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Analysis of crustal deformation in Luzon, Philippines using geodetic observations and earthquake focal mechanisms

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Abstract

We utilize regional GPS velocities from Luzon, Philippines, with focal mechanism data from the Harvard Centroid Moment Tensor (CMT) Catalog, to constrain tectonic deformation in the complex plate boundary zone between the Philippine Sea Plate and Eurasia (the Sundaland block). Processed satellite imagery and digital elevation models are used with existing gravity anomaly, seismicity, and geologic maps to define a suite of six elastic blocks. Geodetic and focal mechanism data are inverted simultaneously to estimate plate rotations and fault-locking parameters for each of the tectonic blocks and faults comprising Luzon. Major tectonic structures that were found to absorb the plate convergence include the Manila Trench (20–100 mm yr^{-1}) and East Luzon Trough (~9–15 mm yr^{-1})/Philippine Trench (~29–34 mm yr^{-1}), which accommodate eastward and westward subduction beneath Luzon, respectively; the left-lateral strike-slip Philippine Fault (~20–40 mm yr^{-1}), and its northward extensions, the Northern Cordillera Fault (~17–37 mm yr^{-1} transtension), and the Digdig Fault (~17–27 mm yr^{-1} transpression). The Macolod Corridor, a zone of active volcanism, crustal thinning, extension, and extensive normal and strike-slip faulting in southwestern Luzon, is associated with left-lateral, transtensional slip of ~5–10 mm yr^{-1}. The Marikina Fault, which separates the Central Luzon block from the Southwestern Luzon block, reveals ~10–12 mm yr^{-1} of left-lateral transpression. Our analysis suggests that much of the Philippine Fault and associated splays are locked to partly coupled, while the Manila and Philippine trenches appear to be poorly coupled. Luzon is best characterized as a tectonically active plate boundary zone, comprising six mobile elastic tectonic blocks between two active subduction zones. The Philippine Fault and associated intra-arc faults accommodate much of the trench-parallel component of relative plate motion.

Keywords: Crustal deformation; Philippines; Geodetic observations

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