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Margin structure and destabilisation processes on the Colombia-Ecuador margin

by 2D quantitative seismic imaging

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We analyse multichannel seismic reflection (MCS) data collected during the SISTEUR cruise (2000) on the Nazca-north Andean plate boundary in order to investigate the tectonic regime of the convergent margin, the destabilization and thinning processes and their correlations with the deep and shallow margin structures. To discover potential agents for tectonic erosion and slope destabilization, we imaged the deep reflectors such as the inter-plate decollement, the subduction channel and the basement of the upper margin.

Preserved amplitude prestack depth migration (PSDM) is applied in the angle domain. In order to get in depth 2D quantitative imaging of seismic reflectors, the accuracy of the tomographic model is gradually improved by iterative corrections of the background velocity model. We present an application to MCS data from the Colombia-Ecuador convergent margin, North of the Carnegie ridge by considering three lines (SIST-22, -54 and -56) perpendicular to the margin. Common Image Gathers (CIG) panels are quite flat and semblance panels are around 1 in the inter-plate decollement and at the top of the oceanic crust. CIG and semblance panels show that the errors in the velocity macro-model estimation are small.

The studied margin shows structural variations along the trench, notably a shift of the northern margin segment oceanward, uplift or subsidence of the margin. The area is characterized by numerous occurrences of slope instabilities, the presence of oceanic seamounts at the toe of the continental margin and that of gas hydrates on the upper margin.

On all studied profiles, we have identified a seismic sequence composed of three acoustically strong reflectors which respectively image the inter-plate decollement, the subduction channel and the top of the upper margin. The oceanic crust, which reaches 9 km of thickness (Moho clearly identified), has strong internal reflectors caused by the Galapagos hot spot activity. The plate interface has been imaged acoustically strong, with discontinuous reflectors dipping landward from the trench, down to a maximum depth of 9 km below seafloor. We consider the shallow presence of gas hydrates and/or the underthrust of asperities like oceanic seamounts beneath the margin as possible explanations for slope instability and crustal thinning of the upper margin. Seamounts observed at the toe of the continental margin, in the oceanic crust, are ready to subducte. Northward, the margin basement has been thinned seaward, broken up and tilted as a consequence of subduction erosion.

Shallower, we identified slump masses associated with the presence of bottom simulating reflector (BSR), which represents the base of hydrates stability field. Pressure and/or temperature variations may turn the basal zone of the gas hydrate into a weakness zone, thus creating slope instabilities. To investigate the relationship between gas hydrates and slump masses, we image the gas hydrate reservoir and analyse the presence or the absence of free gases beneath BSRs. Preliminary results suggest that the BSRs locally exhibit some negative polarities. Along the BSR we observe regions with a relative velocity increase, due to the presence of hydrates, and regions with a velocity decrease, due to free gas beneath the hydrates.