Creep characteristics along the central part of the Philippines Fault on Leyte Island from ALOS-2 time-series analysis

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Observations reveal that slip characteristic varies on sections of active faults. Some sections of the fault may be seismically locked whereas other sections may exhibit creep. Thus, it is usually difficult to characterize these faults with a single slip rate. Analyzing the slip distributions along the active faults allows creating better fault models for the region and developing earthquake disaster mitigation measures more accurately.

Detection and detailed analysis of creeping faults on land have been progressing successfully thanks to the increased number of observations from synthetic aperture radar interferometry (InSAR). Here, we present results of surface creep rates along the central part of the Philippines Fault on Leyte Island using ALOS-2/PALSAR-2 descending data sets acquired between March 2016 and December 2021. A total of 31 interferograms created by the RINC software were analyzed using the small baseline subset algorithm for InSAR time series analysis (DeNTiS). Radar observation geometry of the descending path was favorable for the northwest-southeast oriented left-lateral strike-slip fault to be able to measure the displacements along the fault direction. The study area is highly vegetated, and this led to decorrelation in the InSAR signal. We solved the decorrelation problem by increasing the multi-look to reduce phase noise. Ionospheric and tropospheric delays also contribute as noise in the deformation. We applied a quadratic ramp along with a topography-dependent term to suppress the noises caused by the ionosphere and topographic phase.

We estimated fault creep rates by using the velocity offsets between the sides of the fault, assuming only left-lateral motion. Our result indicates creep rates between 22-99 mm/year with a mean of 34±5 mm/year along the fault which is very similar to Fukushima et al. (2019) where they inferred a creep rate of 33±11 mm/year by using the ALOS/PALSAR data obtained between October 2006 and January 2011. Our result also compares well with other previous studies using GNSS 26±10 mm/year (Duquesnoy et al. 1994), 36±0.2 mm/year (Bacolcol 2003), and alignment arrays 21-27 mm/year (Tsutsumi et al. 2016). The anomalously high creep rate in the northwest part of the study region was an artifact mainly due to the coseismic slip of the Ormoc earthquake that occurred on 6 July 2017. In the next observation period of 336 days in the InSAR time series (between 15 July 2017 and 16 June 2018), the afterslip of this earthquake is still apparent on the line-of-sight displacement map. However, due to low temporal resolution, it is hard to be certain how long the afterslip continued after the earthquake.

Keywords: Philippines Fault, Leyte Island, crustal deformation, fault creep, InSAR