Tectonic motion of the Ryukyu Arc, southwest Japan inferred from GPS velocity field and earthquake mechanism

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Ryukyu Arc is a NE-SW trending islands arc connecting Taiwan and Kyushu, southwest Japan. At its southeastern boundary, the Ryukyu Trench, the Philippine Sea plate subducts at a rate of 6-8cm/yr. Japanese nationwide continuous GPS array has illustrated trenchward extrusion of the islands at a rate of 2cm/yr in the northeastern part and larger than 4cm/yr in the southwest. Tectonic movement of the Ryukyu Arc may be characterized by low plate coupling (loose constrain) at the Ryukyu Trench and backarc opening (or rifting) at the Okinawa Trough, the active backarc basin on the northwest. Though the movement of the Ryukyu Arc looks like a block motion rather than an internal elastic deformation, more details are not clear because GPS stations have been deployed nearly parallel to the Ryukyu Trench and the Okinawa Trough.

At first we divide the region into several blocks based on spatial variation of earthquake focal mechanism and GPS velocity field, and determine Euler vector of each block. As the first approximation, tectonic movement in this region can be reproduced by the motion of five blocks, with an average discrepancy of about 5mm/yr between the observed and predicted velocities. Second we introduce moment tensor solutions of shallow earthquakes and translate them into strain rates in order to quantify plate coupling at the Ryukyu Trench. Plate coupling estimated is about 30% off Kyushu, then steeply decreases to a few percent in the central (near Okinawa Island), and again increases up to about 50% east off Taiwan. However, velocity discrepancy between observation and prediction still remains even after taking the plate coupling into consideration. Current GPS and earthquake data strongly suggest a trenchward motion of the Ryukyu Arc, divided into several tectonic blocks and probably driven by the backarc opening at the Okinawa Trough, accompanying small internal deformation.