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Kinematic Modeling of Crustal Deformation in Kyushu Island Based on Inter-plate Coupling and Block Rotation

Satoshi Miura[1*], Kayo Miyao[1], Laura Wallace[2]

[1]RCPEV, Tohoku University, [2]GNS Science, New Zealand

Global positioning system (GPS) site velocities and earthquake focal mechanisms reveal an active left-lateral shear zone cutting across Kyushu in southwest Japan. Surprisingly, no active faults have been identified in association with this zone of rapid contemporary deformation. To explain the existence of this shear zone, we proposed a model comprising subduction of an aseismic ridge (Kyushu-Palau Ridge) at the southwest end of the Nankai Trough. Because of rapid (~40 mm/yr) along-strike migration of the ridge, we suggest that the ridge subduction point (and resulting left-lateral shear zone) is never in one place long enough to enable the development of a through-going fault zone that can be identified at the ground surface, reconciling the mismatch between the GPS, seismological, and geological data in this region. Our conceptual model is supported by numerical modeling results. We also suggest that the along-strike change in subducting plate buoyancy explains the recent counterclockwise rotation of the Kyushu forearc documented in paleomagnetic studies, as is found in many other western Pacific subduction margins.

Keywords: plate coupling, block rotation, Kyushu Island, GPS, crustal deformation