2009 SCEC Annual Report: SCEC Borehole Instrumentation Program

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Summary:

One of the main accomplishments of the SCEC borehole instrumentation program has been the high degree of collaboration and cost sharing between multiple agencies and institutions that operate networks and collect and archive seismic data. The goal of the SCEC borehole instrumentation program, from its inception in SCEC 1, has been to facilitate the deployment of borehole observation stations in southern California (Figure 1).

The philosophy behind the SCEC borehole instrumentation program was that all data should be integrated with the existing network infrastructure for real-time transmission, processing, and archival. This provides all researchers with equal access to the data as soon as it's made available from the network operators. In addition, the borehole data is being used by the network operators for earthquake locations, as the borehole waveforms tend to have lower noise giving rise to cleaner arrivals.

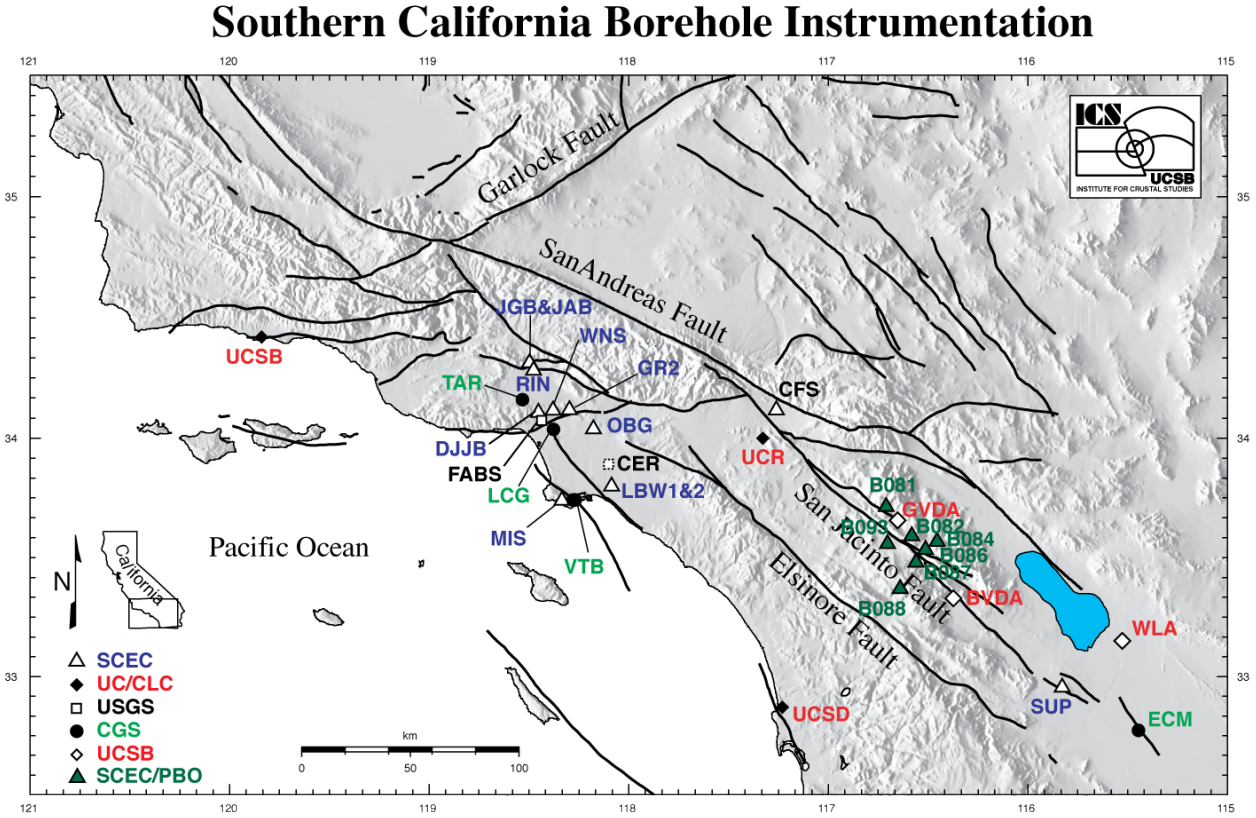

Figure 1. Location of Borehole Sites in Southern California

The operations and maintenance of all the borehole stations requires an active role in assisting with the maintenance of network and data center operations. The continuous real-time data exchange between Caltech and UCSB allows for quality control of the data. Collaboration with the NSF NEES program and the cyber

infrastructure that has been put in place at UCSB through this program facilitates this data exchange.

Highlights of 2009 Efforts and Results

- SCEC collaboration with NEES program.
  - The web-based borehole data dissemination portal has been re-designed in the past year to include a cleaner user interface, and additional metadata for each ground motion recording.
  - Routine processing scripts are being developed that include more of the SCEC supported borehole stations.
- Removal of a failed sensor at the Borrego Valley downhole array.
  - Corrosion of the connector turned out to be the problem, and this is now being investigated at the manufacturer.
- Site visits to the WNS site to diagnose and then replace the failed power distribution box.
  - The station continued to record data from the borehole sensor locally, but the telemetry and surface sensor were inoperable until this unit as replaced.
  - Data telemetry and a working surface sensor was restored when the failed power distribution unit was replaced.
- General quality control on all existing borehole stations.
  - NEES software processing systems at UCSB used to pull data from the real-time systems at Caltech and UNAVCO to ensure data quality and assist with troubleshooting.

Continued Collaboration with the NEES program

The NEES program provides the use of software and cyberinfrastructure for real-time monitoring of the SCEC borehole stations in southern California, and now the ability to provide researchers interested specifically in borehole data to a web-based dissemination tool. For the NEES and USGS collaborative borehole array sites the data from the borehole stations is recorded continuously, and then events are segmented out of the continuous stream by matching ANSS catalog event locations and times with station locations, and segmenting out an appropriate time slice of data. A simple magnitude and radial distance scheme is used to determine when to segment out the data. For example, we match all catalog events that occur out to a radial distance of 20 km from any borehole site. For magnitude 2.0 or greater we extend the radial distance to 40 km of any borehole site, and as the magnitude increases, we extend both the distance and amount of time we segment out. This segmented waveform data is then processed to extract out and then include various parameter of the acceleration traces in the dissemination portal. These parameters are provided at the download page with each channel, which can then be downloaded, with multiple file format options provided to the user.

An example of the new user interface to this data dissemination portal is shown in Figure 2 below with the Superstition Mountain station selected. This is a complete re-design of what was presented last year. The data portal interface starts with the user

selecting the particular station and which of its channels they are interested in from a Google-map based search window. Some of the sites are dense vertical arrays of both accelerometers and pore pressure transducers, so the user can choose which of these sensors they would like to select data from.

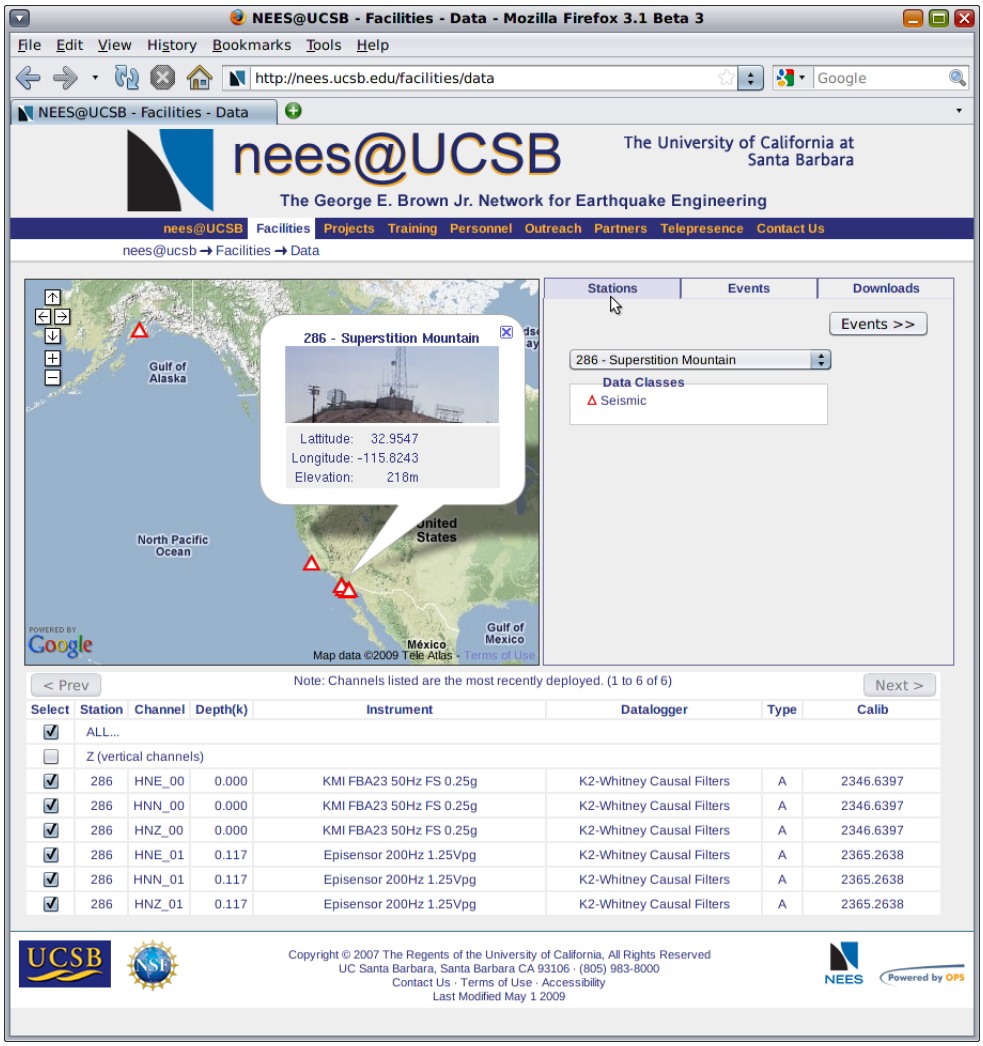

Figure 2. Screenshot of station selection using the new borehole data dissemination interface.

In the example in Figure 2, the user has selected the Superstition Mountain site from the drop down menu, and the 6 available data channels from the surface and borehole sensors show up in the list below the map, with the all channels selected. The next step is to select the events for which you would like data from. Figure 3 shows the event selection component of the user portal. The Google map interface allows you to click on individual events to see basic source information as seen in the pop-up on the map. This part of the interface allows the user to search the event database based on magnitude, distance, and time period criteria as shown on the right. Once the user

selects an event from the list at the bottom of the page, they can then proceed by clicking the “downloads” button.

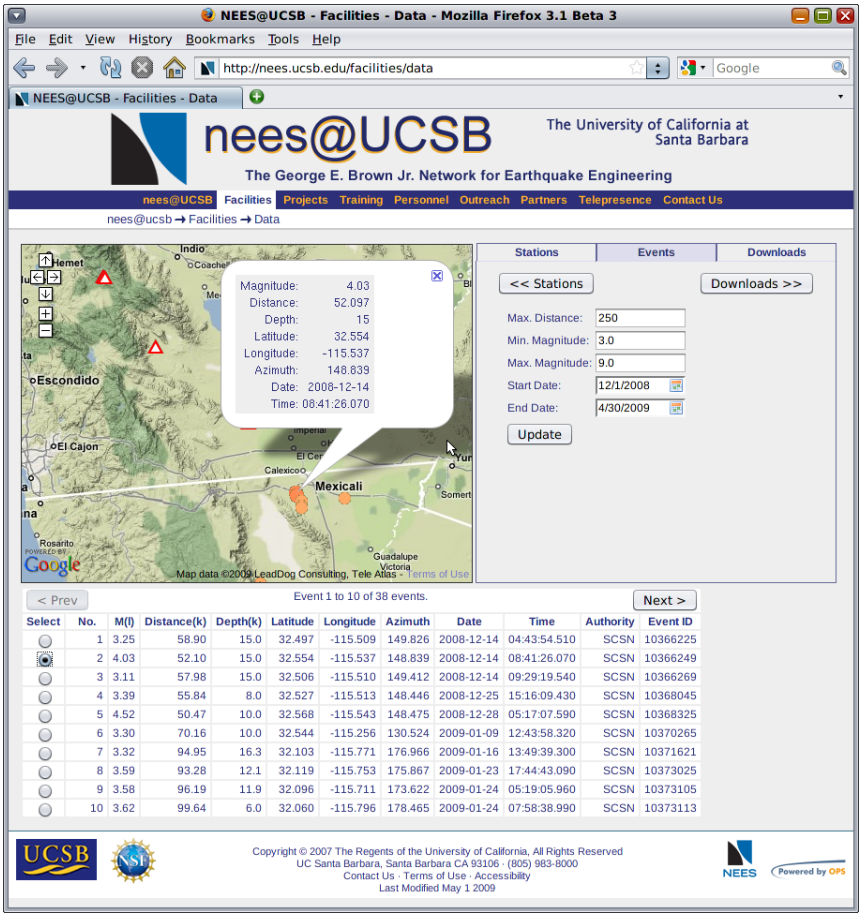

Figure 3. Screenshot of event selection using the new borehole data dissemination interface.

At the download page (Figure 4 below), the user will now be presented with the available data channels from the selected event. These can be “packaged” by selecting the preferred file formats and any options that apply to those formats. The miniseed file format is in counts and values must have the calibration applied later by the user. The RDV and Excel compatible formats can have the calibration applied. The button “Add Package” stores the selected data channels. You can go back to step two or even step one to get different events for the same event at different stations. When you have all the data you’re interested in added into the packages window, you can then enter your email address and click the “download packages” button.

As shown in Figure 4, some of the processing scripts that are now in place already provide the signal to noise ratio of each channels data, along with the peak ground acceleration (PGA) and velocity (PGV). Part of the activities for the future will be adding a web-based data viewer to this component of the data dissemination portal. This new data viewer, already under development as a collaborative effort between the

EarthScope Array Network Facility, NEES, and SCEC, will allow the user to zoom in and out on the data, providing the ability for the user to get a closer look at the data before making the decision on adding it as a downloads package. Sometimes having parametric data alone is not sufficient in terms of deciding if the data is what the user is looking for, so the waveform viewer will improve the search experience for the user.

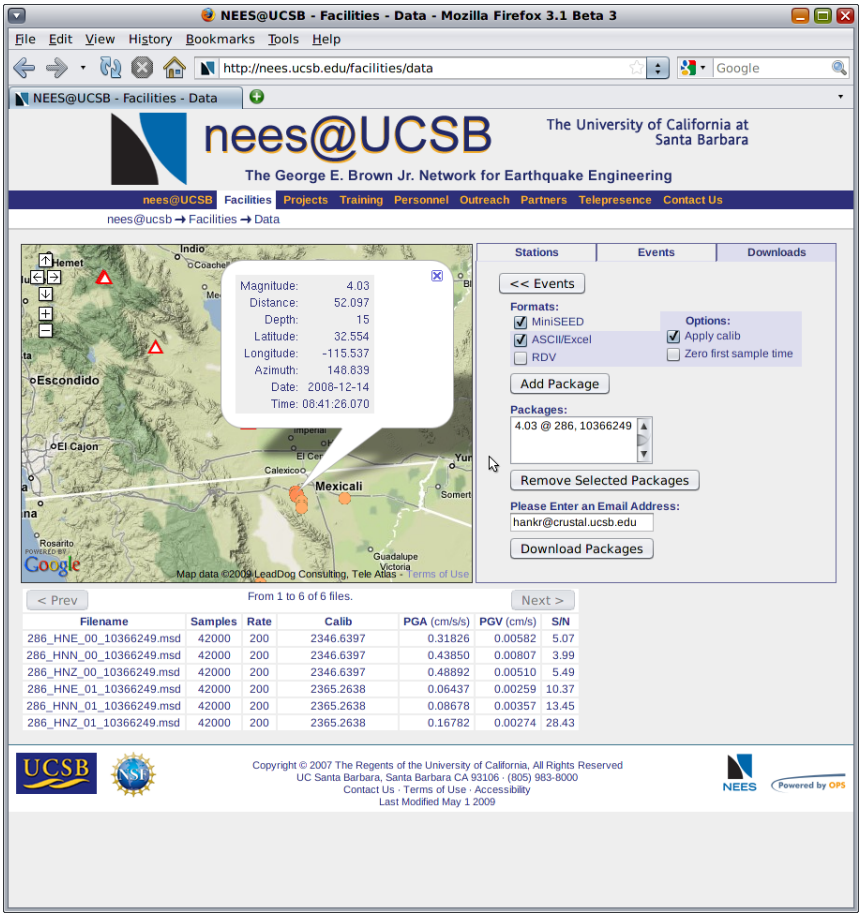

Figure 4. Screenshot of the Download section of the borehole data dissemination interface.