Analysis of crustal deformation and earthquake potential in Taiwan by block modeling and geodetic observations

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Abstract

Taiwan locates on the boundary between the Philippline Sea plate and the passive continental margin of the Eurasian plate and is one of the most active seismogenic regions in the world. In an attempt to evaluate the earthquake potential for large earthquakes, we characterize the kinematics of modern crustal deformation in Taiwan by computing tectonic block motions and fault slip rates of the active faults from GPS observations constrained by geologic slip rate, where our modeled slip rates are reconciled with the geologic slip rate observations. In order to discuss the influence of geologic constraints, we compare the geodetic long-term slip rates with the geologic slip rates. Substantially, our geologic slip rates are higher than geologic slip rates. This circumstance may be related to more earthquake cycles in geologic data than interseismic geodetic data. In our study area, some faults may be locked weakly and creeps in interseismic period, including Hsinhua Fault, Chishan Fault and Chihshang segment of Longitudinal Valley Fault. We test different initial values of coupling coefficient to discuss how creep are these faults in interseismic period, and set the best-fitting value in our model. For characterizing regional tectonics, we separate Taiwan into four sub-regions to exhibit distinct tectonic behavior, which are southwestern, central, northern and eastern Taiwan. In southwestern Taiwan, where an obvious southwestward extrusion was observed. Our model suggests two major domains based on their different principal strain rate, one is the deforming domain with larger strain rates with a major clockwise rotation, another is a quasi-rigid block domain with counterclockwise rotation. This result is coincided with previous geodetic studies. The central Taiwan is characterized by a clockwise block rotation with overall slip deficit rates of about 3 mm/yr. In addition, the estimated long-term slip rates of 10 to 20 mm/yr in the foothills region of central and southwestern Taiwan are higher than that of the hanging wall region. In northern Taiwan, the fault slip rates

are relatively lower because of the waning of the plate motion. On the other hand, due to the ongoing collision of plate motion in eastern Taiwan, the long-term slip rates of the Longitudinal Valley region is highest in whole Taiwan. In our result, we estimate the earthquake potential is relatively higher in southwestern Taiwan and eastern Taiwan.

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