Deep-sea drilling yields clues to mega-earthquakes

December 12 2007

During a successful first expedition to one of the most active earthquake fault zones on the planet, scientists unearthed initial clues to the geophysical fault properties that may underlie devastating earthquakes and tsunamis.

The Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) is the first geologic study of the underwater subduction zone faults that give rise to the massive earthquakes known to seismologists as mega-thrust earthquakes.

"The fundamental goal is to sample and monitor this major earthquake generating zone in order to understand the basic mechanics of faulting, the basic physics and friction," says Harold Tobin, University of Wisconsin-Madison geologist and co-chief scientist of the expedition.

The research team recently returned to shore after eight weeks aboard the Japanese drilling vessel Chikyu at the Nankai Trough, an earthquake zone off the southern coast of Japan that has a history of powerful temblors.

Tobin and other NanTroSEIZE scientists will present their findings from the first expedition at the American Geophysical Union meeting this week (the week of Dec. 10) in San Francisco.

Subduction zone faults extend miles below the seafloor and the active earthquake-producing regions - the seismogenic zones - are buried deep

in the Earth's crust. Their remoteness and inaccessibility have made direct scientific study virtually impossible before now, Tobin says.

"If we want to understand the physics of how the faults really work, we have to go to those faults in the ocean," he explains. "But earthquakes don't happen at the surface; they happen literally miles down beneath the surface along these active faults."

With the deep-drilling capabilities afforded by the Chikyu - which means "Earth" in Japanese - the team will be able to reach the seismogenic zones for the first time.

"No one's been able to make observations inside an active fault like this," Tobin says. "The drilling is unique because it allows us access to where the faults actually are, where the earthquakes actually happen."

On this inaugural expedition, the crew successfully drilled four boreholes - each thousands of feet deep - into the ocean floor near the fault zone.

With a series of monitoring instruments embedded within the drill pipe, the team collected geophysical information about the rock layers while drilling through them, a process called "logging while drilling" (LWD).

"You can tell a lot about the rocks without even sampling them, just by making these measurements," Tobin says.

By comparing regions overlying active and inactive parts of the plate boundary, the team found unexpected differences in the physical stress conditions even in the upper layers of the crust.

"We're understanding now how there's a compartmentalization, or a

partitioning, of the stresses between the place where the stress is accumulating for earthquakes and where it's not," he explains.

Future NanTroSEIZE expeditions will extend the boreholes into the heart of the active fault zone, some more than three miles deep. All of the NanTroSEIZE expeditions are supported by the Integrated Ocean Drilling Program, an international research collaboration.

Ultimately, sensors will be installed in the boreholes to monitor physical stresses, movement, temperature and pressure. From such instruments, rock samples and LWD data, the scientists hope to gain a full picture of the geophysical forces and changes leading up to fault movements and earthquakes.

The pilot holes and technical advances made during the first expedition have paved the way for more extensive surveys of the region's geology. "We're primed for the deep drilling after this stage," Tobin says.

Source: University of Wisconsin-Madison