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Travel-time tomography imaging the Ecuadorian subduction, north of the Mw 7.8 Pedernales earthquake

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The Ecuadorian subduction regularly hosts large earthquakes. Among them, the Mw 8.8 1906 earthquake is the 7th biggest known event. Following the recent 2016 Mw 7.8 Pedernales earthquake, a large deployment of onshore/offshore seismological stations, in addition to the permanent seismological/geodetical network, revealed a complex slip behavior including the presence of seismic and aseismic slip.

During the geophysical experiment HIPER, in march 2020, 47 Ocean Bottom Seismometers (OBS), were densely deployed along a 93-km-long trench-perpendicular profile, recording airgun shots (4990 cu.inch.) performed by R/V Atalante to obtain a high-resolution P-wave velocity image. The profile was located north of the 2016 Pedernales rupture zone passing through an area experiencing aseismic slip and a region of contrasted geodetic interseismic coupling.

We used the traveltimes tomography code « tomo2d » (Korenaga et al., 2000) to invert first arrivals and reflected phases recorded by our OBS. A joint 2D-seismic-reflection profile was acquired (abstract by L. Schenini) and provides details on the oceanic basement topography and on Vp velocities in shallow sedimentary layers.

Regarding the structural complexity in the region, we decided to start the inversion using an a priori 2D velocity model. Several geophysical experiments have already been conducted offshore-onshore Ecuador (SISTEUR, 2000 ; SALIERI, 2001 and ESMERALDAS, 2005). Compilation of velocity models from tomographic images were used to build two a priori 1D Vp velocity models for both the Nazca oceanic crust and the forearc seismic structure. A 2D a priori Vp velocity model was built by merging the results of the two localized inversions using a selection of OBS on each side of the trench.

We obtain the crustal structure of the upper and subducting plates down to 20 km depth. Beneath the trench, a ~30-km-wide low-Vp anomaly is observed at lithospheric scale. This velocity is 10%

lower than the typical V_p values observed for hydrated Pacific-type oceanic crust near the trench (Grevemeyer et al., 2018). Recorded PmP phases will allow us to further constrain the crustal thickness. While we observe PmP phases in areas of low- V_p , the Moho reflectivity weakens and even disappears from the coincident MCS line. This intriguing observation could highlight processes, such as the presence of fluids or serpentinization, that need to be identified and better understood.