Crustal faults in the Java subduction zone from GPS observations: Implications for fault slip partitioning

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Abstract

While significant advances have been made in the study of seismogenic processes on megathrusts in subduction zones, relatively little attention has been payed to crustal faults within the upper-plate overlying the megathrust interface. The reason for this is mainly because of the difficulty in identifying and characterizing the geomorphological expressions of active faults which have very low to low slip rates (1 – 4 mm/yr), as well as the lack of long-term seismic records which would help illuminate these active structures.
The Java subduction zone is a good example of this situation, where the historical seismic archives report a number of devastating earthquakes within the Java Island, suggesting the existence of active faults, but the precise source location and geometry of the active structures remains highly debatable. To better quantify the seismic hazard posed by individual crustal faults and fault systems in Java, it is critical that we develop methods that more precisely localize where and at what rate seismic strain energy is being accumulated.
In this study, we use Global Positioning System (GPS) observations to quantify the present day crustal deformation in Java. The GPS velocities reveal a homogeneous counterclockwise rotation of the Java Block independent of Sunda Block, consistent with a NE–SW convergence between the Australian Plate and southeast Asia. Our results show a N-S velocity gradient across the Baribis Thrust in West Java, suggesting that the Baribis Thrust is an active boundary accommodating the relative motion between the Australian Plate and Sunda Block. Our kinematic modelling shows that this convergence is partitioned between the Java Trench and a left-lateral structure extending E–W along Java with most of the convergence being accommodated by the Java megathrust, and a much smaller parallel motion accommodated along the Baribis ($\sim$5 $\pm$ 0.2 mm/yr) and Kendeng ($\sim$2.3 $\pm$ 0.7 mm/yr) Thrusts.

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