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Seismically active deformation in the Sumatra-Java Trench-Arc region: Geodynamic implications

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Hundred years of hypo central data (1900-2000) of shallow earthquakes (h<70km) within the upper plate and a large number of focal mechanism solutions along with information obtained from previous studies have been utilised in order to study the spatial variation in the deformation pattern below the Sumatra-Java Trench–arc region using the method of moment tensor summation. We identified five broad and distinct seismogenic belts / individual seismogenic sources. Crustal deformation rates have been determined for each one of these sources. The results indicate that the deformation along Sumatran Fault Zone shows average compression along N 9° and extension along N99° direction. The deformation velocities further indicate large variations in dextral shear motion (seismic slip) from 1 mm/yr to 28 mm/yr along the fault. Comparison of these values with the geological or GPS derived slip rate estimates suggest that they are in good agreement between 0° – 2° S. However, seismic slip rates are much lower for the segments north of equator. The deformation velocities estimated for the offshore Sumatra fore-arc region indicate dominantly compression with higher compressional velocities of 17 mm/yr along N 45° near the equator. The deformation pattern further indicates strike-slip or oblique slip, which means that the Mentawai Fault Zone partly accommodates motion due to oblique subduction, takes up a portion of the motion. The deformation velocities for the Sunda Strait show compression of 20 ±2 mm/yr along N-S and extension of 11 ± 1.5 mm/yr along E-W direction. The deformation in the onshore western Java shows compression of 5.7 ± 0.8 mm/yr along N20° and extension of 0.8 ±0.11 mm/yr along N110° direction, while, the deformation in the central and eastern Java is negligible due to absence of large earthquakes within the upper plate. In the offshore Java forearc region, the deformation velocities indicate dominance of compression (average 17mm/yr) in the western part, which gradually changes to extension (average 4 mm/yr) towards eastern part.