

2.6 Seismic Applications (SEI)

The Seismic research area continued analysis of data captured by the Middle America Seismic Experiment (MASE), analysis of the ongoing Peru Subduction Zone Experiment (PeruSZE), and successful testing of GeoNet, the Reftek ENSBox platform for both structural and seismic applications.

MASE and PeruSE

In 2008 our wireless network that was developed and installed across Mexico (MASE Middle America Seismic Experiment) was shipped to Peru (PeruSE Peru Seismic Experiment) and installed along a line (Line 1) across the Andes between the cities of Mollendo and Puno, where the Nazca plate is subducting beneath the west coast generating devastating earthquakes and tsunamis (Figure 5). Graduate and undergraduate students were involved in the installation of the 49 station network. Most stations at the end of the summer were recording on-site. Subsequently Richard Guy and Igor Stubailo installed the networking that links the stations across the Andes. In the summer of 2009, along with colleagues from Caltech, 50 stand-alone Caltech stations were installed along the Puno-Cusco line (Line 2) along the Altiplano in the Andes. In late 2010, 25 stations from the Mollendo-Cusco line were moved to a new line (Line 3) Pisco-Cusco that parallels the first and completes a U shaped network of 100 stations linking the Altiplano to the coast. Data is available from line 1: 2008-present, Line 2: late 2009-present, Line 3: late 2010-present. It is anticipated the full network will run for at least another year.

The Peru experiment (field work funded by the Caltech Moore Foundation grant) provided an opportunity to redesign our networking protocols based on our networking experience in Mexico. Our Delay Tolerant Shell (DTS) was improved. A new website for hourly system status was designed and implemented. The data was input to LabView. The various synergies of CENS have combined to make a significant remote area networking product. The data is radioed across Peru to Internet drops. It is then transmitted to UCLA over the Internet. The Atacama desert, where the network is located, is one of the more remote parts of the world. The facility that has been developed to install a remote wireless network over 250 km, and have the data transmit back to the laboratory, as well as duplex control on the instrumentation in the field, has application worldwide where remote network sensing is required.

Exciting science has been discovered in the MASE data by Mexican graduate students, Luis Antonio Dominguez and Igor Stubailo, and in the Peru data by Emily Foote. All three presented papers at the Fall meeting of the American Geophysical Union.

CENS Development of the Reftek EnsBox with application to GeoNet-SHMnet-ShakeNet-FlexiRAMP

CENS has provided the infrastructure and technology to link UCLA departments in a single development with and industrial partner (Reftek Refraction Technology of Texas). It is the culmination of our experience in wireless networking to design a node that satisfies the digitizing and wireless networking requirements of the following groups to improve their science:

- GeoNet (geophysical monitoring) Paul Davis, Department of Earth and Space Sciences, UCLA, earthquake and tectonic networks.
- SHMnet (Structural Health monitoring) John Wallace, Civil Engineering, UCLA
- ShakeNet (Monitoring civil structures for shaking after earthquakes) Monica Kohler, CENS and Caltech, Ramesh Govindan, USC, Department of Computer science

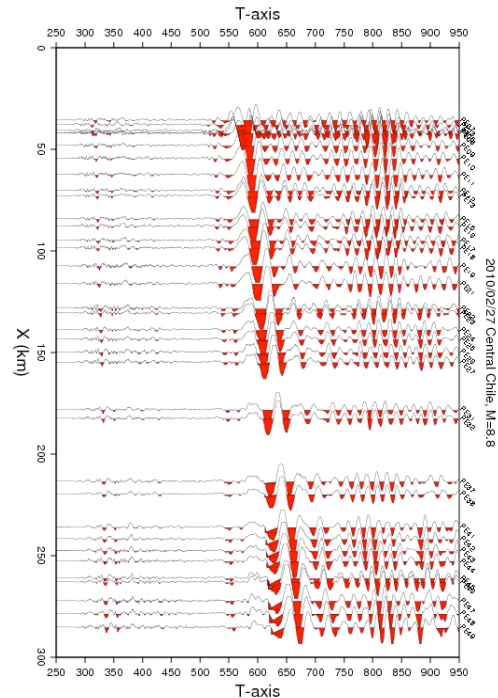


Figure 5. Chile 8.8 earthquake in 2010 February 27 recorded by the Peru network. This unique on-scale recording of a huge earthquake by an array of broadband seismometers provided seismologists with an unprecedented view of the development of a megarupture.

- FlexiRAMP, A flexible network for Rapid Array Mobilization Procedures, IRIS (Incorporated Research Institutions for Seismology) Richard Allen Berkeley, Marcos Alvarez, IRIS, and Paul Davis, UCLA. in association with Deborah Estrin, CENS

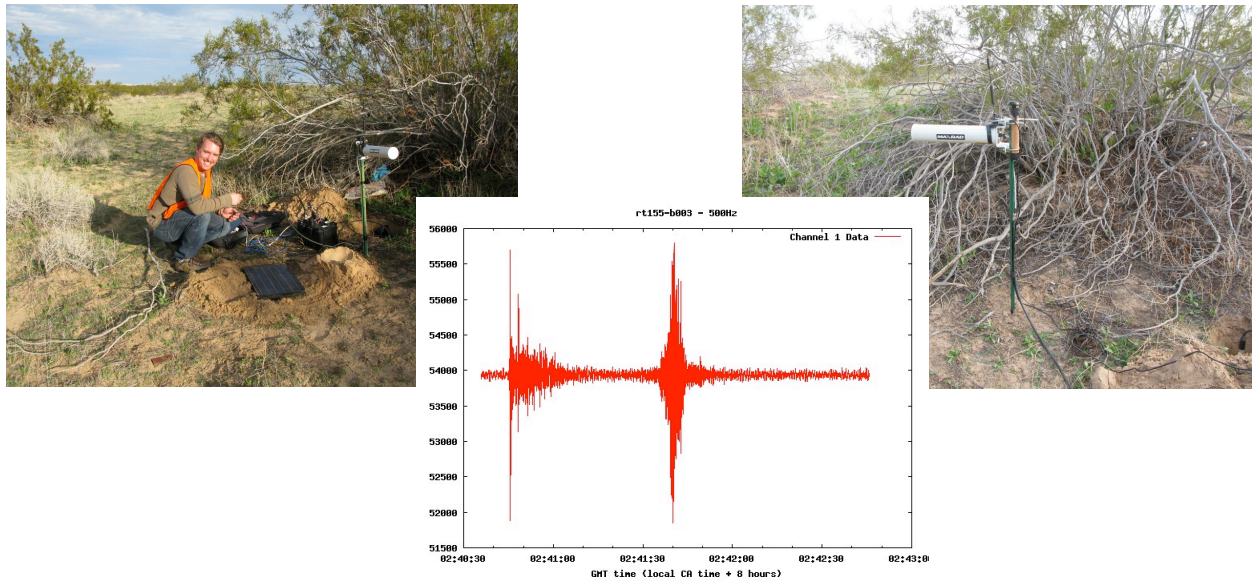


Figure6. March 2011 test of Geonet boxes Salton Sea, California. Data between boxes was transmitted by WiFi. Events (lower left) were automatically detected and transmitted via cell phone modems.

Through CENS, in a multidisciplinary project involving four UCLA Departments (Computer Science, Electrical Engineering, Civil Engineering, and Earth and Space Sciences), the PIs have designed a novel seismic node and have had two built by the leading manufacturer of seismic recorders (Refraction Technology of Texas). The GeoNet nodes incorporate a new generation digital acquisition system (DAS) based on the CENS-developed LEAP (low-power energy aware processing) system and a newly developed low-power A/D converter from Texas Instruments (TI). They will have application over a wide range of field applications involving wide area networks and low power processing and delivery of event data. They will run on small batteries with a laptop sized solar panel. Preliminary tests in the Mojave desert have been carried out in which the boxes recorded explosions from a seismic refraction experiment, detected them as events (Figure 6), aggregated the data using WiFi and used cell phone modems to email the data and plots. As was seen in recent damaging earthquakes in Japan and New Zealand, rapid knowledge of seismic activity is of critical importance to emergency planners.