

Numerical modeling of crustal deformation in the northeastern Taiwan collision area

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Stress and velocity fields in the northeastern Taiwan region were computed using 2D finite-element method.

The convergence between Philippine Sea plate and Eurasian plate in Taiwan drives collision at convergence rate of 80 mm/yr in a 306 degrees direction. East-west shortening generates large E-W horizontal compressional strain rate (2 micro-strain/yr) along the east coast of Taiwan. The subducted Philippine Sea plate collides to Eurasian plate at the depth from 20 km to 80 km beneath north of Hualien, northeast of Taiwan. The convergence induces most seismically active region. Depths of the earthquake clusters range from 0 to 30 km. Reverse-fault type events occur in the clusters. The horizontal compressional strain rate is about 0.1 micro-strain/yr or less at the north of Hualien in spite of seismically active region. One possible model is that deformation in the Philippine Sea plate may decrease the convergence rate at the convergence boundary. The stress and velocity field were reproduced using 2D finite element method to estimate the convergence rate at the boundary between Philippine Sea plate and Eurasian plate in northeastern Taiwan region.

The east-west cross-section, including Ryukyu arc, subducted Philippine Sea plate and Eurasian plate, is used in the model. The model based on seismic surveys. Young modulus has been set to 6×10^{10} at Philippine Sea plate and lower Eurasian plate and 3×10^{10} at Ryukyu arc and upper Eurasian plate. Since Ryukyu arc and underlying Philippine Sea plate may be partially coupled, width of coupling area (25 - 100 km) and coupling rate (0.0 - 1.0) between Ryukyu arc and Philippine Sea plate were changed. The convergence rate between Philippine Sea plate and Eurasian plate was changed between 1.0 cm/yr and 6.0cm/yr.

The computed stress and velocity fields were similar to the observed ones when convergence rate was 1cm/yr, width of coupling area was 25 km, and coupling rate was 50-100%. In this model, computed horizontal velocity was 1cm/yr or less at the northeast of Taiwan. The computed stress was compressional in the upper and lower crust of northeast Taiwan and extension stress was dominant in the Ryukyu arc.

Estimated convergent rate is 1cm/yr at the plate boundary in the northeastern Taiwan. This suggests that intra-plate deformation plays an important role in the convergence of northeastern Taiwan region. It would provide a basis for understanding the occurrence of future large earthquake in Taiwan.