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Interaction between interplate fault topography and tsunamigenic structures at the subduction zone offshore West Mexico

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The megathrust topography is key in conditioning the structural integrity of the overriding plate, and thus, the generation of tsunamigenic structures. Our objective is to investigate the Rivera subduction zone, offshore the Mexican Pacific coast, known for hosting large megathrust tsunamigenic earthquakes (Mw > 7.5), and where little is known regarding the distribution of tsunamigenic structures along the margin. Our working hypothesis is that there is an interaction between the megathrust relief at the surface of the subducted slab (Rivera Plate) and the existence of tsunamigenic structures in the above unsubducted plate (North America). To investigate this interaction, we used seismic methods to characterize the variations of the physical properties of the overriding plate, generally related to tectonic (faults) structures that are sources of tsunamis, with the reliefs of the deeper subducted plate obtained with the same method. Here, we use spatially coincident 2D multichannel seismic (MCS, 5.85 km long-streamer) and active marine wide-angle seismic (WAS) data acquired during the TSUJAL survey in 2014 offshore west of Mexico to measure structural variations of the overriding plate and the megathrust interface. We have jointly inverted refracted and reflected travel-times (TT) from both MCS and WAS data to constrain the P-wave velocity (Vp) structure of the overriding plate and the geometry of the megathrust. Before the inversion and to increase the amount of refracted TT we have applied the downward continuation technique to MCS field data allowing to better image the refracted waves in the records. MCS data has a higher spatial sampling than OBS data, which translates into a higher density sampling of the refracted waves and hence the tomographic resolution. Therefore, the resulting tomographic model displays small-scale velocity structure variations of the overriding plate and the megathrust relief that would not be resolved with TT from OBS data only. We used further refracted and reflected TT from OBS data to constrain the Vp structure of the subducting oceanic plate and the geometry of the oceanic Moho. The inverted megathrust interface obtained with the tomography shows clear topographic features in its shallow portion (<~10 km from the trench). Such topographic variations are smaller than the average size of seamounts of the Rivera plate, but they are similar to the seafloor fabric generated by a relict East Pacific Rise segment identified west of the trench in the bathymetry map of the region. Time-migrated images were also obtained after processing the MCS data to constrain the tectonic framework of the shallow subduction zone regardless of the tomographic models. The seismic sections reveal the lack of an

extensive accretionary prism, implying that subduction-erosion dominates the structure of the margin in this region. Integrating all the data results, we find that megathrust highs correlate with low-velocity anomalies, suggesting the presence of fluids, and correlate with the presence of extensional faults in the overriding plate as well. This correlation demonstrates the control that megathrust topography exerts on the formation of tsunamigenic structures along the Rivera plate boundary.