Detailed Data Available for Recent Costa Rica Earthquake

On 5 September 2012 a magnitude 7.6 earthquake occurred beneath the Nicoya Peninsula of northwestern Costa Rica, rupturing the subduction zone between the Cocos and Caribbean plates. In most subduction zones the locus of seismic slip lies far offshore, making it difficult to infer interface seismogenic processes from on-shore observations. In contrast, the Nicoya Peninsula lies close to the trench (within 70 kilometers), allowing observations directly over the earthquake rupture zone. Because of its favorable location, the frequency and apparent regularity of large earthquakes, and timing (late in the earthquake cycle), the Nicoya Peninsula was a focus site for the Seismogenic Zone Experiment (SEIZE) beginning in 1997. This project was funded by the U.S. National Science Foundation’s (NSF) MARGINS program, which investigated the geological evolution of continental margins. Since then, the region has seen numerous studies of seismicity, velocity structure, heat and fluid flux, bathymetry, geodesy, coastal geomorphology, and paleoseismology, addressing fundamental questions about subduction zone processes.

The September 2012 Nicoya earthquake is a fitting capstone for the SEIZE initiative and also presents an important opportunity to address new science objectives central to the MARGINS successor program, Geodynamic Processes at Rifting and Subducting Margins (GeoPRISMS). These objectives span a spectrum of fault slip behavior from seconds (earthquakes) to months (slow slip events) to decades or longer (seismic cycle strain and net crustal deformation).

Seismic Setting and Observation Campaigns

The Nicoya region produces frequent large (M>7) earthquakes, including similar events in 1853, 1900, and 1950 (M 7.7) [Protti et al., 1995]. Prior geodetic studies mapped the Nicoya segment as a locked zone, with parts of the subduction interface accumulating strain at essentially the rate of motion between the plates, about 8 centimeters per year [Dixon, 1993; Lundgren et al., 1999; Norabuena et al., 2004; Feng et al., 2012]. Geomorphic data are also consistent with these rates of strain accumulation [Marshall and Anderson, 1995]. The history of frequent large earthquakes, combined with geodetic and geomorphic data consistent with locking on the plate interface and accumulating seismic strain, meant that the 2012 event was expected [Nishenko, 1989; Protti et al., 1995]. Smaller (M~7) events in 1978 and 1990 also occurred in the region, and at least five slow slip and tremor events have been recognized here in the last decade.

Fig. 1. Scientific observation stations at the Nicola Peninsula in Costa Rica, where the Cocos plate (CO) is subducting under the Caribbean plate (CA). Institutions involved with study are the University of South Florida (USF); University of California, Santa Cruz; Georgia Institute of Technology (GT); Observatorio Vulcanológico y Sismológico de Costa Rica, Universidad Nacional (OVSICORI-UNA); California State Polytechnic Institute, Pomona (Cal Poly Pomona, CPP); and the Virginia Polytechnic Institute and State University (Virginia Tech, VT). Global Centroid Moment Tensor solution (gCMT) for the 5 September 2012 earthquake is shown along with epicenter estimates from the U.S. Geological Survey (USGS) and OVSICORI-UNA. Arrow shows rate (in millimeters per year) and direction of convergence of CO relative to CA. Depth contours are in meters.
funded rapid response fieldwork to collect real-time geophysical and geomorphic data from the Nicoya Peninsula. These data provide an unprecedented image of the temporal and spatial distribution of slip during and after the earthquake, along with a significant community research opportunity.

Geodetic data from the continuous GPS network (including 5-hertz GPS data for selected stations) are archived and publicly available on the UNAVCO Web site (http://www.unavco.org/voce/viewforum.php?f=56). The seismic and geomorphic data from the recent surveys are being processed and will be archived and available through IRIS and UNAVCO in early 2013. Anyone with an interest in seismic processes and hazards is encouraged to exploit these new data.

References


—Timothy H. Dixon, University of South Florida, Tampa; E-mail: thd@usf.edu; Susan Schwartz, University of California, Santa Cruz; Marino Protti and Victor Gonzalez, Observatorio Vulcanológyico Sismológico de Costa Rica, Universidad Nacional (OVSCORI), Heredia, Costa Rica; Andrew Newman, Georgia Institute of Technology, Atlanta; Jeff Marshall, California State Polytechnic Institute, Pomona; and Jim Spotila, Virginia Polytechnic Institute and State University, Blacksburg