San Andreas fault system were mapped, including a 1-2 km wide swath from Shelter Cove, where the fault first comes ashore north of San Francisco, to near Parkfield on the central coast of California. The fault continues to the

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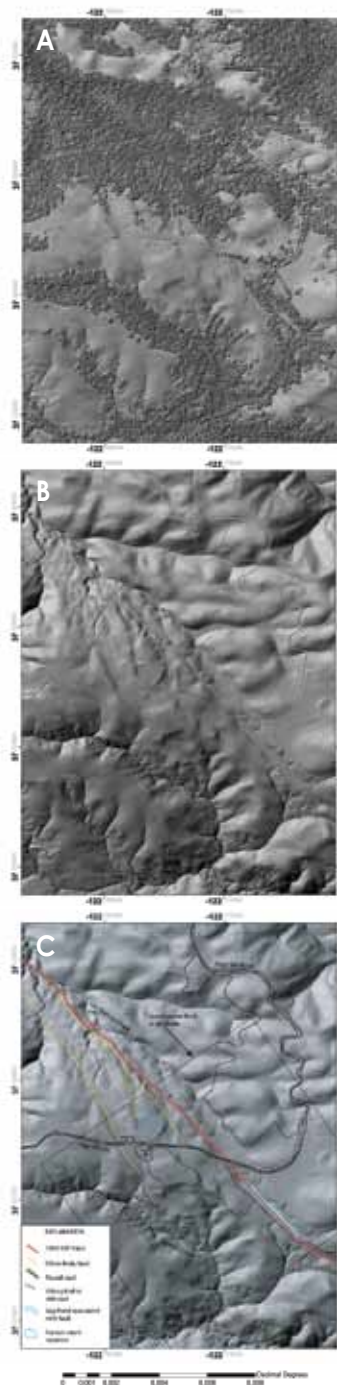
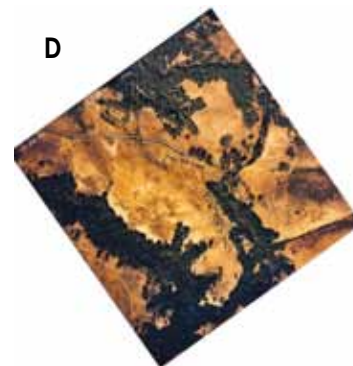


Figure 1. LiDAR data acquired for the GeoEarthScope Northern California project were used to create these shaded relief map images of the San Andreas fault in the Santa Cruz Mountains just south of San Francisco. a) Unfiltered LiDAR data show all surfaces imaged including vegetation. b) Filtered LiDAR data reveal “bare Earth” surface beneath vegetation. c) Fault trace and other features identified and interpreted from LiDAR imagery. d) Traditional aerial photograph for comparison. Acknowledgements: LiDAR images prepared by the National Center for Airborne Laser Mapping (NCALM). Preliminary interpretation and air photo provided by Dr. Carol Prentice, USGS. View these images online at <http://pboweb.unavco.org/?pageid=13&newsid=155>.



project status: USArray

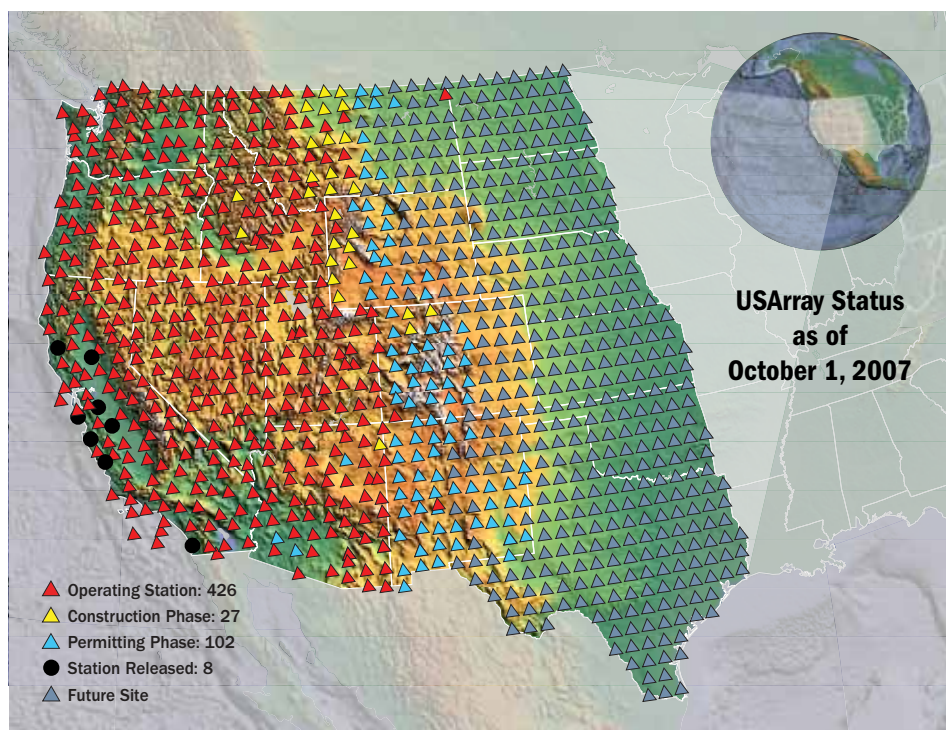
Where is the Transportable Array?

Summer is always a busy time for the Transportable Array and 2007 was no exception. In early August, the Transportable Array installed its 400th station in Newdale, Idaho, achieving this target nearly two months ahead of schedule! With all 400 sets of instruments now deployed, the first stations in California are being dismantled. After the equipment is removed from these stations, the instruments will be shipped for installation at sites on the eastern edge of the array. This marks the beginning of the Transportable Array's multi-year roll across the U.S.



New stations are now operating in Idaho, Montana and Utah, and Wyoming's first station was recently installed in Grand Teton National Park. Over the last few months, construction and installation activities have been taking place in the mountainous regions of Montana, Wyoming, and Colorado. These crews will soon move south and east to avoid the snowfall in the higher elevations. Site verification and permitting are continuing in Montana, Wyoming, Colorado, and New Mexico, following the initial site identification conducted earlier this year by university students and staff in these states.

Working in the field or behind-the-scenes, building, operating and maintaining this 400-station Transportable Array requires a lot of effort from many people. The Transportable Array team includes more than 70 professionals with a wide variety of skills and expertise. From backhoe operators to electronic engineers, from contracting officers to purchasing agents, from data quality analysts to software developers, from inventory specialists to project coordinators and many other talented contributors, we make the Transportable Array happen! ■



REAL-TIME STATION STATUS: To view a map of current Transportable Array stations, visit <http://www.earthscope.org> and click on 'EarthScope Information System (EIS)'.

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.

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

Cores Retrieved from San Andreas Fault Zone

After a two-year hiatus, drilling activities resumed this summer at the San Andreas Fault Observatory at Depth (SAFOD) near Parkfield, California. In 2004 and 2005, the main hole was drilled to a depth of 13,000 feet, boring from the Pacific Plate on the west across the San Andreas fault to the North American Plate on the east. This summer, more than 130 feet of core were retrieved from three different depths within the fault zone by drilling laterally from the main hole. The coring targets included two actively creeping faults. These cores will be analyzed by scientists to determine the physical and chemical characteristics of the rock. In the coming months, a suite of instruments, including seismometers, accelerometers, tiltmeters and a fluid pressure transducer, will be installed to monitor movement along the fault. With the new information being collected from this observatory, scientists hope to answer fundamental questions about the processes that control faulting and

earthquake generation within a major plate-bounding fault. For more information about SAFOD, visit www.earthscope.org. ■



The SAFOD co-PIs, Mark Zoback (Stanford University), Steve Hickman (USGS), and Bill Ellsworth (USGS) look at a section of the core from the "10480" fault zone.

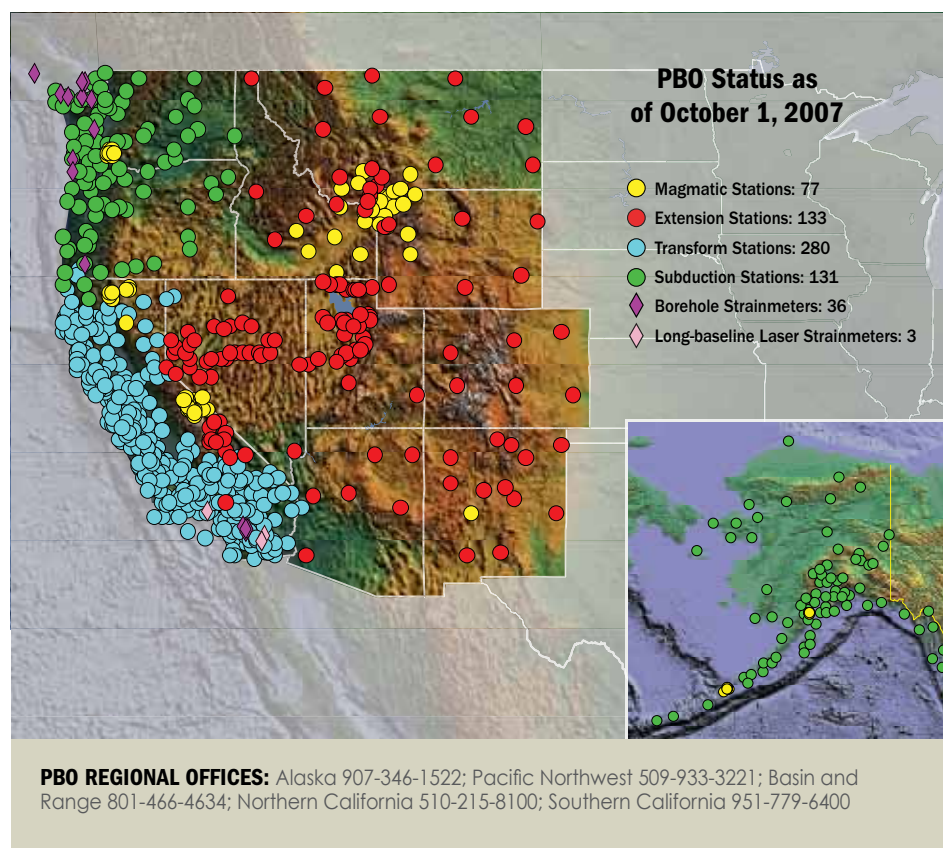
project status:

Plate Boundary Observatory

UNAVCO is building and operating the Plate Boundary Observatory (PBO) as part of the NSF-funded EarthScope project, which is collecting data on the interactions between the Pacific and North American tectonic plates in the form of 3-D motions and earthquake data. When completed in October 2008, the PBO will comprise the largest integrated geodetic and seismic network in United States, and the second largest in the world. Data from the PBO network will facilitate research into plate boundary deformation with unprecedented scope and detail.

As of October 1, 2007, UNAVCO had completed 700 of the 875 planned GPS units, 44 of the 103 planned borehole strainmeters and seismometers, and 12 of the 28 planned borehole tiltmeter stations. In addition, 189 of 209 previously existing GPS stations have been adopted through the PBO Nucleus project. The combined network has provided 450 gigabytes of raw data to date, approximately half of which is GPS data from the PBO network.

Researchers can use these data to understand the earthquake cycle and how tectonic plates interact. All PBO data products are freely available to the community without artificial delay and can be accessed from the PBO web pages at http://pboweb.unavco.org/gps_data and <http://pboweb.unavco.org>. Scientific highlights from PBO to date include capture of the pre-eruptive, eruptive, and post-eruptive phases of activity at



Augustine Volcano, Alaska, during 2005 and 2006; dense coverage of the ongoing volcanic unrest at Mount St. Helens; recording of large earthquakes near Cape Mendocino and Parkfield in California,

Russia, Tonga, and the Kuril Islands; and recording of the 2005 and 2006 episodic tremor and slip events along the Cascadia subduction zone. ■

featured science:

Airborne LiDAR Imagery of Active Faults for GeoEarthScope

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south, and has already been mapped using LiDAR by the NSF-funded B4 project in 2005. Swaths were also mapped along major sections of the Hayward, Rodgers Creek, Maacama, Calaveras, Green Valley, Paicines, and San Gregorio faults, all located in the Bay area. Marine terraces near Año Nuevo and Bodega Bay were imaged, which can provide information on local uplift rates and sea level change. Additional mapping was done on a 5-km wide swath perpendicular to the plate boundary just south of the Mendocino triple junction, which is where three tectonic plates come together and the San Andreas fault ends offshore north of San Francisco. The imagery near the Mendocino triple junction will

help researchers to understand the early stages of the San Andreas fault system's development. Some regional, state and federal groups provided additional funds to increase the data acquisition, particularly in the densely populated San Francisco Bay region, demonstrating the value of these data to the local community. For the first time there is a high-resolution image of one of Earth's major plate boundary fault systems along its entire length!

The acquisition of LIDAR data is providing information on active faults that was previously impossible to gather. As these data for the entire PBO region become available over the next year,

there will be superb opportunities for EarthScope researchers to incorporate these high-quality images of fault behavior into their science. This continues our efforts to mitigate hazards posed by active faults in the western U.S. and Alaska through improvements in earthquake science.

For more information please see: <http://pboweb.unavco.org/?pageid=13&newsid=155>. ■

By Kevin P. Furlong, Department of Geosciences, Pennsylvania State University, and Chair, UNAVCO's GeoEarthScope LiDAR Working Group.

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Newsletter Editors:

Perle M. Dorr
IRIS/USArray
dorr@iris.edu

Kate Tallerdar
UNAVCO/PBO
tallerday@unavco.org



View of GPS station AB28 on Rainy Pass in the Alaska Range. This station was installed in July 2006. Photo submitted by Ryan Bierma.

100th EarthScope Plate Boundary Observatory GPS station completed in Alaska

On September 10, 2007, a significant UNAVCO milestone was reached with the completion of the EarthScope PBO GPS station AC51 near Strandline Lake outside of Anchorage. AC51 is the 100th of 140 permanent GPS stations planned for Alaska. The first Alaskan site, AV09, on Haystack Hill near Dutch Harbor in the Aleutian Islands, was completed in May 2004. PBO will install a total of 875 permanent GPS stations by October 1, 2008. For more information please see: <http://pboweb.unavco.org>.



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1200 New York Avenue, NW
Suite 800
Washington, DC 20005