Geophysical Research Abstracts
Vol. 17, EGU2015-11086, 2015
EGU General Assembly 2015

Forearc deformation processes inferred from drowned shorelines in the Arauco Bay, Southern Chile (37ºS)

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Relict drowned landscapes often constitute preserved snapshots of terrestrial environments prior to flooding episodes during the Quaternary. Forearc deformation processes are usually recorded by coastal landforms, such as paleo-shorelines or marine terraces reflecting pronounced vertical movements. Similarly, drowned coastal landscapes represent past sea-level positions that can be used as tracers of tectonic deformation and sea-level change. In this study we present hitherto unrecognized drowned Quaternary shorelines in the Arauco Bay of southern Chile. The Arauco Bay lies inland of the Santa Maria Fault and is surrounded by densely populated areas, many devastated by the tsunami following the 2010 M 8.8 Maule earthquake. The shorelines are folded, apparently as a result of slip along the Santa Maria Fault, a blind splay-fault system rooted in the Nazca-South America plate-boundary zone, documenting protracted tectonic activity. We mapped and used these drowned geomorphic markers using high-resolution bathymetry (2.5 m) to infer rates and style of deformation along the Santa Maria splay fault. For this purpose we used surface classification models, observations from a remotely operated vehicle (ROV), and sedimentology of sea-bottom samples. High roughness areas correspond to well-exposed bedrock outcrops. The enclosed patches were studied in detail and compared with LiDAR data from emerged and actively forming marine platforms from nearby areas. Three levels of drowned shorelines were identified: at $\sim$110 m, $\sim$40 and $\sim$60 m depth, respectively. The shallower two shorelines are distributed as fringes parallel to the coastline of the Arauco Bay and deepen towards the trench. We selected the shallowest level as an exploratory target for a ROV dive obtaining video and still images of micromorphologic features; a sampling target was selected at 45 m where professional divers collected samples of bedrock and sediments. Chronologic correlation was performed based on global and relative sea-level curves, calibrated with previously obtained uplift rates at adjacent areas, inferring ages of MIS 3 for the sallower levels and MIS 2 for the deepest level. Deformation patterns delineate the geometry of the fault-propagation fold associated with the Santa Maria splay fault. The appraisal of deformation rates beyond the emerged landscape is challenging and their estimates are fundamental inputs for numerical models of earthquake recurrence and for the assessment of seismic hazards in tectonically active coastal areas.