Scientists cable seafloor seismometer into California's earthquake network

March 19 2009

A newly-laid, 32-mile underwater cable finally links the state's only seafloor seismic station with the University of California, Berkeley's seismic network, merging real-time data from west of the San Andreas fault with data from 31 other land stations sprinkled around Northern and Central California.

Laying of the MARS (Monterey Accelerated Research System) fiber-optic cable was completed in 2007 by the Monterey Bay Aquarium Research Institute (MBARI) to power and collect data from a cluster of scientific instruments nearly 3,000 feet below the surface of Monterey Bay, 23 miles from the coastal town of Moss Landing. A broadband seismometer that had been placed on the seafloor in 2002 was connected to the cable on Feb. 27, 2009, obviating the need to send a remotely operated vehicle (ROV) every three months to replace the battery and collect data.

"Before, we had to wait three months to even know if the instruments were alive," said Barbara Romanowicz, director of the Berkeley Seismological Laboratory and a UC Berkeley professor of earth and planetary science. Now, she said, "we can use the data from the seafloor station in real time together with those from the rest of the Berkeley Digital Seismic Network" to determine the location, magnitude and mechanism of offshore earthquakes, learn about the crust at the edge of the continental plate and understand better the hazards of the San Andreas fault system that runs north and south through the state.

According to Romanowicz, earthquake monitoring systems around the world have been trying to place seismometers on the seafloor for decades to cover the 71 percent of the Earth's surface that is beneath the oceans. Islands have generally provided the only offshore data - the Berkeley network has one seismic station on the Farallon Islands - but these provide only spotty coverage.

Because the state's main fault system, the San Andreas, runs along the Northern California coast, seafloor monitors are particularly critical. All but one station - the Farallon station - are east of the fault, making it hard to gain a comprehensive view of the fault system.

"Even though we correct for this lopsidedness, the calculations would be even more reliable if we could include data from more stations west of the fault; with the addition of MOBB, we achieve this goal," wrote Berkeley Seismological Laboratory research geophysicist Peggy Hellweg on the lab's SeismoBlog, http://seismo.berkeley.edu/blogs/seismoblog.php.

Also, while basic, disposable seismometers can be thrown overboard to collect data for short periods of time, more expensive broadband seismometers, which can detect a wide range of vibrational frequencies and a large amplitude range, are preferred. The latter are necessary to gather the data needed for modeling earthquakes and eventually providing a few tens of seconds' warning of impending ground shaking.

Romanowicz teamed up with the institute more than 12 years ago to develop a seafloor seismic observatory. For three months in 1997, in collaboration with the Berkeley Seismological Laboratory and a team from France, MBARI placed a broadband seismometer on the floor of Monterey Bay to test the equipment and installation procedures. The Monterey Ocean Bottom Broadband (MOBB) station was permanently situated on an underwater ridge in April 2002.

With MOBB data coming back to UC Berkeley only once every three months, it could not be used in real-time earthquake monitoring. It has proved valuable in other studies, however, including an investigation of long-period ocean waves, called infragravity waves, that are thought to generate a low-frequency hum in Earth.

This hum - which has a period of 100-500 seconds, too low for humans to hear - was discovered in 1998 and ascribed to atmospheric turbulence. But in 2004, Romanowicz and UC Berkeley colleague Junkee Rhie showed that the source of the hum was in the oceans and related to storms. Somehow, 10-second ocean waves generated by storms interact with each other to produce longer period infragravity waves, which then interact locally to thump the seafloor and create the hum. The specifics are still unclear, although the interactions of the long waves with the ground likely occur near the shore.

"How the interactions of waves couple to the ground is still an open question," said Romanowicz. "MOBB will allow us to compare seismic data with data from buoys to determine the temporal and spatial relationships between ocean waves, infragravity waves and seismic waves."

Earth's hum as well as ocean currents and breaking surf all make the seismic data from MOBB noisier than data from land stations, Romanowicz said, which means MOBB data must be processed to remove the noise before it can be integrated with other seismic data in the network. She and UC Berkeley colleagues are working on real-time algorithms that can do such processing quickly. The data from the ocean floor seismometer will soon be available, along with other broadband seismic data from land-based stations, at the Northern California Earthquake Data Center: http://www.ncedc.org/, an archive of earthquake date maintained by UC Berkeley and the U.S. Geological Survey.

If MOBB turns out to provide useful data for the Northern California seismic network, it will be a prototype for other seafloor seismic stations she hopes to emplace along the coast from below Monterey to Point Reyes.

More information: Romanowicz is first author of a paper describing real-time data acquisition from MOBB in the March/April edition of *Seismological Research Letters*.

Source: University of California - Berkeley (news : web)