Plate coupling along the Manila subduction zone between Taiwan and northern Luzon

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Abstract

We use GPS data, trench parallel gravity anomaly (TPGA), and bathymetry to infer the plate coupling pattern along the Manila subduction zone. Our estimates show that the convergence rate between the Sunda Block and the Philippine Sea Plate decreases southward from 81 mm/yr at Batanes to 50 mm/yr north of Mindoro. Using a backslip dislocation model and a fault geometry constrained by seismicity, the inversion of GPS data reveals partially locked fault patches at latitudes 14°-16.5°N extending from the West Luzon Trough to the east of Scarborough Seamount chain. The backslip rate in this region is in the range of 20~25 mm/yr corresponding to a coupling ratio of 0.3. Aseismic sip is predominately at latitudes 16.5°-18°N; while fault slip behavior is not well resolved offshore northern Luzon. Based on a good correlation between locations of large subduction zone earthquakes and areas possessing gravity low, we investigate a variety of TPGA-based plate coupling models assuming different scaling between TPGA values and plate coupling ratio. We find optimal models with the coupling ratio proportional to the cubic of TPGA values. Although the misfits from TPGA models are slightly larger than the GPS inversion result, these models provide satisfactory fits to GPS observation at latitudes 14°-16°N. The densification of GPS network at central Luzon in the future is crucial to distinguish the present best TPGA-based coupling models. Additionally, the low coupling fault patches near 15°-16.5°N may be associated with the subducted Scarborough Seamount wherein oceanic floor is highly fractured. The great subduction zone earthquake propagates beneath the Scarborough Seamount seems to be unlikely.