Subject title: Intra-plate deformation, great earthquakes and nascent plate boundary in the Wharton Basin, Indian Ocean

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Presentation of the subject: (Maximum 2 pages)

The Andaman-Sumatra subduction zone, where the Indo-Australian oceanic plate subducts beneath the Eurasia plate, is one of the most seismically active regions on Earth and has hosted three great (Mw>8.5) and two tsunami earthquakes just in the last 20 years. Additionally, the subducting oceanic plate in the Wharton Basin is itself actively deforming and has hosted one of the largest strike-slip earthquakes (Mw=8.6) ever recorded. Besides, this earthquake did not rupture only one fault along re-activated N-S fracture zones, but a complex network of faults, oblique to each other, perplexing the scientific community. The occurrence of such large earthquake in intra-plate setting led some scientists to suggest that there might be a nascent plate boundary between India and Australia. Therefore, the Wharton Basin offshore Sumatra is a real scientific laboratory to study the intra-plate deformation, great earthquakes, and nascent plate boundary processes, which are key elements of plate tectonics.

Over the last 18 years, we have acquired high-resolution bathymetry, shallow and deep seismic reflection, gravity, and magnetic data in the Wharton Basin, especially during the two legs of the MIRAGE experiment in 2016 and 2017, where swath bathymetry and seismic reflection data were acquired covering the whole of the 2012 great earthquakes (Mw=8.6 and Mw=8.2) rupture zones. The importance of the area was recognised by the International Ocean Discovery Program (IODP), which drilled two holes in this area, providing hard core information on the rock types, rock properties, and their ages. In this project, we propose to analyse the MIRAGE bathymetry and seismic reflection data, interpret these data integrating the results from the IODP, previous marine surveys and earthquake analyses, and develop a model for intra-plate deformation leading to the development of a nascent plate boundary.

More precisely, we propose to (1) depth convert the processed seismic reflection data using the seismic velocity model derived from the IODP borehole, (2) correlate seismic reflection horizons with sedimentary horizons at the IODP borehole sites, (3) determine the age of these horizons, (4) estimate sedimentation rate, fault growth and slip rate along the main re-activated fracture zones, (5) compute the stretching factor and lithospheric thickness of recently discovered sedimentary basins, (6) perform advanced seismic data processing to image mantle faults, and (7) carry out geodynamical modelling to explain the above observations.

The following hypotheses will be tested: (1) The re-activated N-S fracture zone F6-F7 is a nascent plate boundary, (2) NW-SE shear zones are transfer zones connecting the re-activated N-S fracture zones, (3) the complex deformation along N-S re-activated fracture zones and NW-SE shear zones result from NW-SE compression due to the differential motion between different components of the Indo-Australian plate, and (4) the intra-plate deformation in the Wharton Basin influences coupling along the Sumatra subduction zone.

A student with a background in geophysics and physics, interested in addressing fundamental scientific problems is encouraged to apply. The student will receive training in advanced seismic data analyses methods, interpretation of different types of data and geodynamical modelling, efficiently communicate results through presentations in conferences and writing papers for peer reviewed international journals.

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