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Where is the subduction fault ? : Insights from a PSDM seismic line across the Ecuador convergent margin

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Seismological, geodetic and seismic reflection observations suggest that subduction earthquakes occur at depth along the subduction channel (SC), a shear zone associated with the interplate fault. The shear zone has been shown to involve a layer of underthrusting sediment, and possibly overlying and underlying fractured rocks. It is, however, unclear how the SC accommodates rupture propagation, raising the questions of the distribution and localization of the interplate shear, and of the continuity of the subduction fault, from the earthquake hypocenter to the deformation front. The sediment layer of the SC was clearly identified on seismic reflection line SIS-72 across the Ecuador convergent margin by its top and bottom bright reflectors, its low internal velocity and over pressured fluid content. A calibrated PSDM image with preserved amplitudes of the fore part of line SIS72 is used to discuss the tectonic deformation of the SC and the shear localization. Main results show that the first $\sim$25 km of the SC forms a long, gently folded, underthrust sheet fronted by a recent imbricate thrust sheet. Structural geometry suggests that the top reflector of the SC acted as a major upper décollement, and therefore as the subduction fault, during the subduction of the long sheet. However, the frontal thrust fault is presently disconnected from the upper décollement and might be locally interpreted to join with bottom reflectors of the SC. This hypothesis indicates that the subduction fault might have recently shifted downward along the top of the oceanic crust or the hemipelagic section, thus possibly forming an incipient lower décollement. These hypotheses appear to be supported by structures identified within the SC. The geometry of the reflectors indicates that the SC suffered internal deformation such as small-scale faulting and folding. Seaward-verging reverse and thrust faults soling out at the underlying oceanic crust hint at shear localization with small relative displacements, specifically along two short segments of the lower décollement. By contrast, the absence of significant SC structural complexity near the smoothly undulating upper décollement is compatible with large relative displacements along a mature fault. To analyze physical properties of the inferred décollements, we used the absolute values of Vp, and the correct geometry of seismic reflectors that we obtained by coupling preserved amplitude PSDM with a specific post-processing of the tomographic model. Preliminary results suggest that a sub-continuous double 40-80 meters-thick layer, with negative velocity perturbations ranging from -80 to -150m/s, resolves the upper décollement. The lower décollement could be resolved locally by a $\sim$60-80 m-thick, layer segment with a strong negative velocity perturbation reaching -300 m/s. This segment is associated with a zone of thrust deformation in the SC. Considering negative velocity perturbation in sediment as indicative of elevated porosity and fluid content, shear localization is predicted along most the upper décollement and some segments of the lower one.