SNEP: Understanding the Sierra Nevada and Environs

The 2005-7 Sierra Nevada EarthScope Project (SNEP) is a university-run project building upon earlier National Science Foundation (NSF)-funded projects in the southern Sierra: the 1997 Sierran Paradox experiment and the 1993 Southern Sierra Continental Dynamics Project. Data from those experiments have been archived and are accessible through the Internet; results from those experiments have been published in the peer-reviewed literature, including the journals *Science* and *Nature*. The new experiment will take advantage of the deployment of a nationwide array of seismometers, the Congressionally funded Transportable Seismic Network element of EarthScope (http://www.earthscope.org) also known as USArray (http://www.iris.iris.edu/USArray/).

Scientific Goals of SNEP

The 1993 Southern Sierra Continental Dynamics Project showed that the southern Sierra Nevada lacks the thick crust previously inferred to be present. Without such a thick crust, there must be a body or bodies under the Sierra, less dense than surroundings, that provide the support for the high elevations of the range. The 1997 experiment found that hot, possibly partially molten mantle rises up under the southern High Sierra, supporting the high elevations there and probably producing several of the small volcanoes near Big Pine and in the backcountry of Inyo National Forest. This experiment also found indications that before about 3 million years ago, this hot material was not present. Instead, very heavy material rich in garnet underlay the Sierra. This material apparently came off the bottom of the Sierra and is descending into the Earth's mantle. The removal of this material might have caused the uplift of the range, faulting along the east side of the Sierra, the creation of the volcanic center near Mammoth Mountain (the Long Valley caldera), and possibly helped create the California Coast Ranges.

This new experiment is to determine if the history found for the southern Sierra extends up the length of the range, what evidence remains in the crust of this event, and how the removal of the garnet-rich material effected the surface geology. Events like this have been proposed for other places (such as Tibet and the Appalachians), but unlike these other places, the Sierran event is young enough that we can learn a lot about how such material is removed.

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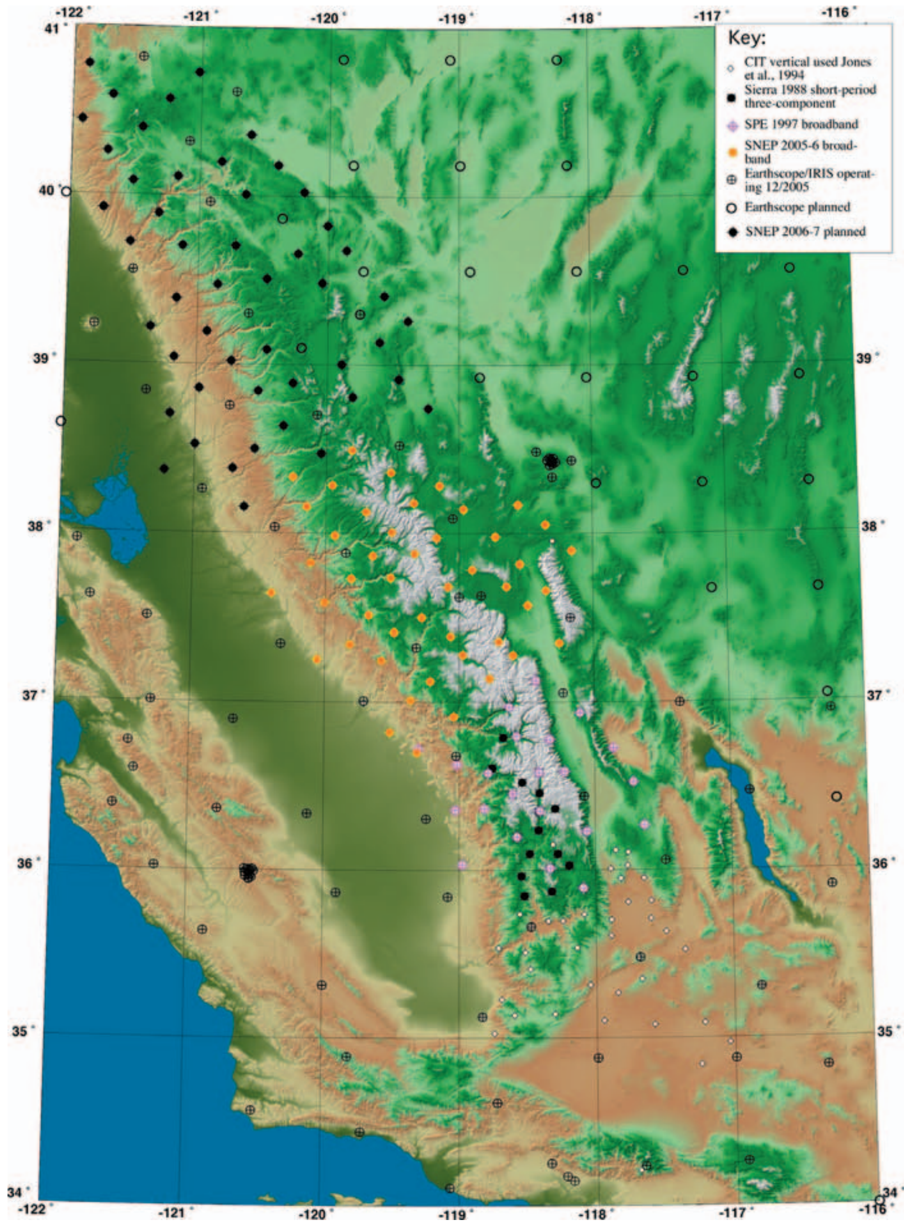
Why do we want to put SNEP seismometers where we do?

We are deploying about 40 seismometers around the Sierra from about Kings Canyon National Park up to near Mt. Lassen from May 2005 to October 2007. These instruments will record earthquakes both from within the study area and from far beyond it; no explosive charges will be used in this study. Because we are using natural sources, we need the equipment to remain in the field for as long as possible so that we might record enough earthquakes from locations suitable for this type of work. Scientific results will be published in the peer-reviewed literature within 2-3 years of the completion of the experiment. The recordings made with these instruments will be archived with the IRIS Data Management Center, an organization funded by NSF to collect such data sets and make them available to all researchers and the public.

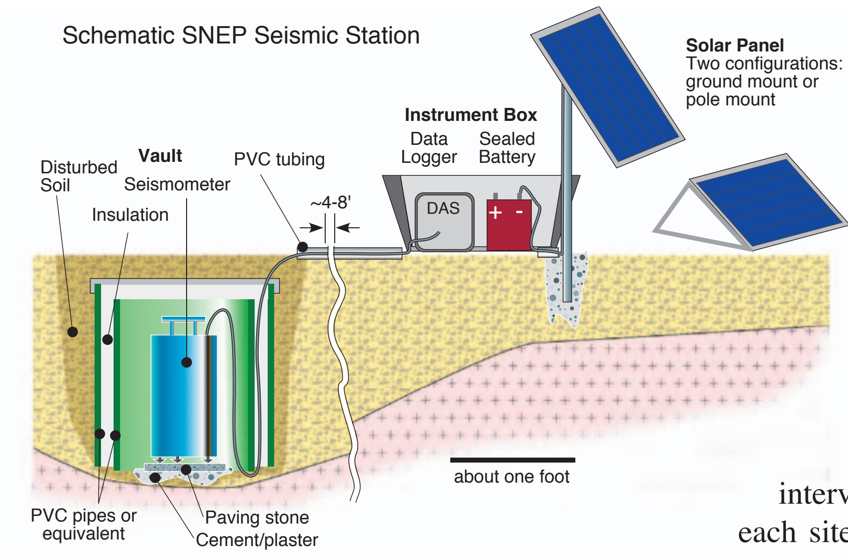


Single seismometers will be placed at regular intervals in the Sierra to provide an optimal geometry for imaging the Earth under the range (see map). While the exact location of any station can vary by about 1 km, we wish to maintain an even coverage and occupy sites that, from our experience, are most likely to produce scientifically valuable results. In addition we reoccupied three sites from the 1997 experiment to better integrate our new data with the old data sets. Thus we would like to place our seismometers within about 1/2 mile of our ideal locations. Local conditions we consider favorable for deployment of a seismometer include a thin veneer of well-drained soil (about 3 feet) over hard rock, away from power poles, rivers, roads, houses or other structures, with enough of a southerly exposure to insure adequate power through our solar panel. Sites away from sources of seismic noise are greatly preferred; such noise can come from highways, railways, farm machinery (tractors, etc.), urban areas, active mines, and irrigation pumps. While stations will not be placed immediately adjacent to roads (because of the seismic noise of cars and trucks as well as the increased potential for vandalism), we seek sites with good road access. This also limits deployment within Wilderness areas to a minimum. Instruments will generally be placed within a few hundred feet of a road, generally closer to less traveled roads (as close as 50 feet) and farther from heavy-duty paved highways.

The station spacing in this experiment is about 25 km, similar to the 1997 experiment. This is the minimum spacing between stations that will allow us to reliably image the lower crust and uppermost mantle under the Sierra.

What does it take to install a SNEP seismometer?

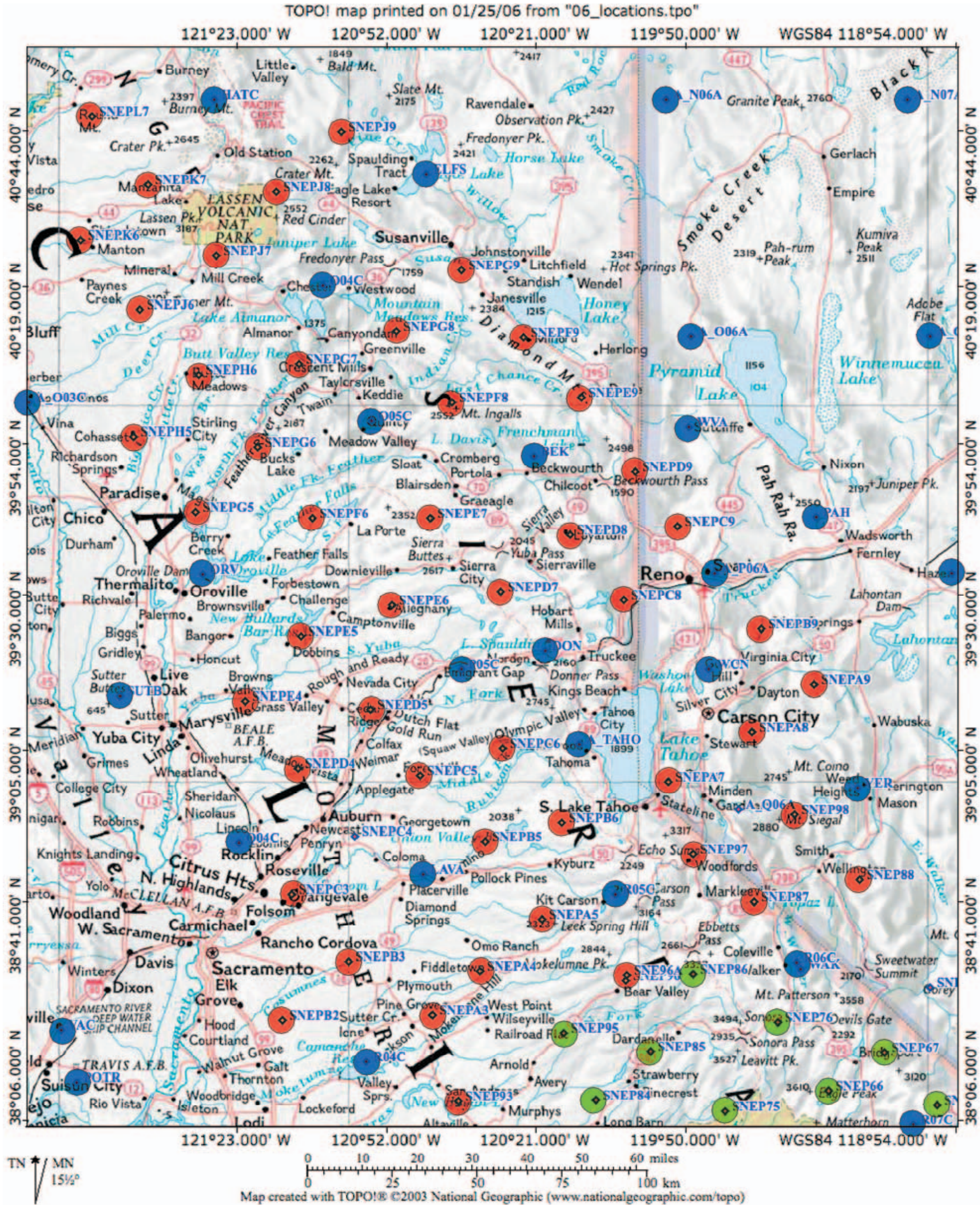
Individual station deployments usually require a hole less than 3 feet in diameter and 3 feet deep, solar panels, and a box of electonics. The seismometer (a modern, “broadband” instrument capable of measuring all three components of ground motion) is buried in the hole. A concrete base with a small paving stone is placed at the bottom of the hole and a ~20” diameter plastic tub surrounds the instrument on the sides to prevent the hole from collapsing on the instrument, to protect the seismometer from moisture and dirt, and to insulate the seismometer. Insulation tops the vault. This construction, which we term a field vault, is covered with a fitting lid and is then buried. A roughly 5’ cable runs from the seismometer to the recording equipment, which is placed inside a box about 3’ long, 2’ wide and 18” high; this box is usually partially buried, depending on the landscape. A sealed lead-acid battery is within the box; it is connected to a solar panel by wiring. A small satellite clock antenna (GPS clock receiver, about 3” by 3” by 1”) is within a few feet of the recording equipment or atop the solar panel mast, depending on the way the panel is mounted. All surface cables are buried under perhaps 1-3” of dirt and/or placed in PVC pipe to prevent animals from chewing on them. The holes in the box are covered to prevent animals from entering the box. If possible, the box is placed in the shade of large rocks, trees, or bushes; this also tends to make the box less conspicuous. Sometimes the box is buried.



We always try to conceal our equipment from view from any nearby roads or trails, both for aesthetics and for security. The box has a note on the top telling any accidental visitors the purpose of the equipment and providing a phone number to call if they are curious. This setup has been used successfully in the 2005-6 stage of this experiment, on BLM lands in eastern California in 1993, 1994, and 1997 (Ridgecrest district), on BLM and USNFS lands in Utah and Nevada in 1994-5, on USNFS lands in 1993 and 1997 (Inyo National Forest, Sequoia National Forest, and Sierra National Forest), on USNPS lands (Sequoia and Kings Canyon National Parks, 1993 and 1997, and Harrisburg Flat area within Death Valley National Park in 1994) and on private land in the western Sierra (1997).

Installation of the equipment only requires a pick and shovel, a bucket of cement, and 2 to 4 people; there will be no need to get a vehicle any closer to the site than the nearest road. The instruments are designed to run for months without human intervention. For this experiment, we expect to visit each site two or three times in the first month or so, then about once every few months thereafter; each visit will be by one or two scientists. Removal of equipment requires a single visit, at which time the field vault is removed, the hole is refilled and all signs of occupation are eliminated. Sites are usually unmarked.

2006-7 SNEP Deployment Map



General location map of proposed SNEP 2006-7 seismometers (red dots), deployed SNEP seismometers (green dots), and USArray's Transportable Array stations in the area (blue dots).