Subduction of serpentinized fracture zone and intraslab earthquakes in southern Mexico

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Oceanic fracture zones are born where spreading centers are offset, creating strong gradients in oceanic floor age and vertical offsets in the oceanic lithosphere. Several lines of evidence, such as tectonic uplift and localized volcanic activity distributed along fracture zones, suggest that oceanic fracture zones represent zones of weakness where seawater can infiltrate several kilometers down into the lithosphere and transform mantle peridotites into serpentinites. Such major serpentinized fracture zones are often consumed into subduction zones where they release large quantities of fluids. The southern Mexican subduction zone is similarly characterized by the presence of a large fracture zone, the Tehuantepec fracture zone (TFZ), which presumably is serpentinized. Moreover, the region where TFZ enters into subduction is marked by a relatively low intraplate seismic activity and a large seismic gap where no large megathrust occurred in the last 100 years or more.

In general the physical processes associated with such seismic gaps are not well understood. However, the presence of TFZ in this area can provide a unique opportunity to advance our knowledge into earthquake mechanics linked to mantle thermal structure. The peculiar 2017 M8.2 Tehuantepec intraslab earthquake nucleated in the vicinity of TFZ, and, from analyses of regional geophysical observations, it is demonstrated that this large normal faulting event ruptured the entire ~26 Ma Cocos slab right beneath the megathrust region. The faulting most likely reactivated a bend fault fabric and ruptured to a depth well below the predicted brittle-ductile transition for the Cocos slab, including regions where temperature is expected to exceed 1000˚C, at far greater P-T conditions than previously considered. Additionally, since the rupture area also propagated laterally along the trench and stopped abruptly when encountered the subducted TFZ, we propose that large and serpentinized fracture zones can act as barriers for intraslab earthquakes. I have to acknowledge that all numerical computations were performed at the National Laboratory for Advanced Scientific Visualization at UNAM (LAVIS).

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