CRISP-EQ: Costa Rican Seismogenic potential outlined by IODP drilling and the 2002 Osa earthquake sequence

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Interplate earthquakes in subduction zones are generated in the seismogenic zone, i.e. the segment of the plate boundary where unstable slip occurs. Understanding the mechanisms that control the updip and downdip limits of this zone, as well as the nature and role of asperities within it, provide significant insights into the rupture size and dynamics of the world's largest earthquakes. The Costa Rica Seismogenesis Project (CRISP) is designed to understand the processes that control nucleation and seismic rupture propagation of large earthquakes at erosive subduction zones (Ranero et al. 2007). In 2002 a magnitude Mw=6.4 earthquake may have nucleated at the subduction thrust to be penetrated and sampled by CRISP, 40 km west of Osa Peninsula (Figure 1). However, global event localization is associated with too large errors to prove that the event actually occurred at a location and depth to be reachable by riser drilling.

We have compiled a database including foreshocks, the main shock, and ~400 aftershocks, with readings from all the seismological networks that recorded the 2002 Osa sequence locally (Figure 1). This includes a temporal network of ocean-bottom hydrophones (OBH) that happened to be installed close to the area (Arroyo et al. 2009). The greatly improved coverage provided by the OBH enable us to better constrain the event relocations that we are presently undertaking. Within the frame of a proposal recently submitted to DFG with IODP emphasis, detailed inspection of the data and 3-D data modelling will be carried out to yield source parameters that can be rated against structural information from seismic and drilling constraints. Moreover, teleseismic waveform inversion will provide additional constraints for the centroid depth of the 2002 Osa earthquake, allowing further study of the focal mechanism.

This sequence is the latest at the Costa Rican seismogenic zone to date, in a segment of the erosional margin where seamount-covered oceanic floor is presently subducting (Figure 1). It took place trenchward from a 1999 Mw=6.9 earthquake sequence, that it is thought to have been nucleated by a seamount acting like an asperity (Bilek et al. 2003).

The work proposed here aims to provide definite evidence that the planned Phase B of CRISP will be successful in drilling the seismogenic coupling zone. Furthermore, the seismological data will be interpreted jointly with thermal and drilling data from IODP Expedition 334 to refine the link between temperature and seismogenesis at erosive convergent margins.

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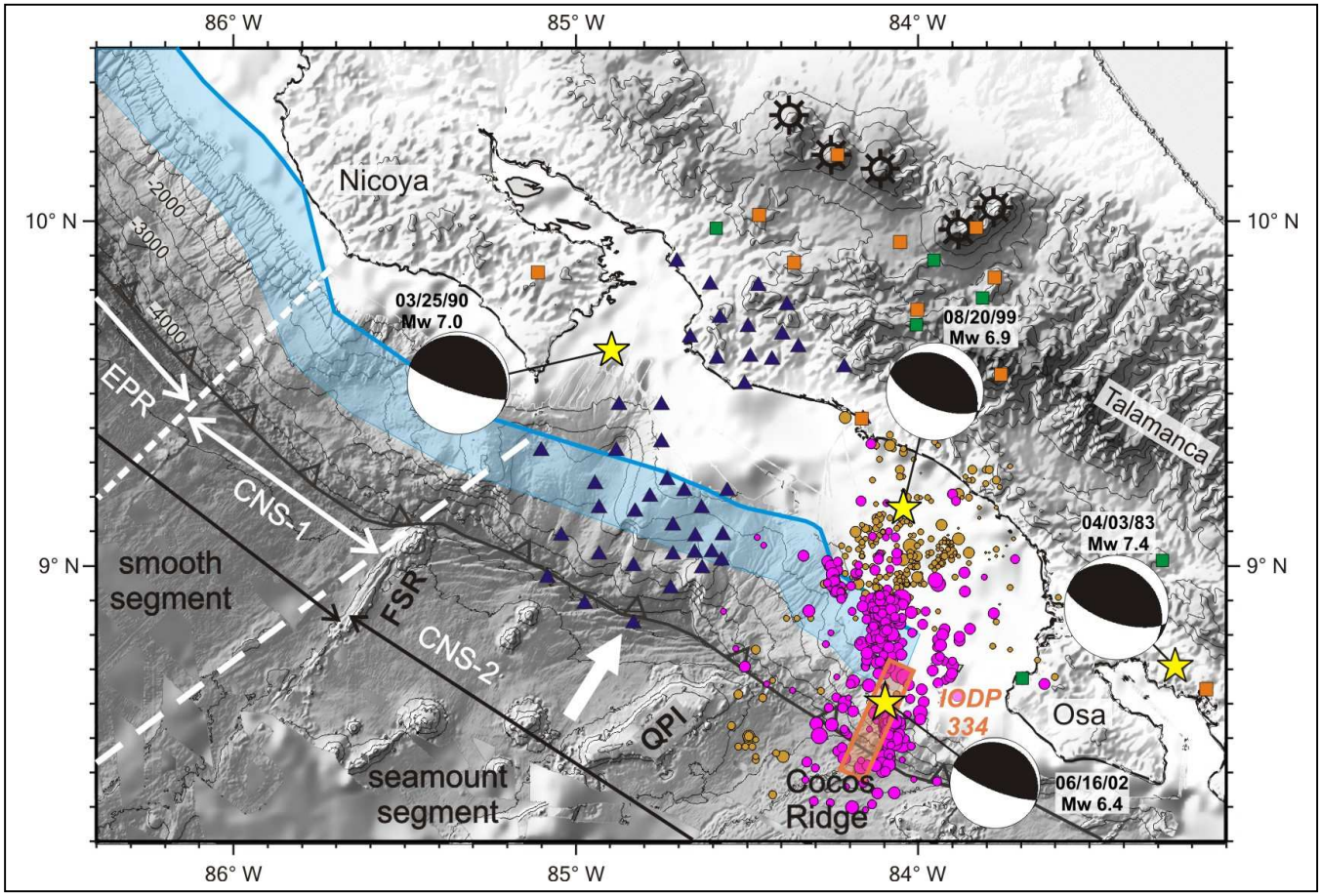

Figure 1. Setting of the June 2002 Osa sequence and the CRISP Project (IODP 334), in the Central Pacific margin of Costa Rica. The Jaco network (triangles) consisted of land and ocean-bottom stations that operated from April to October 2002; additional readings from land stations of the permanents networks RSN (orange squares) and Ovsicori (green squares) complete the coverage. Total recorded seismicity during the sequence is shown (magenta circles), superimposed to the aftershocks of 1999 Mw=6.9 Quepos earthquake (DeShon et al. 2003). Bathymetry (exaggerated), including contours every 500 m, and main tectonic segments after von Huene et al. (2000) and Barckhausen et al. (2001), respectively. Cocos Plate oceanic crust was formed at the East Pacific Rise (EPR) and at the Cocos-Nazca Spreading Center (CNS). The blue line is the 100° C isotherm at the plate interface and the blue shade its seaward displacement considering modest frictional heating, by Harris et al. (2010). Yellow stars represent the epicenters of recent large earthquakes associated to subduction of bathymetric highs: 1983 Mw=7.4, 1990 Mw=7.0 (Husen et al. 2002), 1999 Mw=6.9, and 2002 Mw=6.4 Osa (preliminary location from Jacó and permanent networks combined). FSR: Fisher Seamount and Ridge, QPl: Quepos Plateau.