Estimation of plate convergent rates in the Philippines-eastern Indonesia deformation zone from GPS results

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Westward motion of the Philippine Sea plate (PH) against the Sundaland plate (SU), estimated as large as 10cm/yr, has caused a diffuse Philippines-eastern Indonesia deformation zone with an approximate size of 300km x 2000km. Because of multiple subductions at several trenches surrounding the region and internal deformation related to active faults, very complex deformation field has been formed. We conducted annual GPS campaign measurements in the period from 1997 to 2003 in which 8-16 sites were occupied for one to two weeks, including small islands on the Molucca Sea between Mindanao, the Philippines and Sulawesi, Indonesia. In estimating site displacement rates, we corrected coseismic jumps due to the occurrence of earthquakes nearby. We evaluated coseismic displacements for major earthquakes using seismic moment and focal mechanism on the Harvard CMT catalog and corrected them when they exceeded 1mm. Site displacement rates thus estimated were converted to those in a SU-fixed reference frame using REVEL (Sella et al., 2002).

As the first approximation we estimate plate convergent rataes at the trenches assuming that relative displacement rate between two GPS sites may result from plate convergence at the boundary located between two sites. In western off the Philippines, convergence rates decrease from north toward south such as 6.2cm/yr, 3.7cm/yr, and 2.5cm/yr at the Manila Trench, Negros Trench, and Cotabat Trench, respectively. In eastern off the Philippines, on the other hand, convergence rates increase from 4.0cm/yr at the northern Philippine Trench to 6.2cm/yr at the central part. Southern Philippine Trench seems linked to the Molucca Sea and our estimate shows that convergent plate motion in the southern part is mostly taken up at the Molucca Sea .

Since current distribution of GPS sites is quite sparse, we use strain rate distribution from global strain rate map (Kreemer et al., 2003). In this model rotation rate of a tectonic block and strain magnitude within the block are mostly constrained by horizontal GPS velocities while the style and direction of strain field are inferred from seismic moment tensors. This model shows that the Philippines-eastern Indonesia deformation zone is generally under compression in E-W direction and areas of the largest copmression of 3-5x10^{-7}/yr are recognized at the Manila Trench and on the Molucca Sea. The GPS results are very consistent with the strain rate field. We should propel such an attempt to derive directrly comparable physical parameters from different kinds of observables such as GPS velocities and seismic moment tensors in the region where coverage of geopysical observations is still poor.