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Structure and physical properties of the subduction channel off the Gulf of Guayaquil (Ecuador) from seismic reflection data

A. Calahorrano B. (1,2), V. Sallarès (3), J.-Y. Collot (1), F. Sage (1), & C. Ranero (4)

(1) UMR Geosciences Azur, Villefranche sur mer, France
(2) Instituto Geofisico-EPN, Quito, Ecuador
(3) Unitat de Tecnologia Marina, Barcelone, Spain
(4) IFM-GEOMAR, Kiel, Germany, calahorr@geoazur.obs-vlfr.fr

This work focus on the southernmost Ecuadorian margin, off the Gulf of Guayaquil, which develops between the sub-orthogonal subduction of Nazca Plate below South American Plate at ~5.5 cm/an, and the transtensional fragmentation of the Ecuadorian fore-arc. This fragmentation is revealed by the NE motion of the Noth Andean Block (NAB) (*Pennington, 1981*) at 0.6 cm/an respect to South American Plate (*Trenkamp et al., 2002*) (*Figure 1*). Besides, the Fracture Zone of Grijalva (FZG), separating South Paleogene and North Neogene Nazca crust, is subducting below the GG.

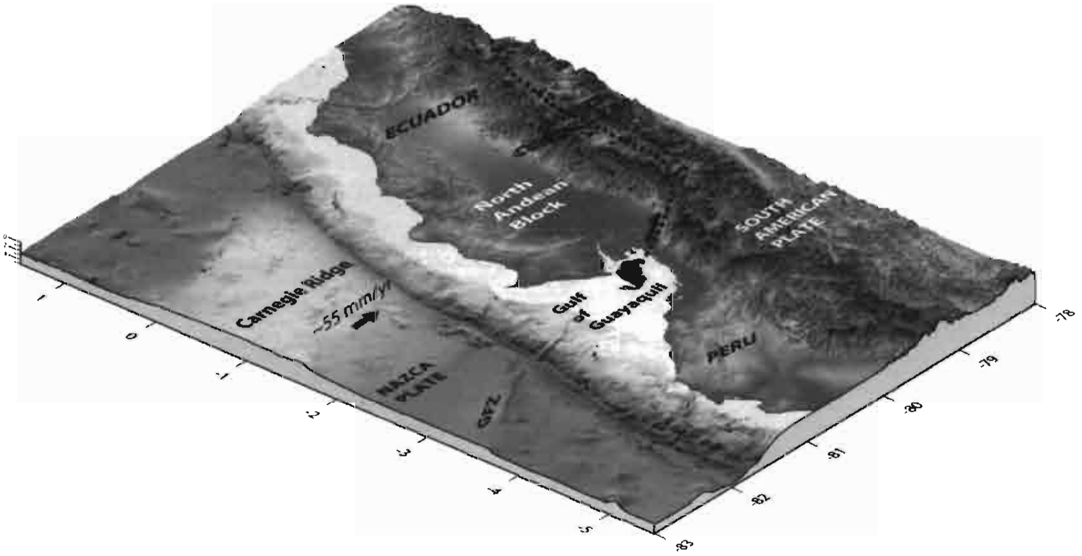

Figure 1. Bathymetric representation of Ecuadorian subduction, and location of the Gulf of Guayaquil.

We use multichannel seismic data acquired during the SISTEUR-2000 survey (*Collot et al., 2002*) to image the subduction channel (SC) and inter-plate contact across ~97 km from the trench and down to ~20 km depth.

A remarkable feature of the SC is its thickness variation, particularly below the margin's front where it is systematically thicker than the incoming sedimentary column. We suggest that these thickness variations may be due to heterogeneous distribution and nature of incoming sediment, as well as to basal and frontal erosion of the overriding plate.

P-wave velocity analysis performed during pre-stack depth migration of line SIS-72 (*Figure 2a*) provided an accurate velocity model over the first ~32 km of subduction down to a 8-km-depth. (*Figure 2b*). This model revealed that the velocity at the SC (2800 m/s ± 150 m/s) is significantly lower than that of the overriding plate basement (~3800 m/s), and allowed us to calculate porosity and fluid pressure at SC. Velocity inversion at SC reflects the existence of fluid overpressures as high as ~40MPa at 25 km from the trench down to a 4-km-depth (*Figure 2c*).

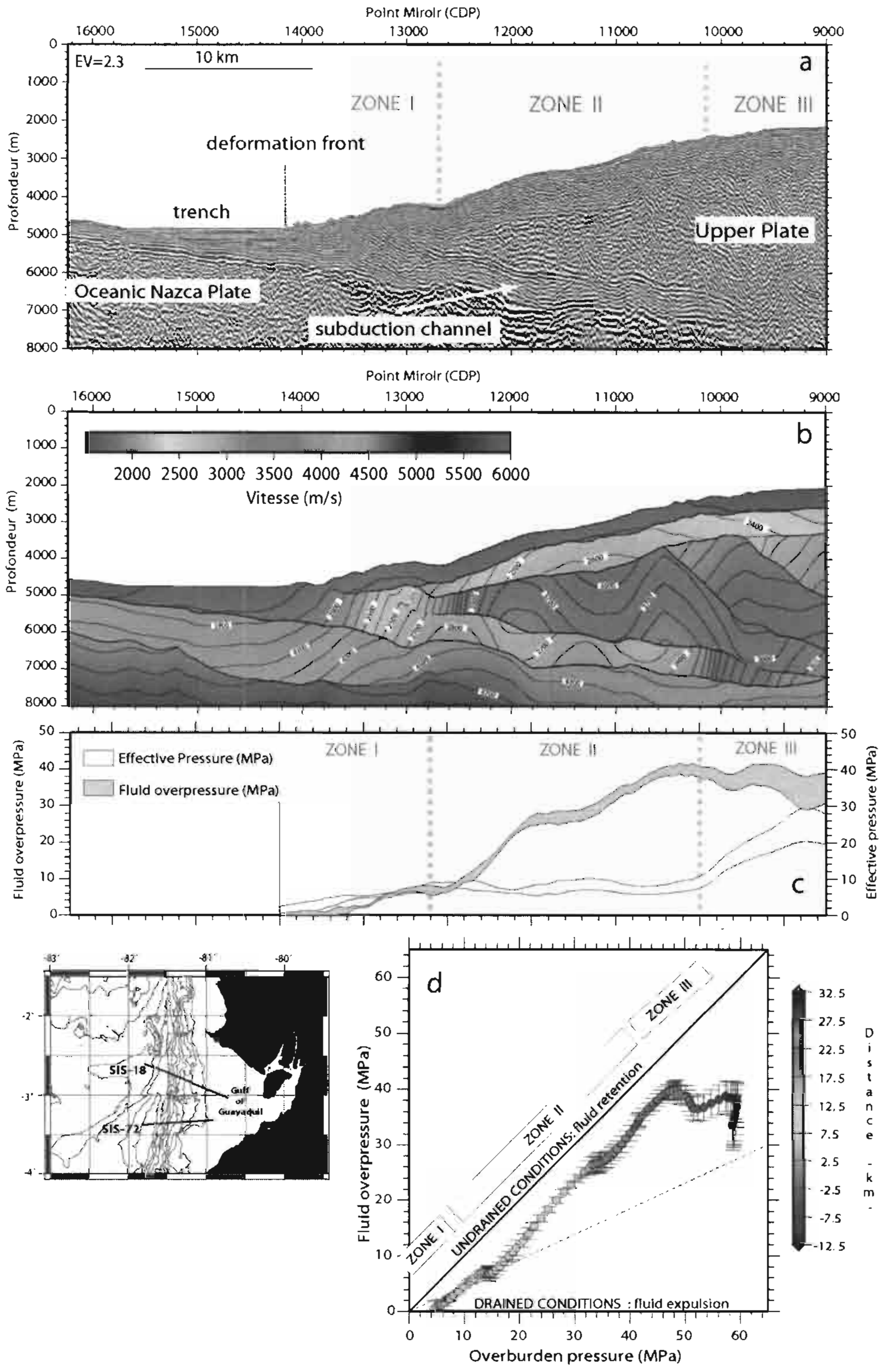

Figure 2.a) Detail of pre-stack depth migrated MCS line SIS-72. b) Corresponding velocity model. c) Effective pressure and fluid pressure at SC. In Zone II, higher values of fluid overpressure than effective pressure indicate that lithostatic pressure is mainly supported by fluids. d) Diagram showing λ^* variations from the trench, until 33 km landward. This variations allow to associate a mechanical behaviour of each Zone along the SC.

The overpressure parameter (λ^*), corresponding to the ratio of fluid overpressure and overburden pressure (p.e. Hubbert and Rubey, 1959) (*Figure 2d*), allowed to identify three zones with different mechanical behaviours in the SC: **a**) at the margin's toe (up to 9 km from the trench), λ^* lower than 0.5 indicates an effective fluid drainage related to high permeability of the incipient young accretionary prism; **b**) between ~9-25 km from the trench, λ^* increases to ~0.8 suggesting highly undrained sediments and fluid retention due to a low permeability, attributed either to the underthrust sediments, the décollement or the overriding-plate basement. Such high fluid overpressure may induce hydrofracturation favouring basal erosion and subsequent thickening of the SC. It could also indicate low inter-plate friction and shear stress, preventing earthquake nucleation but favouring rupture propagation; **c**) Beyond 25 km from the trench, λ^* drops down to ~0.6 indicating that fluids are expelled, probably across ancient faults of the overriding-plate basement. In this zone, decreasing fluid pressures are likely to increase the inter-plate coupling. Consistently, this zone roughly coincides with the area in which the first diagenetic and low-grade metamorphic processes associated to the updip limit of the seismogenic zone occur.

Analogous analysis was carried out on line SIS-18 situated 60 km northwards of SIS-72, showing a similar evolution of velocity along the SC, but higher velocity values at the trench consistent with the lateral heterogeneity of incoming sediments nature observed all along the margin.

Our analysis shows also a direct relationship between fluid pressures and reflectivity variations of the décollement, as it was previously suggested by Bangs et al. (2004). This qualitative approximation could probably explain deeper reflectivity variations along the downdip subduction thrust, and suggest fluid presence and overpressure in depth.

References

Bangs, N., T. H. Shipley, et al. (2004). "Evolution of the Nankai trough décollement from the trench into the seismogenic zone: Inferences from three-dimentional seismic reflection imaging." Geology 32(4): 273-276.

Collot, J.-Y., P. Charvis, et al. (2002). "Exploring the Ecuador-Colombia active margin and interplate seismogenic zone." EOS Transactions, American Geophysical Union 83(17): 189-190.

Pennington, W. D. (1981). "Subduction of the eastern Panama Basin and seismotectonics of northwestern South America." Journal of Geophysical Research 86: 10753-10770.

Trenkamp, R., J. N. Kellogg, et al. (2002). "Wide plate margin deformation southern Central America and northwestern South America, CASA GPS observations." Journal of South American Earth Sciences 15: 157-171.

Hubbert, M. K. and W. W. Rubey (1959). "Role of fluid pressure in mechanics of the overthrusting faulting." Geol. Soc. Am. Bull., 70: 115-166.