The nature of actively deforming Wharton Basin and its role in the subduction processes, offshore northern Sumatra

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The Wharton Basin is one of the most actively deforming ocean basins on Earth, which was confirmed by the occurrence of the 2012 Mw=8.6 strike-slip earthquake, along with its Mw=7.2 foreshock and Mw=8.2 aftershock. The seismological and geodetic data suggest that the Mw=8.6 earthquake ruptured several faults, oblique to each other, down to the base of the lithosphere. Using ultra-deep seismic reflection technique, we have imaged faults down to 45 km depth in this region, indicating that deformation in the Wharton Basin is indeed on the lithospheric scale. We find that the oceanic mantle there consists of two layers; an upper serpentinized layer where a large number of small earthquakes occur and a lower pristine layer where great earthquakes initiate and large stress drops occur. We also find that the boundary between these two layers corresponds to the second Benioff zone (Qin and Singh, 2015) of the Sumatra subduction. Using multibeam bathymetry and high-resolution seismic data, we have also imaged a large number of right-lateral shear zones, which along with the left-lateral, re-activated N-S fracture zones, form a conjugate system of faults accommodating ongoing deformation (Singh et al., 2017). The shear zones are formed by sets of en echelon normal faults, whose strike defines the direction of principal stress in the region. These shear zones and associated normal faults become much more pervasive in the outer rise region of the Sumatran trench, indicating a complex interaction between the bending stress and the principal compressive stress. The pattern of active faults and the occurrence of the great 2012 earthquakes suggest the possible creation of a nascent plate boundary between India and Australia in the northern Wharton Basin.

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