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Potential for a very large earthquake along the southernmost Ryukyu subduction zone

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The Ryukyu Trench extends 2200 km southwestward from Kyushu, Japan to Taiwan. Along the Ryukyu Trench, the Philippine Sea Plate subducts beneath the Eurasian Plate at a rate of 80-85 mm/yr in a 300°-310° direction. Historically, the 24 April 1771 Yaeyama, Japan earthquake (Mw ∼8) broke the shallow portion of the southern Ryukyu subduction zone (124∼125.4°E) and generated a large tsunami with a maximum runup of 30 m on the Ishigaki Island. Seismicity over the past few decades shows frequent medium to large earthquakes occur adjacent to the southern flank of the Ryukyu Arc, while seismicity is absent between the Ryukyu Trench and the accretionary prism. If the pate interface at shallow depths is locked, the evaluation of potential earthquake rupture sources is important for seismic hazard assessments. We use continuous GPS data spanning the time period from 2005 to 2010 to infer the fault geometry and the slip-deficit rate on the southernmost Ryukyu subduction zone. Interseismic GPS data along the Hualien-Suao coast (NE Taiwan) shows a pattern of strain accumulation that is consistent with a potential future large shallow earthquake along the southernmost Ryukyu subduction zone. The measured shortening rate parallel to the Ryukyu Trench is 80 mm/yr, about twice of the shortening rate perpendicular to the Ryukyu Trench. We invert for slip-deficit rates and the geometric configuration of the plate interface. Our preferred fault model dips 10° northward and extends about 70 km from the Ryukyu Trench to a depth of 13 km. The slip-deficit rate exhibits a left-lateral motion of 78.3 mm/yr and a normal motion of 35.9 mm/yr on a 290°-trending fault. The slip rate budget of the southernmost Ryukyu subduction zone is close to the plate convergence rate, suggesting the plate interface is fully locked. Assessments of seismic hazard in this region need to consider the potential threat from Mw 7.5∼8.7 tsunami earthquakes generated by shallow ruptures.