Geophysical Research Abstracts, Vol. 8, 09325, 2006
SRef-ID: 1607-7962/gra/EGU06-A-09325

Interplate patchiness and subduction-erosion mechanisms : evidence from depth migrated seismic images at the Central Ecuador convergent margin

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Subduction-erosion is believed to be a process occurring along at least 50% of all convergent margins. Frontal erosion of convergent margins is known to result from the subduction of seamounts carried by the downgoing plate, whereas basal erosion is indicated by long-term subsidence and subduction system retreat. Models infer that basal erosion could occur either in high friction environment by mechanical abrasion, or in low friction environment by hydrofracturing. These models are however still poorly documented. Based on multichannel seismic pre-stack depth migrated (PSDM) lines, we present new insights on the mechanisms of subduction erosion at the convergent Ecuadorian margin. Along the study sector of the margin subducts the southern flank of the Carnegie Ridge spotted with large seamounts. The rough topography of the incoming plate produces intense deformation of the upper plate expressed on the margin's morphology. In seismic images, a strong patchiness characterizes the plate boundary : a usually very thin subduction channel (under the ˜100-150m data resolution), locally thickens to form lenses few hundreds meters-thick and ˜10-km-wide. These lenses, interpreted as underthrusted fluid-rich sediment supplied by slumping of slope sediment, have low PSDM velocity (2.3ś0.2 km/s) and high porosity (30%), indicating that in the subduction channel, fluids are trapped and are gradually overpressured as they are loaded by the margin weight. The contrast between the water-rich lenses and the usually thin subduction channel implies interplate coupling conditions changes along and across the margin. The margin basement is fronted by a narrow (5-7-km wide) sediment prism, and thins beneath the continental slope from 5km at the shelf edge to 1 km at the rear of the frontal prism. The PSDM lines suggest that two mechanisms of subduction erosion act differently to thin the upperplate, favoured

by the subduction patchiness : o Along the underside of the upper plate, basal erosion is indicated by the seaward thinning and progressive disappearing, ˜15 km away from the trench, of the deepest part of the margin basement. Extension across the continental slope indicates that basal erosion occurs here in a global weak interplate coupling environment. The base of the upper plate consists in a 300 to 800m-thick reflective zone that extends roughly parallel to the interplate boundary. This geometry suggests that the reflective zone is not a pre-existing structure of the margin basement, but is more likely formed during the subduction process. The PSDM-average velocity of this layered zone ranges from 4.0 to 4.2 km/s and is similar to the velocity of the margin's lower basement, and are locally slightly lower (3.7 km/s). We interpret this layer as a damage zone resulting from alteration processes due to hydrofracturation and fluid circulation. The low velocity lenses observed along the subduction channel may form reservoirs providing the overpressured fluids expected for this mechanism. Detached fragments along the underside of the damage zone would be further dragged into the subduction, leading to basal erosion, the removal process being probably accelerated during higher coupled periods. o At the rear of the small frontal prism, where the margin basement is thinner than 2 km, desegregation of the apex of the margin basement is indicated by both a sharp increase of the fault density and a 15-20% PSDM-basement velocity decrease. Here, the margin framework tectonic style varies with the subduction channel patchiness: extension is enhanced above the water rich sediment lenses, where the décollement is weakly coupled, whereas thrust faulting and folds are observed were the subduction channel is very thin and probably higher coupled. During subduction evolution, alternation of lower/higher coupling periods implies superposition of various faults systems in the overlying margin basement, explaining the desegregation of the margin apex. The smaller-size blocks are subsequently either involved in the compressive frontal area, or taken from the underside of the margin to be dragged along the subduction zone, leading to frontal erosion of the apex of the basement margin, at the rear of the small frontal prism. Such process differs from the accidental removal of material at the frontal margin by seamounts, since it corresponds to a long-term erosion process that may also contribute to trench retreat. Deeper, the subduction channel patchiness and related variable coupling may influence processes like earthquake nucleation and rupture propagation, and material and fluid recycling in the mantle.