Structure of the Colombia-Ecuador subduction zone : a contribution to seismic hazard assessment

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At the latitude of Ecuador – southern Colombia, the subduction of the Nazca plate beneath the South American plate. Near the Ecuador-Colombia border the 500 km long rupture zone of the 1906 earthquake (M = 8.8) was ruptured, from south to north, by a sequence of 3 thrust events in 1942 (Mw = 7.8), 1958 (Mw = 7.7) and 1979 (Mw = 8.2).

A quantitative physical approach to seismic hazards requires a good knowledge of the geometry and properties of the subducting plate and subduction channel. Since 1998, five experiments were conducted at sea along this active margin providing a unique set of bathymetry, multichannel seismic data, wide-angle seismic data and seismicity. 2D travel time inversion of wide-angle seismic data provides long wavelength images of the deep structures of the margin, suggesting that variations of the inter-plate coupling in this area are possibly related to the buoyancy of the subducting oceanic plate, the structure and weight of the overriding margin, as well as the tectonic regime of subduction. The margin appears segmented into three structurally and seismologically contrasted zones: the north zone (2˚N-1˚N) is underlined by high seismic velocities (6.0-6.5-km/s). There, normal oceanic crust subducts beneath the oceanic Cretaceous substratum of the margin (Piñon formation). The margin appears controlled by transient phases of erosion and accretion expressed by forearc subsidence and the smooth slope of the margin wedge. In the central zone (1˚N-2.5˚S), the subducting oceanic crust is over-thickened beneath the Carnegie Ridge, thinning progressively toward its southern flank. This area coincides with a gap in great subduction earthquake activity. Similar to the northern segment, the margin is composed of well-developed, high velocity, Cretaceous oceanic basement. The fore-arc shows no evidence of subsidence nor accretion and a steeper slope at margin wedge. In the south zone (2.5˚S-3.5˚S), the subducting oceanic crust is normal. The fore-arc shows indications of subsidence, as evidenced by huge sedimentary basins and the margin exhibits significantly lower seismic velocities. Even if the distance between the three profiles sampling the study area exceeds 150 km, the structural segmentation obtained along the Ecuadorian margin correlates well with the distribution of seismic activity and the neotectonic zonation.

Recent active and passive seismic data will provide the 3D seismic structure of the margin and microearthquakes location and mechanism along the north zone.