What controlled the fault ruptures in the final stage?: A comparison of SAR-derived fault slips with gravity-inferred density structures for the 2016 Kumamoto earthquake in Japan

#Tomokazu Kobayashi[1], Koji Matsuo[1], Ryosuke Ando[2], and Takayuki Nakano[1]
(1. Geospatial Information Authority of Japan, 2. University of Tokyo)

The purpose of this study is to clarify what kind of characteristic crustal structure exists at and around the terminus of fault rupture, and is to discuss what possibly controls fault ruptures in the final stage. For the purpose, we here explored the spatial relationship between the SAR-derived crustal deformation and the crustal structure inferred by gravity. The target seismic event is the 2016 Kumamoto earthquake in Japan.

First, we conducted InSAR analysis using ALOS-2 SAR data to obtain the crustal deformation over the source region including nearby the faults. In addition to standard InSAR, we applied a split-bandwidth interferometry (SBI) method to range and azimuth components; in particular, SBI for azimuth is often called MAI. Thanks to the SBI techniques, we successfully mapped spatially detailed displacements not only in far field but also in near field where a standard InSAR cannot work well to measure displacements due to large displacement gradients. We finally estimated the full 3D displacement field by a least squares method, using the derived displacements with multiple view angles. Next, we analyzed gravity data. For the analysis, we conducted campaign gravity observations in and around the bifurcated fault rupture area, and inverted the campaign data and pre-existing gravity data to estimate the density structure under the ground.

The estimated density structure shows that a wedge-shaped low-density body exists at the shallow part (~1-2 km in depth) in the western part of Aso caldera. The striking point is that the bifurcated faults inferred by SAR are located along the side of the low-density body. It may suggest that the fault ruptures propagated along some physical boundary featured by the anomalous density structure. Further, the rupture terminus almost overlaps the low-density body, maybe suggesting that there exists some ductile material that terminates brittle ruptures caused by high temperatures and/or partial melt.

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