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"Intra-plate Deformation, Great Earthquakes, and Serpentinization in the Indian Ocean and their roles in the Subduction Process"

ABSTRACT: The equatorial Indian Ocean is deforming actively with deformation taking place along E-W trending thrust faults in the Central Indian Basin, west of the Ninety-East Ridge, and along N-S trending re-activated fracture zones in the Wharton Basin. The existence of active deformation in the Wharton Basin was confirmed by the 2012 twin Mw=8.6 and Mw=8.2 earthquakes, the largest intra-plate earthquakes ever observed on Earth. Seismological and geodetic data for the Mw=8.6 earthquake suggest the development of new lithospheric faults. Using a combination of newly acquired bathymetry and seismic reflection data, we report the existence of pervasive 294º-striking shear zones, oblique to the plate fabric, and reactivated N9ºE trending oceanic fracture zones, forming a conjugate set of faults that might have ruptured during the Mw=8.6 event in echelon form. We have imaged faults down to 45 km depth, suggesting that the 2012 earthquakes might have ruptured the whole lithosphere. We find that the deformation in the Wharton Basin can be divided into two layers; a highly fractured fluid-filled serpentinized upper layer and a pristine brittle lithospheric mantle where great earthquakes initiate and large stress drops occur. The intense serpentinization of the upper layer could release hydrogen, and subsequently forming methane, that may explain the widespread presence of high-amplitude negative polarity reflection below Bengal-Nicobar fan sediments. This weak layaer may act a decollement surface during the subduction. On the other hand, the dehydration of serpentinite at the boundary of these two layers may create a reaction zone leading to seismicity that may explain the presence of the second Benioff zone along the subduction zones worldwide.