Postseismic deformation unveiled by InSAR observation

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Introduction

SAR data have successfully mapped the spatially detailed coseismic crustal deformation associated with the 2016 Kumamoto earthquake with its high spatial resolution. SAR observation have been conducted after the earthquake continuously, thus we expect to map the spatial distribution and its temporal deformation on the postseismic deformation in more detail. In this study, we report the postseismic deformation derived from InSAR analysis.

Analysis and Data

We conducted InSAR analysis to map the postseismic deformation by mainly using ALOS-2 data acquired after the Kumamoto earthquake. Here we used ascending orbit data (path 131) and descending orbit data (path 23). Further, we converted the two LOS displacement data to quasi-vertical and –east-west components using a data pair with a small difference on acquisition date.

InSAR-derived postseismic deformation

We successfully mapped widely and locally distributed postseismic deformation in and around the Futagawa fault zone and the Hinagu fault zone. First, we found widely distributed postseismic deformation in the ascending orbit data, which shows line-of-sight (LOS) shortening and lengthening signals in the east and west of the Futagawa fault, respectively. By contrast, in the descending orbit data, corresponding broad signals cannot be identified. To clarify the displacement components, we converted the LOS displacements to quasi-vertical and –east-west components. The results show that westward movement and uplift can be recognized in and around the east Futagawa fault (Futagawa segment), whereas eastward movement and subsidence can be recognized in and around the western part (Uto segment). Of note, no ground displacement suggesting dislocation of fault can be recognized in the Futagawa fault. If an afterslip occurred on the Futagawa fault, a right-lateral with a normal slip motion should be observed around the Futagawa fault across which eastward/upward and westward/downward ground movements should be observed on the hanging wall and foot wall, respectively. It implies that viscoelastic deformation contributes to the ground deformation. In this context, we computed the viscoelastic deformation by three-dimension finite element method. The computation results reproduce the observed spatial pattern of the postseismic deformation well.

In addition to the broad deformation, InSAR unveiled several interesting local postseismic deformation. One of them is a displacement discontinuities (highly-deformed zone) along the Takano-Shirahata segment of the Hinagu fault and the west of the Futagawa segment. Further, it is noted that we can identified small but clear displacement discontinuities (highly-deformed zone) along the south of Hinagu segment of the Hinagu fault where no significant coseismic slip occurred. It strongly suggests that an afterslip occurred at shallow level. These discontinuities almost run on the previously known fault traces. We further identified clear postseismic deformation on the hanging wall of the Idenokuchi fault, where subsidence exceeding 10 cm is observed.

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Keywords: InSAR, Kumamoto earthquake, Postseismic deformation, Viscoelastic deformation

